MINISTERUL AGRICULTURII, PĂDURILOR ŞI DEZVOLTĂRII RURALE
ACADEMIA DE ŞTIINŢE AGRICOLE ŞI SILVICE
„Gheorghe Ionescu-Şişeşti"

LUCRĂRI ŞTIINŢIFICE

ANALE

INSTITUTUL DE CERCETARE - DEZVOLTARE PENTRU CARTOF ŞI SFECLĂ DE ZAHĂR

Vol. XXXI

PROCEEDINGS OF EAPR AGRONOMY SECTION MEETING
MAMAIA, ROMANIA
JUNE 23 - 27th 2004

BRAŞOV 2004

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CUPRINS

CONTENT

NOTĂ

Acest volum cuprinde lucrările prezentate la Simpozionul Internațional privind **"Dezvoltarea producerii cartofului în zona central și est-europeană"**, organizat la Mamaia/Constanța, România, în perioda 23-27 iunie 2004, de către Institutul de Cercetare-Dezvoltare pentru Cartof și Sfeclă de Zahăr (ICDCSZ) Brașov, România și de Secția de Agronomie a Asociației Europene pentru Cercetarea Cartofului (EAPR), cu sediul la Wageningen, Olanda.

Folosind modul rapid, on-line, de comunicare, autorii și-au asumat responsabilitatea redactării lucrărilor într-o formă finală.

Conform hotărârii comitetului de redactare, ordinea publicării lucrărilor în acest volum a fost următoarea: genetică și ameliorare, înmulțirea rapidă și producerea cartofului pentru sămânță, tehnologia cartofului, economie și marketing.

Mulțumim conducerii Ministerului Educație și Cercetării și conducerii Institutului de Cercetare-Dezvoltare pentru Cartof și Sfeclă de Zahăr Brașov pentru sprijinul logistic și financiar acordat.

Mulțumim tuturor participanților pentru contribuția științifică.

De asemenea, dorim să mulțumim dlui prof.dr. Enrique Ritter – președinte în funcțiune al EAPR și dlui prof. Fernando MARTINS – președintele Secției de Agronomie a EAPR pentru sprijinul acordat în organizarea și desfășurarea acestui simpozion științific.

NOTE

This volume comprises the papers sustained at the International Symposium on **"Development of potato crop in Central and East-European countries"**, organized at Mamaia, Romania, on June 23-27th by Research and Development Institute for Potato and Sugar Beet (ICDCSZ) Brașov, Romania, and the Agronomy Section of European Association for Potato Research, Wageningen, The Netherlands.

Using the most rapid way of communication (on-line), the authors have assumed the responsibility of the final version of papers.

According to the decision of editors board, the succession of papers in this volume is the following: genetics and breeding, rapid multiplication and seed potato production, potato technology, economy and marketing.

We gratefully acknowledge the logistic and financial help of Romanian Ministry of Education and Research, as well as of Research and Development Institute for Potato and Sugar Beet Brașov.

We thank all the participants for their scientific contribution.

We also wish to express our thanks to prof.dr. Enrique RITTER – president of EAPR and to prof.dr. Fernando MARTINS – chairman of Agronomy Section of EAPR for their great support in organizing and carrying on this scientific meeting.

Dr.ing Constantin DRAICA

Președintele Comitetului Local de Organizare a Simpozionului și coordonatorul acestui volum / President of Local Organizing Committee and coordinator of this volume.

RESEARCH AND DEVELOPMENT PRIORITIES IN POTATO FIELD WITH A VIEW TO THE SUSTAINABLE DEVELOPMENT OF ROMANIAN AGRICULTURE

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SUMMARY

In relation to the process of applying the principles of sustainable agriculture in Romania a logical sequence of the current components of the agricultural system is presented for the potato crop; the limiting factors, development sectors, short and long term aims for designing priorities for research and development.

The perspective of the European integration of Romania and the complexity of this process, the need for the reorganization and restructuring of the research-development activity (especially in producing material from superior biological categories on the basis of Romanian varieties) impose a new approach in the management activities at the Institute for Research and Development for Potato and Sugar Beet (ICDCSZ) Brasov.

Key words: *sustainable agriculture, priorities, integration, research & development strategies*

INTRODUCTION

Nowadays mankind is confronted with three major issues generating conflict and concern: demographic growth, the limiting of food resource, pollution and degradation of the environment (Picu and Sin, 2001; Olteanu et al., 2001). Agriculture is able to and must intervene in solving these major issues. Modern agriculture sets as its main objective the continuous improvement of the production process (Chiru and Olteanu, 2004). Only by up-dating concepts and methods in research and agriculture practice this can be attained (Olteanu et al., 1989; Olteanu and Dudui, 1997).

The concept of sustainability has a universal validity and applies in all human, sociological, economical and technological activity. Related to agriculture, *"the term sustainable agriculture means an integrated system of plant and animal production practices having a site-specific application that will, over the long term: a) satisfy human food and fiber needs; b) enhance environmental quality and the natural resource base upon which the agricultural economy depends; c) make the most efficient use of nonrenewable resources and on-farm resources and integrate, where appropriate, natural biological cycles and controls; d) sustain the economic*

viability of farm operations; and e) enhance the quality of life for farmers and society as a whole." (US Congress Public Law 101-624, Title XVI, Subtitle A, Section 1683, Government Printing Office, Washington, D.C., NAL KF 1692.831 1990)

Sustainable agriculture components include the use of resistant and/or tolerant varieties; zoning, structure and crop rotation; soil and mineral nutrition management; control of pollution and waste; integrated control of competing organisms (diseases, pests and weeds); precision management of the farm.

Moving from a conventional agriculture towards an alternative sustainable agriculture represents a progressive transition implying knowledge, monitoring, systems perspective, management and coordination of processes involved by applying principles of precision sustainable agriculture.

THE IMPORTANCE OF POTATO CROP

Potato crop is one of the most intensive crops. Production performance is in accordance with the level of management dedicated. Technological input costs are high (over 100 mil. Lei/ ha) but the profit is one of the highest in comparison with other crops. The high degree of natural, technological, economical and social resources involved generate complex environmental problems. Thus, the potato crop gets al the attention from agricultural systems seeking sustainability.

Due to its chemical composition, potato is considered to be a main, almost complete dietetic and easily digestible food. Its usage is extremely diverse, from the consumption of the fresh potato (extra-early, summer, autumn-winter), forager, to the processed potato (frozen, dried, chips, fries, flakes etc.), industrially processed (starch, alcohol) and seed potato.

Although it covers less than 5% of the areas cultivated with alimentary cereals (corn, wheat and rice), the world potato yield (over 310 mil. tons) represents more than 25% of the three yields. Therefore potato has a special nutritional importance on a world scale, ranking 4th after corn, wheat and rice or 2nd after cereals, and rightfully considered the second bread of mankind.

EVOLUTION OF AREAS AND MEDIUM YIELD

The evolution of areas and medium yield for potato in Romania and the EU over the last years is presented in figure 1.

The tendency to continuously decrease cultivated area along with the increase of medium yield (35 t/ha) is noticed in the EU. In Romania, during the last few years, the area oscillated between 250 000 and 300 000 ha, with a medium yield of 12-14 t/ha.

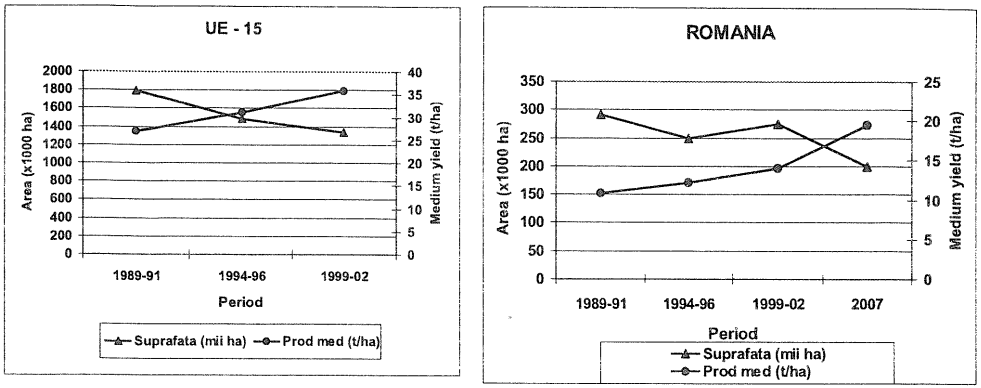

Figure 1 - Trends in the evolution of potato area and yield in EU and Romania

In order to accomplish the MAPDR strategy for potato crop (which foresees for 2007 an area stabilization of 200 000 ha with a medium yield of 19.5 t/ha and a total yield of 3.9 mil. tons), in accordance with the EU integration of our country, it is necessary for the potato cultivated area to significantly decrease, through yield concentration and specialization. Only the producers that can compete with the EU producers will survive on the market. This will not lead to the total yield decrease but to the concentration of yield into large agricultural exploitations with the means for community funds absorption and up-to-date technology acquisition. A strong increase of the medium yield is hoped to affirm Romania as a potato seed, early potato (for both internal consumption and export), autumn-winter potato and potato for industrial processing producer.

Limiting Factors

The low yield obtained in Romania is due to multiple factors:

The reduced size of land areas, consequence of the fragmentation of land derived from the enactment of Law 18/1991 (Figure 2), do not allow the use of up-to-date technologies on a large productivity mechanized system (Draica, 2003);

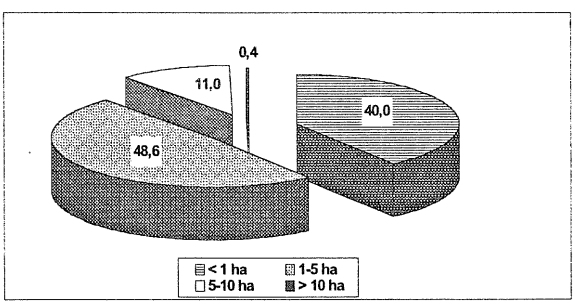

Figure 2 - Percentage of farms (size area)

➢ The improper sanitary quality of planting material used in the last years. The supply of only 1-5% (50.000 t) of the country necessary amount (850.000 t) with certificated material (Prebase, Base, Certificated A and Certificated B) while the rest of

the seed material is uncertificated, coming from the farmer's own yield or from exchanges between farmers. Figure 3 presents the relation between the consumption of certified seed an the medium yield in Europe.

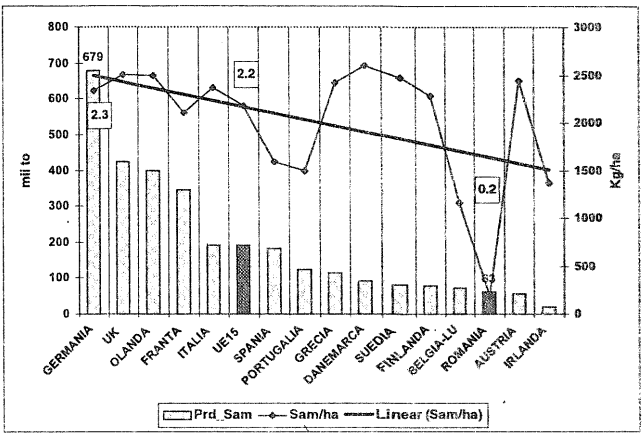

Figure 3 - Medium yield (to/ha) related to the certificated seed consumption (Kg/ha) in EU15 and ROMANIA (1998-2002) (From FAO)

- The low level of professional education and training of most potato growers.
- The lack of financial sources for farmers to apply proper technology (quality seed, good variety, effective machines); most farmers use a minimum of technology on the edge of subsistence.
- The climatic conditions of last few years (severe drought, Figure 4) have lead to the intensification of the hydrothermic stress and have imposed, as technological requirement, irrigation and the use of resistant and tolerant varieties, which the most potato growers couldn't apply for financial reasons.

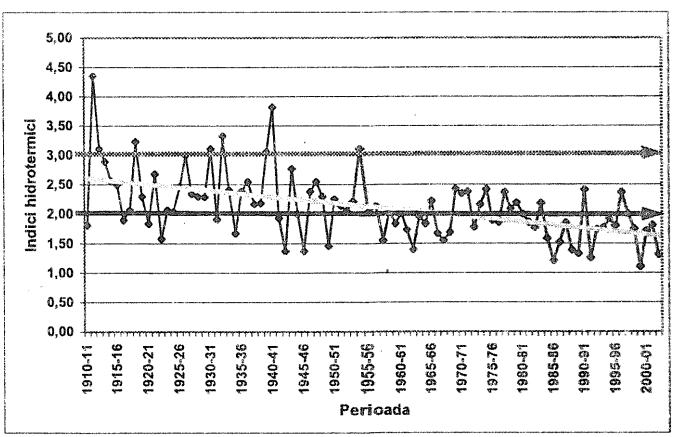

Figure 4 - Evaluation of hydrothermic index during vegetation period (april-october) Braşov (191011-2002/3)

MAIN OBJECTIVES FOR RESEARCH AND DEVELOPMENT

The Institute for Research and Development for Potato and Sugar Beet (ICDCSZ) Brasov was founded on June 1, 2002 in accordance with the law 290/29.05.2002 through the reorganization of the research and development activity in the former Institute for Potato Research and Production and the Station for Sugar Beet and Sweet Substances Research and Production Brasov.

ICDCSZ Brasov must take a well-defined position within the framework of Romanian agricultural research as an institution of national interest due to the strategic importance of the two crops: potato and sugar beet. Over the last few years the land area cultivated with potato in Romania was of 240 000-280 000 ha, with a medium yield of 12-14 t/ha - performance way below the average in EU countries (36-40 t/ha). The main cause responsible for this situation is the low sanitary quality of the seed planted by the large majority of the small potato growers that make a total of 90% of the whole cultivated area.

The main research and development directions at ICDCSZ Brasov, which were periodically reconsidered in their specificity and importance, can be summarized by the following objectives:

- Breeding of new potato varieties with valuable agronomic traits, adapted to ecological conditions of Romania, using classical or unconventional methods
- Seed potato production of high biological classes (prebase and base) for ensuring the Romanian necessary amount
- Drawing up modern technologies in potato crop, with low input, less harmful to the environment and generating benefits for different categories of growers;
- Drawing up methods of forecast and warning against the main pests and diseases in order to achieve an integrated protection system
- Turning into account the production by a suitable marketing
- Establishment of physiological bases for crop growth
- Transfer and extension of the results acquired through research and development activities.

1. Breeding new potato varieties

One of the priority aims of the ICDCSZ Brasov and of the specialized research stations is breeding new potato varieties mainly defined by high productivity, constant quality in time and space and good adaptability to the climatic and soil conditions of Romania.

The Romanian official crop varieties catalogue for 2003 (pp. 34-35) records 73 potato varieties, 42 of them being Romanian varieties. At this point the situation is satisfying but becomes critical when we analyze the percentages of Romanian varieties from the total land areas cultivated in 2001-2002 (Figure 5).

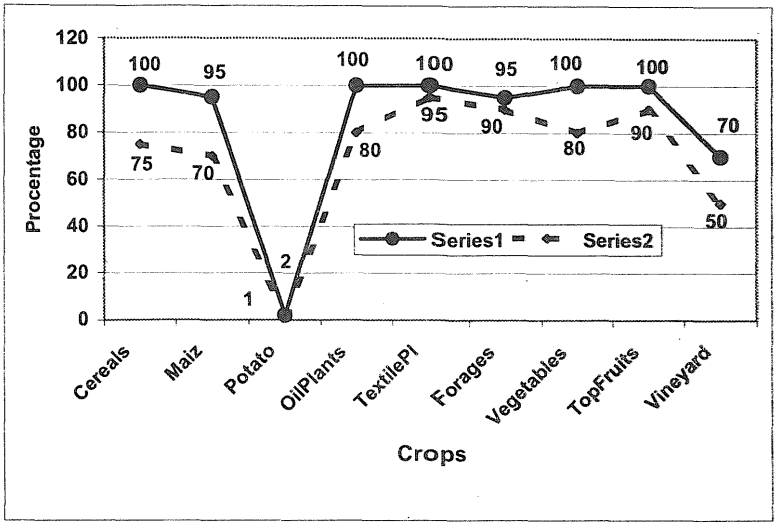

Figure 5 - Area percentage of romanian varieties

With a percentage of 1-2% (2 700-5 400 ha) from the cultivated area of Romania (approximately 270 000 ha) the Romanian potato varieties were practically absent. The main varieties cultivated in 2002 were Sante (36%), Desiree (31%) and Ostara (11%), varieties grown for over 20 years. We have to notice here that during 1978-1985 Romanian varieties (Semenic, Colina, Sucevita, Super) were grown on 40% of the potato cultivated area in Romania.

For the efficient capitalization of the investment of work volume, mind resource and funds allocated by the state for financing Romanian varieties breeding activities, and for getting over the current insignificant presence of Romanian potato varieties in the potato crop, the following recovery and development measures are imperative. We have grouped them into two types of strategies:

1.1. Short term strategy (2004-2012)

➢ Choosing 6-9 Romanian varieties, more resistant to drought and temperature stress (AMELIA, CHRISTIAN, ROCLAS, DACIA, REDSEC, TENTANT, PRODUCTIV, MAGIC, ASTRAL) which will be promoted with precedence by a coherent market policy based on good seed quality, variety-specific technology and proper marketing (2004)

➢ Drawing up a list of "Recommended potato varieties" on the basis of the results obtained in Romanian research (2004)

➢ Warning the potato growers against the major risks of importing potato varieties susceptible to quarantine diseases (2004)

➢ Reaching again, within the framework of the breeding program, of the minimun threshold of 100 000 generative seedlings (2004-2006)

➢ Realistic application of conventional and non-conventional breeding methods, according to the current level of facility supply of the institute and affiliated agricultural stations (2004-2012)

1.2. Long-term strategy 2004-2020

➢ Continuation of breeding programs by dynamic reconsideration of breeding objectives and joining traditional aims (yield of 40-60 t/ha, resistance to pests and diseases) with special aims of breeding for the different uses of potato (for industrial processing: changed starch structure, higher protein content);

➢ Drawing the interest of seed potato production companies in order to grant the breeding programs

➢ Promoting contracts with private farmers ("hobby breeders")

➢ Breeding programs shared (through fair collaboration contracts offering economic advantage for Romania) with renowned potato breeding companies from Holland, Belgium, Germany, The UK, Czech Republic;

➢ Determining of new germplasm sources by testing the world's most valuable potato creations in the fields of the Institute and of the affiliated research stations

➢ Breeding of potato varieties suited for sustainable agriculture with resistance to hydro-thermic stress

➢ Rapidly promoting the technology of potato production by true potato seed (TPS) that can revolutionize potato crop with low input

➢ The profit obtained by the Institute through a rational promotion & marketing policy of the Romanian varieties (for both the national and international market) will insure the basis for approaching new breeding methods and techniques (genetic manipulation of the germplasm) (Directive 2003/90/EC)

2. Seed potato production

This activity represented the main aim of research and development from the start and presented decisive implications for the independence of the Romanian agricultural policy with direct social implications.

Over the last 15 years a shift from the state seed potato production to the private production occurred. However, it is considered that for the present and for the future of the seed material production system the presence of a strong public sector (alongside the private one) is needed to ensure stability on the market, eliminating centrifugal tendencies.

Potato cultivated land areas decreased dramatically in our country after 1990 when, through the enactment of the Law of landholding no. 18/1991 a radical change in the structure of agricultural land property occurred. This had repercussions on the national seed potato production system through the continuous reducing of land areas.

Thus, from 12 000 ha grown with seed potato from superior biologic categories (Prebase and Base) in 1990 the area decreased to 1 650 ha in 1998, to 1 860 ha in 1999, to 1 315 ha in 2000, to 1 100 ha in 2001, to 553 ha in 2002 and to 398 ha in 2003 (Source: FCCR)

Seed potato from the following biological classes: Prebase; Base (class SE and E); Certificated (class A and class B) was grown on 5 642 ha in 1998, on 4 945 ha in 2000, on 3 353 ha in 2002 and in 2003 reached 2 810 ha, 50% of it being certified B seed (1 383 ha) to be used only for commercial crops (source: FCCR).

The variety structure analysis, performed on the basis of the all-categories seed growers replication declarations, in 2003 (Table 1) shows that from the 44 varieties grown, 8 are Romanian varieties covering 7.7% of the area; this percentage is due to the presence of the Redsec variety (7%) from SCDC Tg. Secuiesc, while the other 7 Romanian varieties cover only 0.7% of the given area.

Small areas authorized producers do not ensure the isolation distance of seed crops from the viruses infection sources (potato for consumption, aphids wintering spaces) and do not follow strictly the seed potato production technology, this leading to a large percentage of rejected or declassed areas (46% in 1998, 32% in 1999, 35% in 2000, 41%in 2002) (source: FCCR).

Due to the clearing of customs tax for seed potato from superior biologic categories (Base and Prebase) coming from EU countries (OUG. No. 124/2000) an annual quota of 3 500 - 4 000 t from different varieties was imported by private authorized producers, summing up a value of 2.7 mil. Euro.

The amount of certificated seed produced in Romania over the last few years did nor reached more than 5% of the total needs, when for potato the biologic and sanitary quality of planting material and the variety influence yield level and quality up to 50%.

Summing up exposed data it can be asserted that today the seed potato production in Romania is precarious, the situation being on the edge of generating major problems for potato crop in our country, and an import need for annual seeding material up to 100 mil. Euro.

For redressing this sector we propose the following measures:

2.1. Short-term strategy (2004-2012)

- Urgent reconsideration and reorganization of "closed areas" for seed potato production of high biological classes (Prebase and Base) by micro-zones with strictly applied technological operations.
- Nomination of producers of Prebase and Base and their variety structure.
- Re-organization of seed potato multiplication in micro-zones beyond the closed zones and the periodical renewal of planting material
- Application of virus elimination methods in micro-zones within and outside "closed areas"

Development of a specific program of redressing and strengthening seed potato production, starting with 3-4 Romanian varieties (Roclas, Christian, Dacia, Redsec) benefiting from priority promotion and reaching by the end of the program a percentage of 30% of the Romanian potato grown areas and 3-4 foreign varieties (Ostara, Desiree, Sante şi Romano) required by Romanian market.

Table 1

Declaratin of certificated seed potato area (ha) - 2003

COUNTY VARIETY	Botoşani	Bacău	Braşov	Covasna	Harghita	Iaşi	Neamţ	Suceava	Total
AGATA	-	-	22,0	27,0	9,0	-	2,0	-	60,0
ALWARA	-	-	-	21,2	-	-	-	-	21,2
ARINDA	-	-	6,0	5,5	-	-	-	-	11,5
ASTERIX	-	-	5,0	11,0	-	-	-	-	16,0
BOLESTA	-	-	-	-	11,0	-	-	-	11,0
COLETTE	-	-	3,0	-	-	-	-	-	3,0
COSMOS	-	-	21,0	-	-	-	-	-	21,0
COLUMBUŞ	-	-	-	16,0	-	-	-	-	16,0
COVAL	-	-	-	1,0	-	-	-	-	1,0
DESIREE	-	5,0	77,5	15,0	126,0	64,0	68,0	162,0	517,5
FABULA	-	-	-	3,0	-	-	-	-	3,0
FARMER	-	-	58,0	-	-	-	-	-	58,0
FONTANE	-	-	-	2,0	-	-	-	-	2,0
HERMES	-	-	-	7,1	-	-	-	-	7,1
IMPALA	-	-	16,0	50,0	2,0	-	-	-	68,0
KARLENA	-	-	-	-	7,0	-	-	-	7,0
KONDOR	-	5,0	97,0	93,8	16,0	4,0	10,0	15,0	240,8
KURODA	-	-	-	3,0	-	-	-	-	3,0
LADY CLAIRE	-	-	-	2,0	-	-	-	-	2,0
LADY ROSETTA	-	-	5,0	24,0	20,0	-	-	-	49,0
LATONA	-	-	-	14,0	-	-	-	-	14,0
LAURA	-	-	18,5	3,0	-	-	-	-	21,5
LUIZA	-	-	-	1,0	-	-	-	-	1,0
MARKIES	-	-	-	2,0	-	-	-	-	2,0
MILENIUM	-	-	-	2,5	-	-	-	-	2,5
MINERVA	-	2,0	-	-	-	-	-	-	2,0
NEMERE	-	-	-	2,5	-	-	-	-	2,5
OSCAR	-	6,0	-	-	-	-	-	-	6,0
OSTARA	-	-	22,0	74,64	26,0	-	-	3,0	125,64
PRODUCTIV	-	-	-	1,5	-	-	-	-	1,5
REDSEC	26,0	40,0	39,0	13,5	-	-	44,0	35,0	197,5
ROCLAS	-	-	7,5	-	-	-	-	-	7,5
ROMANO	-	-	16,0	25,0	10,0	-	4,0	-	55,0
ROSARA	-	-	4,0	6,0	4,5	-	6,0	-	20,5
SANTANA	-	-	31,0	6,0	-	-	-	-	37,0
SANTE	9,0	13,0	400,5	49,6	370,8	-	44,0	219,0	1105,9
SATINA	-	-	3,0	-	-	-	-	-	3,0
SATURNA	-	-	-	9,0	-	-	-	-	9,0
SIGNAL	-	-	-	-	1,0	-	-	-	1,0
SOLARA	-	-	5,5	-	-	-	-	-	5,5
SUCEVIŢA	-	-	-	-	-	-	-	2,0	2,0
TIMATE	-	-	2,5	-	-	-	-	-	2,5
TOMENSA	-	-	7,0	13,0	38,0	-	-	7,0	65,0
VINETA	-	-	3,0	-	-	-	-	-	3,0
TOTAL	35,0	71,0	870,0	504,84	641,3	68,0	178,0	442,0	2810,14

** FROM: FCCR*

With the current facilities of ICDCSZ Brasov 3-4 Romanian varieties can be developed within the volume and structure presented in figure 6. This is the classical traditional scheme of clones replication on high altitude (with centers at Lazarea, Pauleni, Apa Rosie and Lucina) improved with micropropagation elements.

Figura 6 - Propunere de schemă clasică îmbunătățită de producere a cartofului pentru sămânță soiuri românești (3-4)

ANUL			
I	2004	15.000 plantule → Seră → 30.000 minitub.	
		5.000 microtub. → Seră → 25.000 minitub.	
		TOTAL	**55.000 minitub.**
II	2005	1ha*	clone A (Lăzarea)
III	2206	5 ha*	clone B (Lăzarea)
IV	2007	25 ha*	clone C (Lăzarea, Păuleni, Apa Roşie)
V	2008	125 ha*	clone D (Braşov, Tg. Secuiesc, Mc. Ciuc)
VI	2009	625 ha*	BSE (Braşov, Tg. Secuiesc, Mc. Ciuc)
VII	2010	3125 ha*	SE (PRODUCĂTORI AUTORIZAȚI)
VIII	2011	15625 ha*	E (PRODUCĂTORI AUTORIZAȚI)
IX	2012	40000 ha	Certificată A

*producție previzibilă de 15 t/ha

Until proper facilities acquisition the improved classical scheme for seed potato production will not be abandoned.

By obtaining better facilities the time of obtaining areas of 40 000 ha can b reduced to a half. The same thing can be possible by contracting a collaboration with Codlea Greenhouses (Sere Codlea)

➢ Bringing the seeding material produced at ICDCSZ into the sanitary quality parameters compatible with EU requirements (EU Council Directives no. 70/458/2000 and 55/2002) and regaining growers trust into the "brand" ICDCSZ Brasov

➢ Cooperation with the following stations: SCDC Tg Secuiesc, SCDC Miercutea Ciuc and SCDC Suceava on economical basis by signing clear commercial contracts, both ways profitable, mentioning ICDCSZ Brasov as head of the system (clone material, Prebase) and the stations as producers of high biological classes (Prebase, Base).

➢ Development, in co-operation with FCCR and MAPDR, of a selective system of licensing the seed producers, based on observing the biological class, the crop rotation and the isolation distances.

➢ Development, in co-operation with FCCR, of necessary actions in order that MAPDR subsidize the certified seed buying price, the full price of seed potato from higher biological classes, and the treatment of common and golden nematodes, Colorado beetle and aphids.

2.2. Long-term strategy (2004-2020)

➢ Acquiring proper facilities will make the shift to a new scheme of seed potato production, that would permit a reduction by 3-4 years of the necessary cycle of certified seed production (classes A and B).

➢ Drawing the interest of large areas (200-300 ha) private producers in pre-financing the activities of ICDCSZ and affiliated agricultural stations

➢ Development of new methods and techniques of planting material production compatible with those used in the EU

3. Technology and protection

The genetic potential of the potato varieties in conditions of proper sanitary quality of planting material can be expressed only by using up-to-date technologies with the protection of the environment and the cutting down of pollution.

Research in technology and protection will define one of the main directions for research and development at ICDCSZ and its affiliated stations, with clearly defined aims for each of the two crops.

For future development of this sector we propose the following actions:

3.1. Short-term strategy (2004-2012)

Ř Production and protection technology improvement in view of cost reduction and environment protection and adapting to the new machines system;

➢ Development of variety-specific technologies;

➢ Development of specific technologies for small companies (>90% of the grown area), including irigation technology;

➢ Potato crop technologies for mountain areas

➢ Up-dating of the blight attack forecast and warning model for potato

3.2. Long-term strategy (2004-2020)

➢ ICDCSZ and affiliated agricultural stations will develop an "Integrated crops and pests management" technological system fitted for sustainable and precision agriculture;

➢ Developing a technology for organic crops, based on varieties with genetical resistance and tolerance;

➢ Modernizing the technologies of potato production, storage and marketing;

➢ Development of some potato protection less polluting practices, cutting down to a minimum the use of synthesis pesticides.

4. The high capitalization of research and development results through proper management and marketing policy

In view of the expected European integration of Romania in 2007, a revolutionary change must be produced in the thinking and leadership of ICDCSZ Brasov. The entire

research and development activity must end in offering new products (varieties, seed, technology, animal products) able to penetrate specific market sectors and bring profit.

Development at ICDCSZ and its affiliated stations must look for implementing potato scientific research results; the existing farms must become pilot-farms from where the technological transfer towards producers should start.

Priority aims for development must design the plan for the recovery of Romanian varieties and for the production of proper sanitary quality high biological class seed (Prebase and Base)

Management policy will be supported by a thorough marketing study sustaining economically correct decision making. In order to achieve this goal we propose the following measures:

4.1. Short-term strategy (2004-2012)

- Management of turning into account the research results (technological sequences, rotations, cropping-systems)
- Recovering the internal market of potato (aiming at variety and planting material quality) by aggressively promoting the Romanian potato varieties
- Increasing the market quote for seed potato in Republic of Moldavia
- Advertising the Romanian varieties and the quality seed produced at ICDCSZ Braşov, SCDC Tg. Secuiesc, SCDC M. Ciuc şi SCDA Suceava

4.2. Long-term strategy (2004-2020)

- Penetration of the EU and CIS (former soviet countries) market of consumption early potatoes and of the seed potato market of some EU countries (e.g. Hungary) or Asian countries (China)
- Promoting several products with valuable quality traits, as potato variety with high protein content (> 4 %)
- Promoting technological packages (variety, quality seed, variety specific technology)

5. Internal and international cooperation

Internal and international cooperation will ensure a better capitalization of the scientific and human resource potential, offering the conditions for an active participation on the European market. This cooperation will be developed through the following actions:

5.1. Short-term strategy

- Development of cooperation with affiliated agricultural stations on an economic basis profitable for both partners, setting the ground for future scientific research coordination in different sectors
- Advisement of affiliated stations for accession to internal and international projects
- Strengthening of scientific relations with other research institutes and universities using ICDCSZ Brasov facilities

➢ Setting some economic agreements with the main seed potato producers in order to pre-finance the activities of the institute and affiliated stations

5.2. Long-term strategy

➢ Strengthening of scientific relations with other research institutes and stations from abroad

➢ Participation to competitions for international projects or initiated by EU, NATO, FAO

➢ Involvement in co-operation with foreign partners in the competition for „key projects" for Asian and African areas

➢ Determine new possibilities of co-operation after Romania accession to EU

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PRIORITĂȚI DE CERCETARE-DEZVOLTARE LA CULTURA CARTOFULUI ÎN PERSPECTIVA DEZVOLTĂRII DURABILE A AGRICULTURII ROMÂNIEI

Rezumat

În contextul creat de aplicarea principiilor dezvoltării durabile a agriculturii României sunt prezentate într-o succesiune logică componentele actuale ale sistemului agricol la cultura cartofului, factorii limitativi, direcțiile de dezvoltare şi stagiile pe termen scurt şi lung în vederea stabilirii priorităților de cercetare-dezvoltare.

Perspectiva integrării europene a României, complexitatea acestei acţiuni, necesitatea de a restructura şi reorganiza activitatea de cercetare-dezvoltare şi cu precădere a celei privind producerea materialului din categorii biologice superioare pe baza soiurilor româneşti impun o nouă abordare a ctivităţii de management la Institutul de Cercetare-Dezvoltare pentru Cartof şi Sfeclă de Zahăr Braşov.

Cuvinte cheie: agricultură durabilă, priorităţi, integrare, strategii de cercetare-dezvoltare.

Tabele:

1. Situaţia centralizatoare a declaraţiilor de producere a cartofului pentru sămânţă (2003)

Figuri:

1. Tendinţe în evoluţia suprafeţelor şi producţiilor de cartof în UE şi România
2. Procentul exploataţiilor după suprafaţă
3. Producţia medie de cartof (to/ha) în funcţie de consumul de sămânţă certificată (Kg/ha) în ţările UE15 şi în România (1998-2002)
4. Evoluţia indicilor hidrotermici în perioada de vegetaţie (intervalul aprilie-octombrie) Braşov (1910/11 – 2002/03)
5. Ponderea creaţiilor româneşti din totalul suprafeţelor cultivate (2001-2003)
6. Propunere de schemă clasică îmbunătăţită de producere a cartofului pentru sămânţă soiuri româneşti (3-4)

IDENTIFICATION OF WATER STRESS RESPONSE GENES

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SUMMARY

In respond to water deficit stress plants experience changes in gene expression. To gain a better understanding of the genes that provide drought resistance in potato, their expression has been analysed with microarray and cDNA-AFLP methods. These techniques allow to identify genes expressed in response to water stress deficit. We used water stress resistant and susceptible material from different *Solanum* wild species, as well as controls. Microarray analysis revealed several transcripts, which are involved in stress reactions and senescence. Comparative analysis of expressions patterns of stressed *vs.* non-stressed genotypes by cDNA-AFLP technique suggests that progressive drought treatment displays a differential level of gene expression. We observed polimorphisms related to water stress conditions based on the presence/absence of a transcript as well as on their intensity. Future experiments using microarrays, cDNA-AFLP and others gene discovery techniques will be performed in order to give a broad answers to the cellular plant response under water stress

Keywords: water stress, Solanum, expression analysis, microarrays, cDNA-AFLP.

INTRODUCTION

Plant cellular water deficit may occur under reduced soil water content and cause osmotic stress and dramatically limits plant growth and crop productivity (Boyer, 1982). Under these conditions, the plant responds regulating specifically gene expression. Changes in gene expression are induced by complex transduction signals that have not been clearly established. The molecular basis involved in tolerance to water stress is still far from being completely understood (Ingram & Bartels, 1996).

Within the frame of the UE R&D project APOPHYS (QLK5-CT-2002-01849) NEIKER wants to identify genes which provide drought resistance in potato. Molecular markers derived from such genes could be applied in marker assisted selection (MAS) for breeding potato varieties which are highly drought resistant.

To provide insights into physiological and biochemical changes associated with water stress, *Solanum* genotypes characterized previously as water stress resistant and susceptible materials were submitted to water stress. Water stress resistant material includes genotypes from different *Solanum* wild species such as: BER 3607, GND 2423, IFD 1704, LPH 27215, PLT 53650, SCT 18315, SPL959, and the susceptible

material includes the genotypes: BLB 8008, CPH 18325, VNT 8239, PCS 2877, DDS 2880, MRN 2278, PTA 15442 as well as the controls: DESIREE, SH, RH, BST7986.

Genome-wide expression analysis is a powerful and valuable tool for studying changes in gene expression that occur in response to water deficit conditions. Two different molecular techniques based on expression analysis have been used for this purpose: microarray analysis and cDNA-AFLP.

Microarray analysis provides a powerful method for differential screening of many genes at the same time. The challenge is to determine which genes occur specifically due to plant adaptation to conditions of reduced soil water content. We used a microarray containing 10000 cDNAs provided by the Institute for Genomic Research (TIGR - www.tigr.org/), and analyzed changes in gene expression within the whole genome of potato applying labelled mRNA population from plant material under water stress and non-stressed material from the same genotype.

On the other hand, also cDNA-AFLP represents a robust method to visualize differential gene expression (Bachem *et al*, 2000; Dellagi *et al*, 2000; Durrant *et al*, 2000), a tool for the isolations of genes (Bachem *et al*, 2000; Bachem *et al*, 2001; van der Biezen *et al*, 2000; Durrant *et al*, 2000) and can be used for quantitative transcript profiling (Breyne *et al*, 2003). The technique targets coding regions of the genome and does not require prior sequence information. Transcriptional modulation of gene activity under drought treatment can be monitored genome-wide by comparing gene expression patterns of stressed and non-stressed plant material.

In the present paper, we report some putative genes related to water stress which were identified using microarray data and some preliminary results using cDNA-AFLP.

MATERIALS AND METHODS

Microarray analysis

For microarray analysis, plants of *S. brachistotrichum* BST7986 subjected to non-irrigated and irrigated conditions were used. mRNA from leaves were extracted using biomagnetic separation technology (Dynabeads mRNA Direct Kit, DYNAL A. S., Oslo, Norway). 4mg of total mRNA samples were converted into single-stranded cDNA using SuperScriptII following a modified protocol from TIGR (www.tigr.org/). cDNAs were labelled with Cy3-dUTP (plant under water stress) and Cy5-dUTP (normal irrigated control), respectively (Amersham Biosciences, UK). The fluorescently labelled cDNA samples were purified using the QIAquick PCR Purification kit (QIAGEN). The heat-denatured probes were mixed with the hybridization buffer, covered with a glass coverslip and hybridized competitively at 42 °C in the darkness for 16-20hs with the cDNAs of the microarray. After hybridization, slides were washed and dried using a speed air pressure system. Microarrays were scanned and quantified using the *VersArray ChipReader* with the corresponding *VersArray Analyzer* software (Biorad). The criteria used for the selection of differentially expressed genes were based on the normalization and

preprocessing of data. That is essential to allow data sets from two or more samples to be compared to each other. This process was followed by inferential statistics that make statements for an exploratory statistics. The main idea of data preprocessing is to remove the systematic bias in the data as completely as possible while preserving the variation in gene expression. Normalization process is necessary to prevent changes in average gene expression in an experiment and it refers to the process of correcting two or more data sets prior to compare their gene expression values. We used a scatter plot analysis to identify genes that are differentially up and down regulated under water stress conditions. Data of the mean intensity of gene expression and of the expression ratio were log transformed (log base 10).

CDNA-AFLP

Water stress resistant and susceptible genotypes from the plant material mentioned above were grown in the greenhouse under 16hs of light, 24-25 °C and 60-80% relative humid (RH). The water stress resistant and susceptible material as well as the controls were grown in pots containing a turf-sand mixture. To induce water stress, plants of each genotype were subjected to progressive drought by withholding water. Control plants of each genotype were irrigated daily. RH and temperature variation along the day was registered daily. The absolute water content of the soil during and before treatment was determined by measuring the gravimetric soil water content. After 2 weeks treatment, leaves from stressed and non-stressed plants were collected and used for expression analysis. At this stage the stressed plants showed clearly the known symptoms of water deficit.

Total RNA was extracted from leaves as described by Bachem *et al* (1998). The total RNA concentration was estimated by spectrophotometer and visualized on 1% agarose gel. Poly-A^+ RNA was obtained from 10mg of total RNA using 5' biotinylated oligo (dT) primer (5'-biotin-TTTTTTTTTTTTTTTTTTTTTTTTV-3') bound to paramagnetic beads coated with streptavidin (Dyanabeads M-280 Streptavidin, DYNAL A.S. Oslo, Norway). First and second strand cDNAs were synthesized according to Sambrook *et al* (1989). Doble-stranded cDNA (ds-cDNA) was digested with *Ase*I and *Taq*I (NEB laboratories) followed by ligation of *Ase*I and *Taq*I adaptors with T4 DNA ligase (Invitrogene). cDNA-AFLP amplifications were carried out as described by Bachem *et al* (1998).

Labelled primers with two different fluorescence dyes (700 and 800nm) were used to visualize transcripts using LICOR sequencer system. Samples were denatured and separated on 6% polyacrylamide (19:1) sequencing gels.

Bands corresponding to differentially expressed transcripts were cut out from the gel and the cDNAs were eluted from the polyacrilamide gel followed by an ethanol precipitation and reamplification of fragments under the same PCR conditions as for selective amplification. These fragments were cloned using TA Cloning 2.1 vector (Invitrogene) and sent for sequencing.

RESULTS AND DISCUSSION

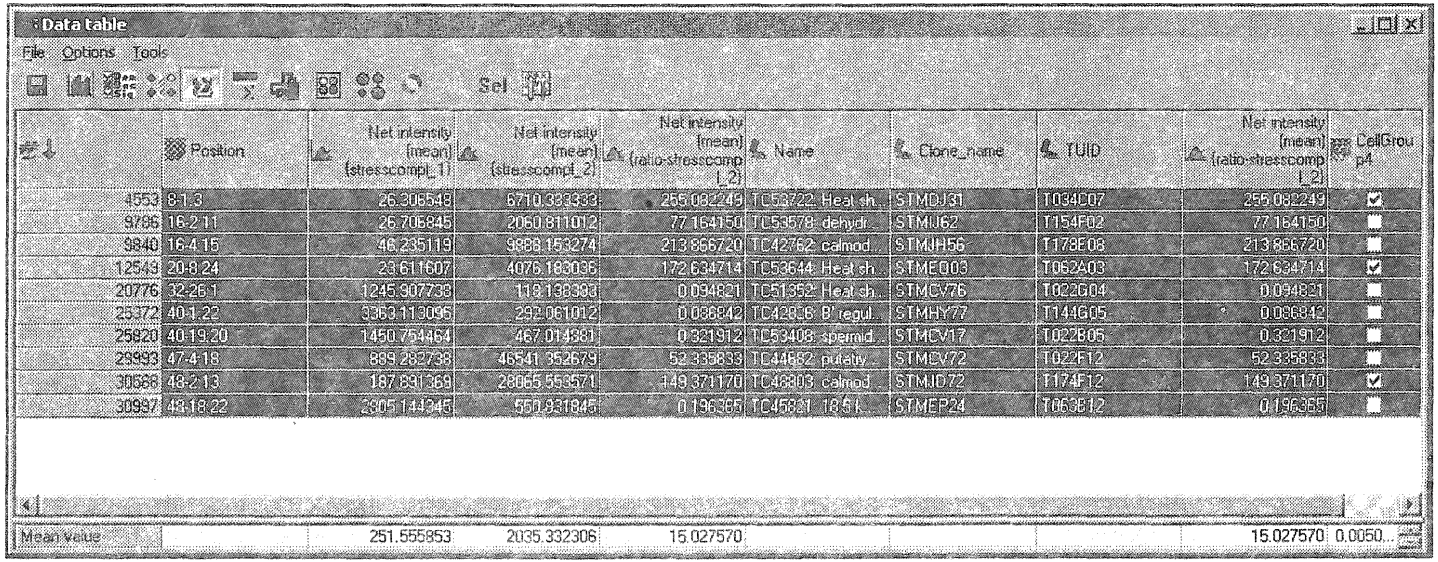
Microarray analysis

Microarray analysis revealed several transcripts which are involved in stress reactions and senescence (Table 1). These include heat shock proteins: HSP83 (TC51352) and HSP18.5 (TC45821), a protein phosphatase B′ subunit (TC42826), a spermidin synthase gene (SPDS, TC53408), a senescence associated gene (TC44682), calmodulin-binding protein (TC48803) and particularly the known dehydration induced protein ERD15 (TC53578). Several genes encoding proteins with functions not directly related to stress were expressed in higher levels in response to drought treatment. Incorrect protein folding and assembly have been hypothesized as possible effect of water stress. HSPs are involved in protein stabilization, folding and translocation and may help to recover native protein conformation attenuating the effect of stress. Osmotic adjustment is considered as one of the most important mechanism of plant adaptation to low levels of water in soil (Turner, 1986; Munns, 1988). Dehydrins accumulate during periods of water deficit and display particular structural features predicted to be involved in hydrophobic interactions to macromolecule stabilization (Close, 1996) through detergent and chaperone-like properties, suggesting that they induce an adaptive response during water stress. *Calmodulin* is a calcium-binding protein that may have a pivotal role in stress tolerance. One or more components of the protein involved in the perception and intracellular transduction of the stress signal might be altered during the adaptation processes. The *Spermidin synthase* gene acts as inhibitor or down regulator of metabolism processes related to tissue senescence and increases the content of polyamines during stress conditions.

Microarray data analysis implies the normalization and preprocessing of data. A series of data transformation can help to identify significantly regulated genes. A global representation of the changes in expression of all genes spotted on the microarray slide is depicted in Figure 2. In this format we can identify easily genes that are up or down regulated. Black points on the graphic identify the subset of genes which are listed in Table 1 and are mentioned before as closely related to water stress.

Table 1. List of mRNAs with differential hybridisation (induced or silenced) in *S. brachistotrichum* exposed to water stress against a normal irrigated control

Position	Water stressed material	Control non-stressed material	Ratio	Name / Description
44-1:12	2100.02	92.88	22.61	TC55942: harpin inducing protein {Nicotiana tabacum}
44-9:24	2410.55	175.06	13.77	TC44893: probable 60S ribosomal protein L9 [imported] - Arabidopsis thaliana
28-14:4	1162.42	90.67	12.82	TC49463: ethylene-responsive elongation factor EF-Ts precursor {Lycopersicon esculentum}
36-24:1	1391.92	111.41	12.49	TC49889: 3-phosphoinositide-dependent protein kinase-1 {Arabidopsis thaliana}; TC46842: 3-phosphoinositide-dependent protein kinase-1 {Arabidopsis thaliana}
12-22:18	1232.21	104.04	11.84	TC42382: protein F1E22.4 [imported] - Arabidopsis thaliana
40-1:22	3363.11	292.06	11.52	TC42826: B' regulatory subunit of PP2A {Arabidopsis thaliana}
36-12:14	1077.66	95.45	11.29	TC54741: vacuolar protein sorting protein [imported] - Arabidopsis thaliana
32-26:1	1245.91	118.14	10.55	TC51352: Heat shock protein 83. [Violet Japanese morning glory] {Pharbitis nil}; TC53264: Ribulose bisphosphate carboxylase small chain 1 chloroplast precursor (EC 4.1.1.39)
48-17:2	1520.24	147.98	10.27	TC51833: At1g09020/F7G19_11 {Arabidopsis thaliana}
36-1:2	4565.49	544.96	8.38	TC49954: gene_id:MCE21.3~refINP_055486.1~strong similarity to unknown protein {Arabidopsis thaliana}
44-1:20	2250.50	268.99	8.37	TC52723: putative glycyl-tRNA synthetase {Arabidopsis thaliana}; TC54758: putative glycyl-tRNA synthetase {Arabidopsis thaliana}
24-1:11	1467.02	182.53	8.04	TC54610: phototropin-like protein PsPK4 {Pisum sativum}
48-25:14	2065.82	270.58	7.63	TC46836: amidase {Arabidopsis thaliana}
44-9:11	3351.81	468.47	7.15	TC54438: Zeatin O-xylosyltransferase (EC 2.4.1.204) (Zeatin O-beta-D- xylosyltransferase).
32-13:4	3736.59	545.79	6.85	TC56852: finger protein Dof - common tobacco (fragment)
24-7:14	2035.08	331.26	6.14	TC43910: (S)-2-hydroxy-acid oxidase peroxisomal (EC 1.1.3.15) (Glycolate oxidase) (GOX)
24-25:15	34,4405	892,01	25,89	TC55541: calcium/calmodulin-dependent protein kinase CaMK3 {Nicotiana tabacum}
40-11:8	2086.59	535.32	3.90	TC47307: Unknown protein {Arabidopsis thaliana}
40-5:6	2337.66	670.66	3.49	TC53908: ARP protein [imported] - Arabidopsis thaliana; TC53907: NADPH oxidoreductase homolog {Cicer arietinum}
32-24:5	1336.81	386.08	3.46	TC50575: unknown protein {Arabidopsis thaliana}
40-5:14	1750.19	525.88	3.33	TC52630: GT2-like protein - Arabidopsis thaliana
40-19:20	1450.75	467.01	3.11	TC53408: spermidine synthase {Solanum tuberosum}
40-10:2	1508.69	523.92	2.88	TC53579: dehydration-induced protein ERD15 {Lycopersicon esculentum}
48-16:24	1472.22	526.38	2.80	TC54946: putative phosphatidylinositol-4-phosphate 5-kinase {Oryza sativa}
40-25:16	2379.95	851.06	2.80	TC43923: En/Spm-like transposon protein [imported] - Arabidopsis thaliana
44-21:18	4387.24	1727.92	2.54	TC54453: cytochrome P450 (EC 1.14.-.-) 81B1c - Jerusalem artichoke; TC54452: cytochrome P450 (EC 1.14.-.-) 81B1c - Jerusalem artichoke
44-21:22	2661.54	1118.55	2.38	TC53528: CITRATE SYNTHASE {Nicotiana tabacum}
44-19:15	1917.46	816.53	2.35	TC52130: xylosidase {Arabidopsis thaliana}
20-26:12	1467.02	640.19	2.29	TC57343: N-acetylglucosaminyltransferase I {Solanum tuberosum}
40-25:18	1327.34	616.03	2.15	TC46172: ubiquitin-conjugating enzyme (E2) {Nicotiana tabacum}
40-17:4	1726.95	820.68	2.10	TC43719: protein F1N19.1 [imported] - Arabidopsis thaliana
8-11:17	1273.08	610.00	2.09	TC49889: 3-phosphoinositide-dependent protein kinase-1 {Arabidopsis thaliana}; TC46842: 3-phosphoinositide-dependent protein kinase-1 {Arabidopsis thaliana}
36-24:13	1569.67	774.90	2.03	TC46975: gblAAB64041.1~gene_id:MZF16.2~similar to unknown protein {Arabidopsis thaliana}
47-4:18	889.28	46541.35	0.02	TC44682: putative senescence-associated protein {Pisum sativum}
22-20:14	735.28	40527.95	0.02	TC56746: unknown protein {Arabidopsis thaliana}
23-18:13	813.49	46702.92	0.02	TC46699: unknown protein {Arabidopsis thaliana}
23-19:13	697.21	44839.86	0.02	TC57413: cysteine protease {Ipomoea batatas}; TC45375: vacuolar processing enzyme (EC 3.4.22.-) isozyme gamma precursor - Arabidopsis thaliana



	Position	Net intensity (mean) (stresscompt_1)	Net intensity (mean) (stresscompt_2)	Net intensity (mean) (ratio:stresscompt_2)	Name	Clone_name	TUID	Net intensity (mean) (ratio:stresscompt_2)	CellGroup4
4553	8-1.3	26.306549	6710.333333	255.082249	TC53722 Heat sh...	STMDJ31	T084C07	255.082249	☑
9786	16-2.11	26.706845	2060.811012	77.164150	TC53578 dehydr...	STMIJ62	T154F02	77.164150	☐
9840	16-4.15	46.235119	9888.153274	213.866720	TC42762 calmod...	STMJH56	T178E08	213.866720	☐
12543	20-8.24	23.611607	4076.183036	172.634714	TC53644 Heat sh...	STME003	T062A03	172.634714	☑
20776	32-25.1	1245.307738	118.138393	0.094821	TC51352 Heat sh...	STMCV76	T022G04	0.094821	☐
25372	40-1.22	9363.113095	292.061012	0.036842	TC42846 B' regul...	STMHY77	T144G05	0.036842	☐
25820	40-19.20	1450.754464	467.014881	0.321912	TC53408 spermid...	STMCV17	T022B05	0.321912	☐
29993	47-4.18	889.282738	46541.352679	52.335833	TC44682 putativ...	STMEV72	T022F12	52.335833	☐
30588	48-2.13	187.691369	28065.553571	149.371170	TC46803 calmod...	STMJD72	T174F12	149.371170	☑
30997	48-18.22	2305.144345	550.931845	0.196385	TC45831 18.5 k...	STMEP24	T063B12	0.196385	☐
Mean value		251.555853	2035.332306	15.027570				15.027570	0.0050...

Figure 1. Data table generated by *Vers Array Analyzer* Software showing a subset of interesting genes related to water stress

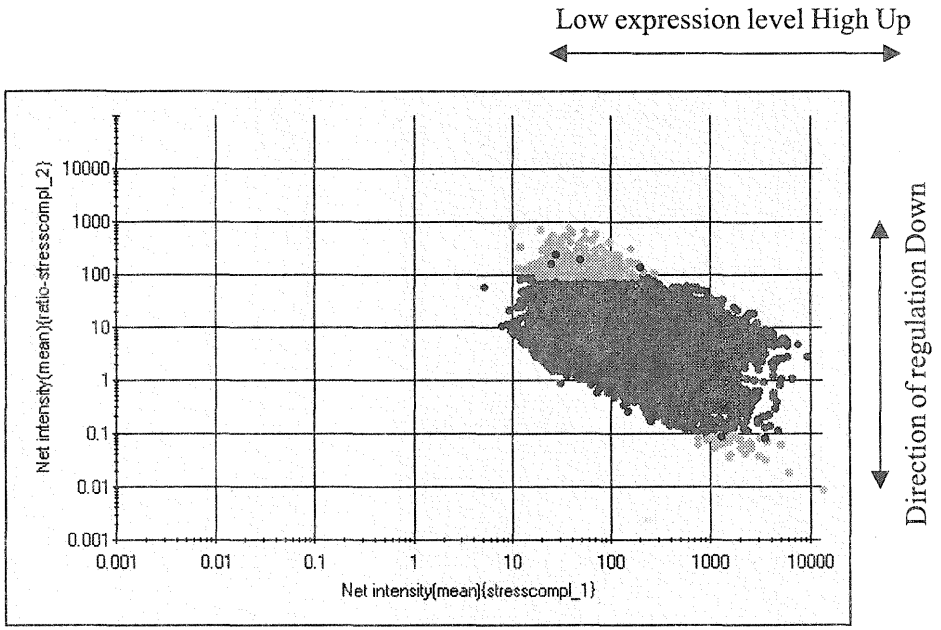


Figure 2. Scatter plot of the microarray experiment showing the distribution of the log of mean intensity in untreated plants (*x* axis) versus the log of the gene expression ratio (*y* axis). The x axis reflects levels of gene expression and the y axis reflects up or down regulation of gene expression. Black point identify specific genes expressed differentially under water stress (see Table 1)

cDNA-AFLP

Comparative analysis of expressions patterns of stressed *vs.* non-stressed genotypes in Fig. 3 suggests that progressive drought treatment displays a differential level of gene expression. Banding patterns generated independently, using the same primer combination and the same mRNA populations were highly reproducible. The fragment sizes were distributed between 50 to 500bp. Different primer combinations were screened and up to 20 polymorphic bands were obtained with some of these primer combination, with an average of 10 polymorphisms per genotype. Figure 3 shows polymorphisms related to the stress conditions. In addition to the presence/absence of transcripts we can also observe intensity polymorphisms. This variable band intensity suggests that the preferential accumulation of transcripts is associated to an adaptive response occurring in these plants subjected to water limitation. Identical, differentially expressed bands ocurred in different genotypes in many cases. Sequencing and sequence analysis of differentially expressed cDNAs is in progress.

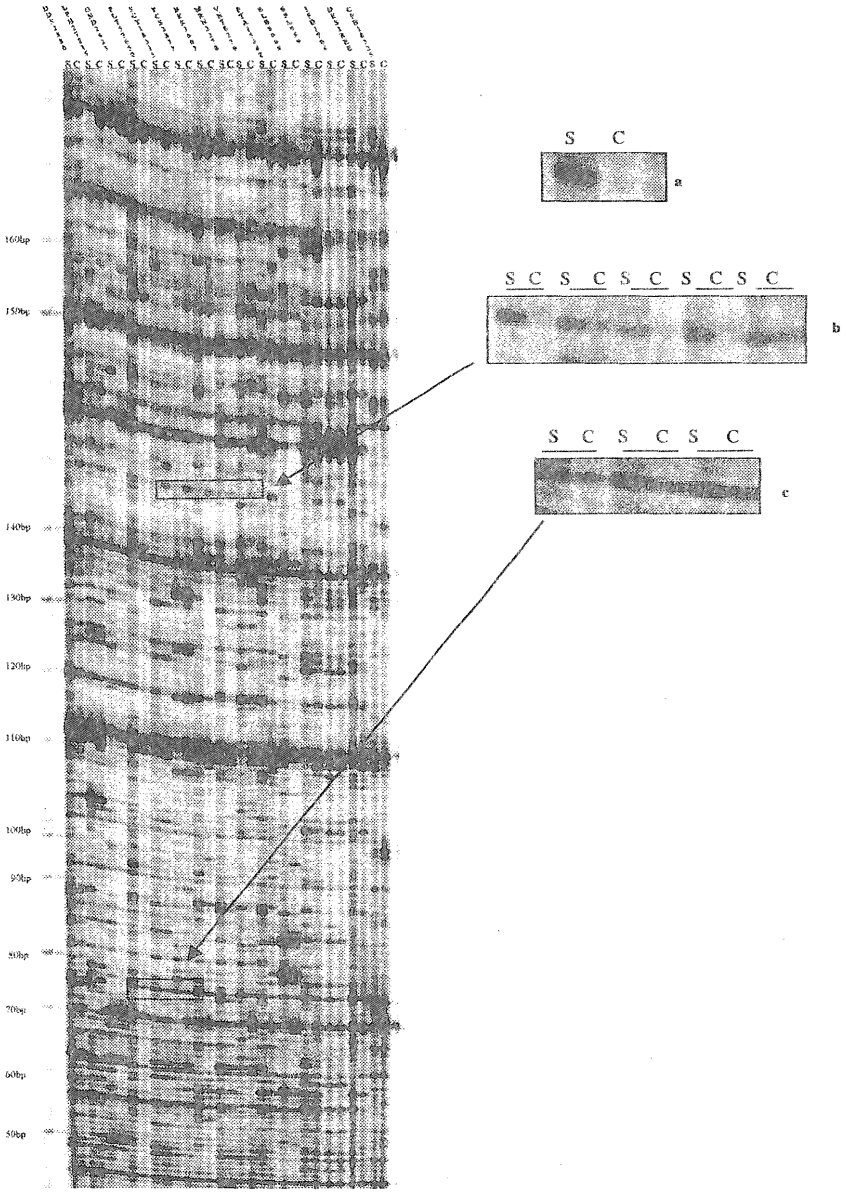


Figure 3. Example of a cDNA-AFLP gel showing differentially expressed amplification products under water stress. Lane1 represents a size marker. The other lanes represent the assayed genotypes. S: stressed genotype. C: non-stressed genotype **a. b.** Section of the gel with clear polymorphisms based on presence/absence of bands. **c.** Section of the gel with polymorphisms based on intensity

Future experiments using microarrays, cDNA-AFLP and others gene discovery techniques will be performed in order to give a broad answers to the cellular plant response under water stress. In this contents the use of library enrichment procedures such as SSH (subtractive suppression hybridization) will be useful to increase the number of detectable cDNAs. Full-length cDNA isolation together with complemen-tation tests using transgenic plants will be necessary to confirm the function of specific differentially expressed cDNA fragments.

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IDENTIFICAREA GENELOR DE REZISTENȚĂ LA STRESUL HIDRIC

Rezumat

Ca răspuns la stresul provocat de lipsa apei plantele manifestă schimbări genetice. Pentru a înțelege mai bine care sunt genele care conferă rezistența la secetă a cartofului s-a analizat expresia lor prin metodele *cDNA-AFLP* şi microarray. Aceste tehnici permit identificarea genelor exprimate ca răspuns la stresul cauzat de deficitul de apă. Am folosit material rezistent şi sensibil la stresul hidric din diferite specii sălbatice de *Solanum* precum şi martori. Analiza microarray a dezvăluit câteva transcrieri care sunt implicate în reacțiile la stres şi la îmbătrânire. Analiza comparativă a elementelor de expresie a genotipurilor stresate *vs.* non-stresate prin tehnica cDNA-AFLP sugerează că supunerea la secetă progresivă duce la nivele diferite de exprimare a genelor. S-au observat polimorfisme legate de condițiile de stres hidric pe baza prezenței/absenței unei benzi precum şi pe baza intensității lor. Viitoarele experimente care vor folosi metodele microarrays, cDNA-AFLP şi alte tehnici de descoperire a genelor vor fi realizate cu scopul de a da răspunsuri mai cuprinzătoare în ceea ce priveşte reacția celulară a plantelor la stresul hidric.

Cuvinte cheie: stres hidric, Solanum, analiza expresiei genetice, microarray, cDNA-AFLP

Tabele

1. Lista acizilor mARN cu hibridizare diferențială (indusă sau reprimată) la *S. brachistotrichum* supus la stres hidric în comparație cu un martor irigat normal.

Figuri

1. Tabel de date generate prin programul computerizat *Vers Array Analyzer* prezentând o submulțime de gene interesante legate de stresul hidric.

2. Câmpul de dispersie a testului microarray care arată o distribuție a trunchiului de intensitate medie la plantele netratate (axa *x*) în comparație cu trunchiul coeficientului de expresie a genei (axa *y*). Axa x indică nivelele de expresie a genelor iar axa y indică regalrae în sus sau în jos a expresiei genei. Punctul negru identifică genele specifice exprimate diferențiat la stresul hidric. (vezi tablelul 1).

3. Exemplu de gel cDNA-AFLP care arată produse de amplificare exprimate diferit la stresul hidric. Culoarul 1 reprezintă un marker de dimensiune. Celelalte culoare reprezintă genotipurile analizate. S: genotip stresat. C: genotip nestresat a. b. Secțiunea de gel cu polimorfisme clare bazate pe prezența/absența of benzilor. c. Secțiunea de gel cu polimorfisme bazate pe intensitate.

RESULTS CONCERNING THE GENETIC TRANSFORMATION OF TWO ROMANIAN POTATO VARIETIES USING THE *CRYIIIA* GENE WITH INDUCED RESISTANCE TO COLORADO BEETLE ATTACK

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SUMMARY

One of the most important potato pests all over the world is the Colorado beetle. Genetic modification is the first step in obtaining potato cultivars with resistance to Colorado beetle.Our aim was to obtain transgenic lines of Romanian potato varieties by using specific expression vectors that transferred the cryIIIA gene into the potato genome.

The transgenic lines were screened for the level of cryIIIA gene expression using ELISA analysis.

Keywords: *cryIIIA* gene, potato transformation, ELISA analysis,

INTRODUCTION

Adoption rates for transgenic crops are unprecedented and are the highest for any new technology by agricultural industry standards (James, 2002). From 1996, when GM crops were first adopted, to 2003 the global area of transgenic crops increased 40 fold, from 1,7 million hectares in 1996 to 67,7 million hectares in 2003 (James, 2003). High adoption rates reflect farmer satisfaction with the products that offer significant benefits ranging from more convenient and flexible crop management, higher productivity and/or net returned per hectares (James, 2002; Gianessi *et al.*, 2002; Brookes, 2003a,b; Otiman, pers. comm..), health benefits (Pray *et al.*, 2002) , and a safer environment through decreased use of conventional pesticides (Phipps and Park, 2002; Gianessi, 2002), which collectively contribute to a more sustainable agriculture.

The first wave of transgenic crops that are currently commercialized are tolerant to herbicide and resistant to pests. Bt technology makes possible to control the most harmful pest in corn, cotton and potato. One of the most important potato pests all over the world is the Colorado beetle. For Romania, growing transgenic potato plants with resistance to this pest means not only the reduction of chemical soil pollution, protection of beneficial predators and avoiding the presence of pesticide residues in water and food, but also

economic benefits representing 10 million dollars per year (4 million insecticide cost and 6 million cost of insecticide spreading) (Otiman, pers. comm).

Colorado potato beetle resistance has been achieved through the incorporation of a gene for the *Bacillus thuringiensis* (Bt) CRY protein into potatoes. *Bacillus thuringiensis* is a spore-forming bacterium species, commonly found in soil, which contains a native crystal protein that when ingested by insect pests, causes a lethal paralysis in the digestive track. Bt foliar sprays have been used for 50 year to control insect pests and have a long history of safe use.

Genetic modification is the first step in obtaining potato cultivars with resistance to Colorado beetle. In this report we described the obtaining of transgenic lines from two Romanian varieties by using specific expression vectors that transferred the *cryIIIA* gene into the potato genome. The level of *cryIIIA* gene expression in the transgenic lines was also studied.

MATERIALS AND METHODS

Plant material

Two Romanian potato varieties, Redsec and Coval, provided by the Târgu Secuiesc Potato Research Station were used for genetic transformation. The two varieties used for transformation were selected due to their good yield, virus resistance and quality traits. All the material used for transformation obtained from spouts tubers was confirmed as virus free. Each plant was serologically tested (ELISA) for the presence of the most worldwide potato viruses PLRV, PVX, PVY, PVA, PVS and PVM. The analysis were performed both in the laboratory from AgroBioInstitute Sofia, Bulgaria and from AGDIA, USA. Only virus free plants were used to obtain stock material. The stock plants were maintained through monthly subculture of the shoot tips (2-3 nodes) at 19°C under 16 hours illumination. For transformation experiments, explants consisting for internodes segments long of about 5mm (without leaves) were prelevated from aseptically grown plants.

Bacteria strain and vector

The transformation experiments were carried out using *Agrobacterium tumefaciens* harboring the binary plasmid pMON 9843 with the *cryIIIA* gene, encoding the Bt CRY protein and the marker gene *epsps* conferring the glyphosate resistance provided by the Monsanto Company.

Bacteria were inoculated in Luria-Bertani (LB) medium supplemented with chloramphenicol 25mg/l, streptomycin 50 mg/l, spectinomycin 50 mg/ml and kanamycin 50 mg/ml. The culture was grown with continue stirring (120 rmp) at 25°C. After 24 hours, the bacterial culture was diluted 1:10 in LB medium, supplemented with the same four antibiotics and grew for an additional night in the same conditions. For transformation, the bacterial culture was diluted 1:9 in MS medium.

Transformation and regeneration of transformants

Potato explants obtained from the young shoots were immersed in bacterium suspension for 15 minutes, blotted on sterile filter paper and transferred to co-culture medium. After 2 days co-cultivation, at 19°C, under 16 hours illumination, the explants were transferred for callus induction to selection medium (table 1) containing 4.23mg/l glyphosate and 500 mg/l cefotaxime.

The cultures were incubated for 1 week at 19°C, under a 16 hour light cycle. After one week on callus induction medium, explants were transferred onto regeneration medium (table 1) containing 4.23mg/l glyphosate and 500 mg/l cefotaxime. At this stage, all shoots were discarded because they grew from the "escaped" buds and therefore they are not transformed.

After four weeks, the appearing shoots from the callus maintained on the regeneration medium were removed. Only one shoot per end of an explant was transferred onto PM medium containing 8.26mg/l glyphosate. The non-rooting plants after one month on medium with glyphosate were discarded.

Table 1. Media used for obtaining potato transgenic plants

Propagation medium PM	**Co-culture medium**	**Callus induction medium**	**Regeneration medium**
Murashige&Skoog macro and micro elements	1/10 Murashige &Skoog macro and micro elements	Murashige&Skoog macro and micro elements	Murashige&Skoog macro and micro elements
Vitamins	**Vitamins**	**Vitamins**	**Vitamins**
Thiamine. HCl 0.40 mg/l	Glycine 2.00 mg/l	Glycine 2.00 mg/l	Glycine 2.00 mg/l
Myo-inositol 100.00 mg/l	Thiamine.HCl 0.40 mg/l	Thiamine.HCl 0.40 mg/l	Thiamine. HCl 0.40 mg/l
	Nicotinic acid 5.00 mg/l	Nicotinic acid 5.00 mg/l	Nicotinic acid 5.00 mg/l
	Pyridoxine.HCl 0.50 mg/l	Pyridoxine.HCl 0.50 mg/l	Pyridoxine.HCl 0.50 mg/l
	d-Biotin 0.05 mg/l	d-Biotin 0.05 mg/l	d-Biotin 0.05 mg/l
	Folic acid 0.50 mg/l	Folic acid 0.50 mg/l	Folic acid 0.50 mg/l
	Myo-inositol 100.00 mg/l	Myo-inositol 100.00 mg/l	Myo-inositol 100.00 mg/l
		Phytohormones	**Phytohormones**
		Naphthaleneacetic acid 0.10 mg/l	Gibberelic acid 0.50 mg/l
		zeatin riboside 5 mg/l.	zeatin riboside 5 mg/l.

Propagation of transgenic plants

Each transgenic plantlet rooted on medium supplemented with glyphosate was multiplied in order to be maintained *in vitro* and to be transferred into pots containing a

pre-moistened peat-based mixture. At 3 and 7 days after transplanting, a fertilizer solution with a 50 ppm of a 9-45-15 (N-P-K) was applied.

This fertilization procedure was repeated at least two times, after 10 and 18 days post transplantion, with a 200 ppm solution of a 20-20-20 fertilizer.

One leaf from three weeks old plants was collected and used for the quantification of gene level expression. The best 20 lines from each variety was selected and propagated in the greenhouse using the same technique as for *in vitro* propagation.

Plants grown in pots were multiplied using single nod cuttings (at least 3mm of stem on both sides of the node). The fertilization procedure applied to the nod cuttings was similar with that applied to the plants, that is with a 50 ppm solution of N-P-K (9-45-15) before rooting and with 200 ppm solution (20-20-20) after rooting. Days of application: first, third and seventh before rooting and third and tenth after rooting.

The plants were grown at 20°C in a greenhouse with natural light.

The immunological test for the CRY III A protein quantification

ELISA kits were purchased from ADGIA, USA. Each kit contained: coating antibody (ABI), alkaline phosphates (AP) conjugated antibody, the substrate 4-nitrophenyl phosphate-disodium salt (pNPP), negative and positive controls (Table 2).

The tests were performed on extracts from 30 mg of tissue obtained from leaves harvested from 3 week old plants. After ELISA buffer was added in a ratio of 1:25, the tissue was homogenized until no clamps were visible. The extract was diluted 1:5000 in ELISA buffer.

Table 2. The solutions used for the ELISA tests

Antibody coating buffer	1xPBS	1xPBST	ELISA buffer
0.159% Na_2CO_3	0.08%NaCl	1xPBS + 0.05% Tween 20	1xPBST+ 0.02%BSA
0.293%$NaHCO_3$	0.2168%Na_2HPO_4		
	0.02%KH_2PO_4		
	0.02% KCl		
pH 9.9	pH 7.3-7.5	pH 7.3-7.5	pH 7.3-7.5

The ABI was diluted 1:1000 in the antibody coating buffer. 200 ml from this solution was added in each well of the ELISA plate. The plates were incubated at 4°C for 24 hours in a sealed box containing a moist paper towel. The plates washed 3 times with 1x PBST and blocked with 250 ml 1xPBST + 5% not-fat dry milk were incubated at room temperature for 30 min.

The AP conjugated antibody was diluted 1:1000 in ELISA buffer and a volume of 200ml was added to each well. After 4 hours incubation at room temperature, the plates were washed 3 times with 1x PBST solution. 20 ml of the substrate solution (pNPP) was then added to each well which were developed at room temperature for one hour. The absorbance of each probe was determined using an ELISA reader plate by comparison with negative and positive controls.

RESULTS AND DISCUSSIONS

Obtaining of transgenic plants

After propagation and evaluation of regeneration ability (figure 1) of the two Romanian varieties, we have proceeded to transform stem pieces obtained from 4 week old plants. On the selection medium containing glyphosat, toxic for untransformed cells, and cefotaxime for bacteria elimination, a callus was formed through multiplication of transformed cells. All shoots seen after one week are untransformed and therefore were discarded. After four weeks on the regeneration medium, the shoots appear on the growing calli (figura 2). The larger shoots were removed from the calli and transferred onto propagation medium (PM) containing selection agent – glyphosate. For preventing the harvesting of clonal plants from the same event, only one shoot per explant end was removed.

After rooting, the transformed shoots were propagated *in vitro* (figure 3). All the plants rooted on medium supplemented with glyphosate were transferred in pots and then multiplied (figure 4).

As can be observed from the data presented in table 3, the two Romanian varieties have about the same transformation ability, in spite of a lower explant number used for Coval variety (because of poor *in vitro* growing capacity)

Table 3. The transformation frequency of the two Romanian varieties

Transformation series	Explants	Harvested shoots	Rooting plants	Explants	Harvested shoots	Rooting plants
	REDSEC variety			COVAL variety		
I	450	151	106	200	76	31
II	500	290	155	360	316	167
III	500	340	198	200	55	24
IV	100	49	38	240	110	65
TOTAL	**1550**	**871**	**497 (32.06%)**	**1000**	**557**	**287 (28.70%)**

According to our previous experience we consider the rate of transformation as being high. Using the same procedure with a construction carrying *nptII* marker gene, the transformation frequency was lower (Frantescu *et al.*, 2003). Purwati *et al.* (1997) have shown that the regeneration frequency of potato can be influenced by many factors such as: bacterial strain, the optical density of the bacterial suspension, the media, light, temperature, etc. The high rate of regeneration can be associated with the use of glyphosate as a selective factor. Transformation efficiency is negatively influenced when kanamycin is used for selection of transformed cells (Visser *et al.*, 1989).

Obtaining a large number of potted plants is conditioned by the transfer of short, sturdy and well rooted plantlets. Excessive growth plants are not successfully transplanted.

The acclimatization rate of the two Romanian potato varieties is about the same (table 4).

Table 4. The acclimatization frequency of the plants growing in greenhouse

Transformation series	Plantlets transferred to soil	Acclimatized plants	Plantlets transferred to soil	Acclimatized plants
	REDSEC variety		COVAL variety	
I	106	99	31	29
II	155	127	167	121
III	198	111	24	16
IV	38	22	65	28
TOTAL	**497**	**359 (72.23%)**	**287**	**194 (67.60%)**

Quantification of *cryIIIA* gene expression level

ELISA quantification of cryIIIA gene expression was performed on leaves that were collected from all of the healthy, growing plants.

We used ELISA double antibody sandwich due to its simplicity, adaptability, rapidity, sensitivity and accuracy. According to this test, the CRY protein is first selectively trapped by the specific antibody adsorbed on a solid surface after which a specific enzyme-labeled antibody is added to the immobilized protein and after adding a suitable enzyme substrate, the results of the reaction are measured spectrophotometrically. The standard CRYIIIA protein is used as a positive control, and a not modified plant, as negative control.

The serological quantification was performed for 553 genetically transformed plants (359 from the Redsec variety and 194 from the Coval) (Table 5). The CRY III A protein content was estimated using the calibration curve obtained from different concentrations of the standard protein.

Table 5.The level of cryIIIA gene expression in leaf tissues collected from potted plants

The results obtained have shown that a high number of plants have a high protein

CRYIIIA Content in leaves tissues	Plants number	
	REDSEC	COVAL
< 10 ppm	119	16
10-20 ppm	33	23
20-30 ppm	33	18
30-60 ppm	140	117
> 60 ppm	34	20

content (higher than 10 ppm being considered a value for obtaining successful transformants).

For this reason, we retained only 20 plants per variety that have a protein content higher than 60 ppm. Only these plants were considered to represent genetically modified lines of interest and were propagated in the greenhouse, with the aim to obtain a minimum of ten plants from each selected line. The average number of plants per line was 8.10 (with maximum 12 plants and minimum 2) for Redsec and 7.05 (with maximum 10 plants and minimum 2) for Coval variety.

The plants were grown in the greenhouse and they produced minitubers. The average number of minitubers per plant was 6 for Redsec and 4 for Coval varieties. These minitubers will be used for beginning of field trials.

Our results show that these the two Romanian varieties, Redsec and Coval, can be easily transformed via *Agrobacterium tumefaciens*, which has ensured the obtaining of a high number of lines with a high level of gene expression.

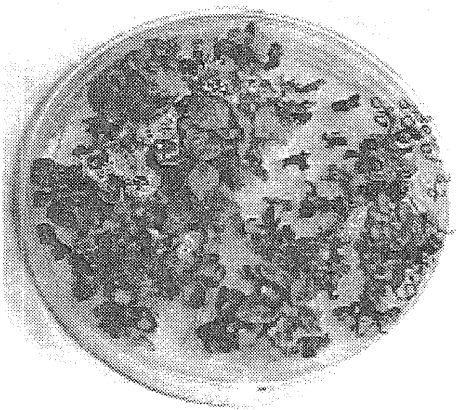

Fig. 1. Highly regenerative culture from untransformed potato explants

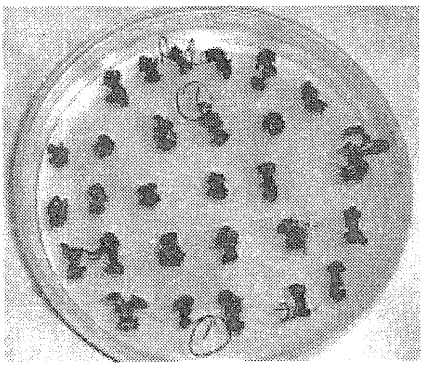

Fig. 2. Internodal stems of potato on the callusing medium

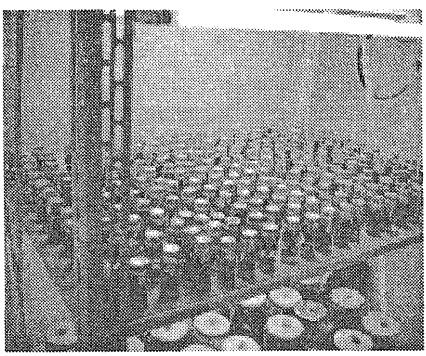

Fig. 3 Propagation of genetically modified plants

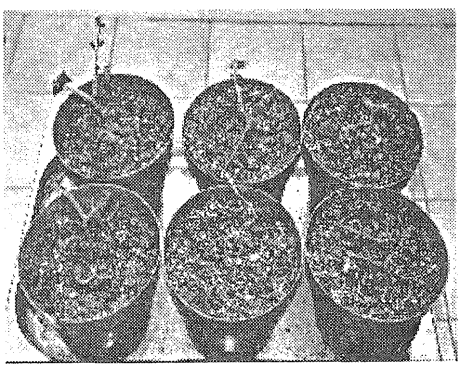

Fig. 4. *Ex situ* multiplication of genetically modified plants

CONCLUSIONS

Redsec and Coval potato varieties are able to grow and regenerate on specific in vitro culture media , presenting a good regeneration rate.

Regarding selection procedure in potato transformation, glyphosate has lead to better results compared with kanamycin.

The two Romanian varieties have about the same transformation ability, in spite of a lower explant number used for Coval variety.

ELISA analysis showed that all the transformed lines are expressing CRY III A protein and about 10% had more than 60ppm CRY IIIA protein.

The selected lines can be a valuable start material for future field trials and molecular selection in order to develop the best genetically modified line for each variety.

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REZULTATE PRIVIND TRANSFORMAREA GENETICĂ A DOUĂ SOIURI DE CARTOF ROMÂNEŞTI FOLOSIND GENA *CRY IIIA* CU INDUCEREA REZISTENŢEI LA GÂNDACUL DIN COLORADO

Rezumat

Unul din cei mai importanţi dăunători la nivel mondial este gândacul din Colorado. Modificarea genetică este prima etapă în obţinerea soiurilor cu rezistenţă la gândacul din Colorado. Scopul nostru a fost să obţinem linii transgenice la soiurile de cartof româneşti prin folosirea vectorilor de transfer al genei *cry IIIA* în genomul cartofului.

Liniile trangenice au fost analizate cu privire la nivelul de expresie a genei *cryIIIA* folosind tehnica ELISA.

Cuvinte cheie: genă *cryIIIA*, transformarea cartofului, analiză ELISA

Tabele

1. Mediul folosit pentru obţinerea plantelor transgenice la cartof;
2. Soluţiile folosite pentru testele ELISA;
3. Frecvenţa transformării la două soiuri româneşti (Redsec şi Coval);
4. Frecvenţa aclimatizării plantelor crescute în seră;
5. Nivelul expresiei genei *cryIIIA* în ţesutul frunzelor de la plantele din ghivece;

Figuri

1. Cultură regenerativă puternică din explante de cartof netransformate genetic;
2. Tulpini internodale de cartof pe mediu de calusare;
3. Înmulţirea rapidă a plantelor modificate genetic;
4. Creşterea în ghivece a plantelor modificate genetic.

PERFORMANȚELE NOILOR SOIURI DE CARTOF CREATE DE INSTITUTUL DE CERCETARE-DEZVOLTARE PENTRU CARTOF ŞI SFECLĂ DE ZAHĂR, BRAŞOV

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REZUMAT

Pe plan mondial, dar şi în România, se cultivă o mare diversitate de soiuri. Cultivarea lor este necesară, întrucât cartoful are scopuri de utilizare foarte diversificate, se cultivă în condiţii ecologice foarte diferite, este atacat de un număr foarte mare de boli şi dăunători, iar pretenţiile producătorilor şi consumatorilor de cartof sunt schimbătoare şi mereu crescânde.

Din multitudinea de soiuri trebuie incluse în sistemul naţional de producere a cartofului de sămânţă şi recomandate, cele mai performante, întrucât soiurile pot fi înmulţite doar într-un număr limitat.

Din cele 37 soiuri create la Insitutul de Cercetare-Dezvoltare pentru Cartof şi Sfeclă de Zahăr au fost incluse în sistemul naţional de producere a cartofului pentru sămânţă soiurile **Amelia**, **Christian**, **Dacia**, **Nicoleta**, **Tâmpa** şi **Roclas**, fiind considerate cele mai performante soiuri pentru viitor.

Cuvinte cheie: cartof, soiuri noi, rezistenţa la virusuri, capacitatea de producţie.

INTRODUCERE

Ameliorarea poate fi definită drept un proces de adaptare a plantelor de cultură la sistemul tehnologic utilizat la momentul dat de cultivatori (Săulescu, 1999). Ameliorarea este un proces continuu, care trebuie să ţină pasul cu modificarea condiţiilor ecologice, cu creşterea agresivităţii şi a lărgirii patogenităţii agenţilor patogeni, datorită apariţiei de noi rase, tulpini, biotipuri şi patotipuri, dar şi de cerinţele mereu crescânde ale producătorilor şi consumatorilor.

Cartoful se numără printre plantele de cultură care necesită o mare diversitate de soiuri datorită următoarelor considerente:

- are scopuri de utilizare foarte diversificate. Astfel, cartoful se cultivă pentru consum timpuriu, consum de vară, consum de toamnă – iarnă, pentru industrie (amidon, spirt, glucoză, dextrină, etc.), industrializare (chips, pommes – frites, fulgi, etc.) şi furajare;
- se cultivă în condiţii ecologice foarte diferite;
- este atacat de un număr foarte mare de boli şi dăunători;

– cartoful european, fiind originar din America Centrală şi de Sud, a fost lipsit de schimbul de material genetic cu speciile genului tuberifer *Solanum* şi a evoluat sub forma unui număr foarte mic de genotipuri.

Astfel pentru fiecare scop de utilizare trebuie cultivat un soi corespunzător. Însă în alegerea unui soi de cartof trebuie avute în vedere şi condiţiile ecologice specifice zonei respective şi posibilităţile de aplicare a unor tehnologii adecvate.

Aceste cauze duc la o înlocuire firească a soiurilor mai vechi, cu soiuri noi, mai performane, care să îşi manifeste pe deplin principalele caractere de producţie, rezistenţă şi calitate şi să satisfacă cerinţele cultivatorilor şi consumatorilor de cartof.

MATERIAL ŞI METODE

Pe parcursul procesului de ameliorare a cartofului din România, dar mai ales în ultimul deceniu, au fost create şi înregistrate un număr însemnat de soiuri, care au fost cultivate o perioadă de timp mai lungă sau mai scurtă. Este firesc ca dintre acestea să fie incluse în sistemul naţional de producere a cartofului de sămânţă cele mai performante. Performanţele soiurilor au avut în vedere producţiile realizate în deferite condiţii pedoclimatice, rezistenţa la boli şi dăunători, în special la mană şi viroze grave şi manifestarea principaleleor însuşiri de calitate.

Dintre soiurile de cartof româneşti create la Institutul de Cercetare – Dezvoltare pentru Cartof şi Sfeclă de Zahăr, cele mai performante s-au dovedit a fi următoarele:

– Soiuri timpurii şi semitimpurii: DACIA, ROCLAS şi CHRISTIAN;
– Soiuri semitârzii: AMELIA, TÂMPA şi NICOLETA.

Capacitatea de producţie a soiurilor s-a verificat în 10 centre, în condiţii ecologice foarte variate, specifice zonelor de cultură ale cartofului din România. În condiţii foarte favorabile culturii cartofului s-a determinat capacitatea biologică de producţie. Ca metodă de lucru s-a utilizat tehnica culturilor comparative şi prelucrarea statistică a rezultatelor.

Rezistenţa la boli şi dăunători a fost verificată în câmpuri experimentale şi laboratoare. Ca metode s-a utilizat tehnica infecţiilor provocate.

Însuşirile de calitate au fost determinate în laborator şi au avut în vedere aspectul fizic, compoziţia chimică, calitatea culinară şi pretabilitatea la industrializare.

REZULTATE ŞI DISCUŢII

Principalele caractere care determină performanţele unui soi de cartof sunt următoarele:

– capacitatea de producţie;
– rezistenţa la boli şi dăunători;
– manifestarea insuşirilor de calitate.

Aceste caractere se manifestă diferit la fiecare soi şi depind de foarte mulţi factori ca: lungimea perioadei de vegetaţie, condiţiile ecologice a zonei respective de cultură, presiunea de infecţie cu boli şi rezerva de dăunători şi nu în ultimul rând de tehnologia aplicată.

Capacitatea de producție a soiurilor românești incluse în sitemul național de producere a cartofului pentru sămânță este ridicată. Capacitatea biologică de producție a variat între 65,9 și 90,6 t/ha, la soiurile timpurii și semitimpurii și între 70,6 și 80,7 t/ha, la soiurile semitârzii (tabelul 1).

Tabelul 1

Capacitatea biologică de producție a soiurilor de cartof românești incluse în sistemul național de producere a cartofului de sămânță *

SOIUL	Dacia	Roclas	Christian	Amelia	Tâmpa	Nicoleta
Capacitatea biologică de producție (t/ha)	90,6	65,9	70,6	80,7	77,4	70,6

* - verificările au fost efectuate la S.C.D.A. Brăila

Producțiile realizate în diferite condiții pedoclimatice arată o mare plasticitate ecologică a soiurilor (Chiru, 1995, Bozeșan, Chiru, 1999, Chiru, Bozeșan, 2000, Bozeșan, Draica, 2001). Rezultatele sunt prezentate în tabelul 2.

Tabelul 2

Producția realizată de soiurile de cartof românești incluse în sistemul național de producere a cartofului de sămânță în diferite condiții pedoclimatice

Centrul de verificare	Producția fizică a soiurilor (t/ha)					
	Dacia	Roclas	Christian	Amelia	Tâmpa	Nicoleta
A. în condiții de neirigare						
I.C.D.C.S.Z. Brașov	38,3	41,0	30,4	34,1	26,9	36,9
S.C.D.C. Miercurea Ciuc	24,4	45,8	25,7	38,1	30,9	37,1
S.C.D.C. Tg. Secuiesc	38,3	40,0	28,4	33,1	33,3	33,5
S.C.D.H. Tg. Jiu	42,9	44,3	22,6	-	25,1	36,6
S.C.D.A. Suceava	33,0	39,2	26,9	-	30,4	19,9
S.C.D.A. Secuieni	-	44,8	30,2	40,7	33,0	42,7
B. în condiții de irigare						
S.C.D.C. Mârșani	45,6	52,4	51,1	33,9	34,1	41,3
S.D.A. Tulcea	56,9	44,0	48,3	54,1	34,0	51,9
S.C.D.A. Valu lui Traian	-	56,5	40,5	48,0	33,8	49,2

Alegerea soiului corespunzător trebuie să se facă în primul rând după destinația producției.

Pentru consum timpuriu și de vară se recomandă soiurile timpurii și semitimpurii. Acestea au o dinamică rapidă de acumulare și realizează producții foarte bune în condiții de irigare, lucrare esențială pentru producerea cartofului destinat consumului timpuriu și de vară (Chiru, 1995, Chichea, 2000).

Pentru consum de toamnă – iarnă, cele mai mari producţii sunt realizate de soiurile semitârzii (Bozeşan, Chiru, 1999).

Pentru industrie şi industrializare trebuie cultivate soiuri specializate (Chiru, Bozeşan,2001).

Condiţiile climatice din România, în general, dar mai ales cele din ultimii ani, în special, au supus culturile de cartof unor puternice stresuri termohidrice. Temperaturile ridicate şi lipsa precipitaţiilor, au afectat culturile de cartof din toate zonele de cultură, cu excepţia celor irigate (Ianoşi, 1998). Rezultatele experimentale obţinute, privind rezistenţa soiurilor româneşti de cartof incluse în sistemul naţional de producere a cartofului pentru sămânţă, dar şi diferenţele mici dintre producţiile obţinute în condiţii de irigare şi neirigare, ne îndreptăţesc să afirmăm că unele dintre soiurile recomandate sunt rezistente la stresul termhidric (Săninoiu, 1996).

Rezistenţa la boli şi dăunători a avut în vedere comportarea soiurilor recomandate în faţa atacului de mană (*Phythophthora infestans Munt. (de Bary.)*, la viroze grave, produse de virusul Y al cartofului (*Solanum virus 2*) şi virusul răsucirii frunzelor de cartof (*Solanum virus 14*), precum şi la râia neagră a cartofului (*Synchytrium endobioticum Schilb. (Perc.)* şi nematodul auriu al cartofului (*Globodera rostochiensis Woll.*).

Soiurile recomandate se comportă diferit în faţa atacului de mană (*Phythophthora infestans Munt. (de Bary.)*. S-a constatat o sensibilitate mai mare la soiurile timpurii şi semitimpurii, în special la atacul pe frunze. Soiurile semitârzii au o rezistenţă mai bună. Toate soiurile au o bună rezistenţă la atacul pe tuberculi, ceea ce nu permite transmiterea infecţiei de la un an la altul (tabelul 3).

Datorită unei mari presiuni de infecţie cu boli virotice a apărut necesitatea creării şi promovării unor soiuri rezistente. Soiurile recomandate au o rezistenţă ridicată şi foarte ridicată la viroze grave, indiferent de grupa de precocitate (tabelul 3). Manifestarea acestor caractere permit înmulţirea lor în condiţii cu o presiune de infecţie virotică mai ridicată (Bozeşan, Draica, 2001).

Toate soiurile recomandate sunt rezistente la râia neagră a cartofului (*Synchytrium endobioticum Schilb. (Perc.)*, dar sensibile la nematodul auriu al cartofului (*Globodera rostochiensis Woll.*) (Tabelul 3).

Tabelul 3

Rezistenţa soiurilor de cartof româneşti incluse în sistemul naţional de producere a cartofului de sămânţă la boli şi dăunători

Rezistenţa la atacul de:	Soiul					
	Dacia	Roclas	Christian	Amelia	Tâmpa	Nicoleta
Mană pe frunze	FS	MR	MS	MS	MS	R
Mană pe tuberculi	MR	MR	MS	MS	R	R
Virusul Y	FR	MR	MR	MR	FR	FR
Virusul răsucirii frunzelor	R	R	S	MR	R	R
Râia neagră	R	R	R	R	R	R
Nematodul auriu	S	S	S	S	S	S

Legenda:
FS – foarte sensibil; *MR – mijlociu rezistent;*
S – sensibil; *R – rezistent;*
MS – mijlociu sensibil *FR – foarte rezistent.*

Însușirile de calitate se manifestă foarte diferit între soiuri.

Din punct de vedere al aspectului fizic, soiurile recomandate satisfac pe deplin cerințele producătorilor și consumatorilor de cartof.

Compoziția chimică și în special conținutul în amidon, le încadrează în diferite scopuri de folosință, pentru consum timpuriu, de vară și toamnă - iarnă, în stare proaspătă, dar și pentru industrie și industrializare. Calitatea culinară le recomandă pentru majoritatea preparatelor (tabelul 4). Acesta a fost un criteriu de recomandare a acestor soiuri pentru a fi în sistemul național de producere a cartofului de sămânță, dar constitue și un criteriu de bază în alegerea soiului corespunzător de cultivatori și consumatori, precum și pe cele care au ca destinație industria și industrializarea.

Tabelul 4

Principalele însușiri de calitate a soiurile de cartof românești incluse în sistemul național de producere a cartofului de sămânță

Însușirea de calitate	Soiul					
	Dacia	Roclas	Chrisitan	Amelia	Tâmpa	Nicoleta
Culoarea cojii	g	g	r	r	g	g
Culoarea pulpei	g	g	g	g	g	g
Forma tuberculilor	o	o	o	ro	o	o
Adâncimea ochilor	s	sa	fs	sa	sa	sa
Conținutul în amidon	16,0	17,0	17,0	20,0	16,5	21,5
Înnegrirea pulpei crude	3,8	3,1	3,7	3,5	2,5	1,9
Clasa de calitate	B	B	B	A/B	A/B	B
Destinația	Consum timpuriu și de vară	Consum timpuriu, de vară și industrializare	Consum timpuriu și de vară	Consum de toamnă-iarna	Consum de toamnă - iarnă și industri-alizare	Industralizare

Legenda:
Culoarea cojii: *g – galbenă;*
r – roșie.
Culoarea pulpei: *g – galbenă.*
Forma tuberculilor: *o – ovală;*
ro – rotund ovală.
Adâncimea ochlor: *fs – foarte superficiali;*
s – superficiali;
sa – semiadânci.
Înnegrirea pulpei crude: *1 – nu se înnegrește;*
9 – se înnegrește complet.
Clasa de calitate: *A- cartof consistent;*
B – cartof semiconsistent.

CONCLUZII ŞI RECOMANDĂRI

Soiurile de cartof româneşti, incluse în sistemul naţional de producere a cartofului de sămânţă, au o capacitate de producţie ridictă, similară, sau superioară, cu a celor mai valoroase soiuri din sortimentul mondial.

Soiurile recomandate au o bună rezistenţă la virozele grave (PVY şi PLRV), ceea ce permite înmulţirea lor în condiţiile specifice României;

Din punct de vedere a manifestării principalelor însuşiri de calitate, acestea satisfac cerinţele producătorilor şi consumatorilor de cartof, utilizate atât pentru consum în stare proaspătă, cât şi sub forma unor produse industrializate.

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PERFORMANCE OF NEW POTATO VARIETIES BRED AT RESEARCH AND DEVELOPMENT INSTITUTE FOR POTATO AND SUGAR BEET BRAŞOV

Summary

In the world but also in Romania a broad range of potato varieties is cultivated. Their cultivation is necessary as potato possess different use purposes, it is grown under very different ecological conditions; potato is subject to a large number of pest and growers' and consumers' demands are changing and increasing.

Out of the multitude of varieties the most performant recommendedvarieties must be included in the national system of seed potato production, taking into account that only a reduced number of varieties can be multiplied especially sold.

From 37 potato varietes bred at Research and Development Institute for Potato and Sugar Beet Braşov, the best of them: **Amelia, Christian, Dacia, Nicoleta, Tâmpa** and **Roclas** have been introduced in the National System for Seed Potato Production as the most performant varieties.

Keywords: potato, new variety, resistance to viruses, yield capacity.

Tables

1. Biological yield potential of potato varieties included in the National System of Seed Potato Production (NSSPP)

2. Potato yield of the varieties included in the NSSPP under different climatic conditions

3. Resistance of potato varieties included in the NSSPP to diseases and pest: 1. late blight on leaves; 2. late blight on tubers; 3. PVY; 4. PLRV; 5. wart disease(*Synchitrium endobioticum*); 6. cyst nematode (*Globodera rostochiensis*).

4. The main quality features of potato varieties included in the NSSPP: 1. Colour of skin: g- yellow, r – red; 2. Colour of flesh: g- yellow; 3. Shape of tubers: o – oval, ro – round to oval; 4. Shallowness of eyes: fs – very shallow eyes, s - shallow eyes, sa – moderate deep eyes; 5. Blackening of fresh flesh: 1 – not blackening, 9 – full blackening; 6. Quality class/cooking type: A – firm, B – fairly firm.

NEW POTATO VARIETIES, CREATED AT AGRICULTURAL RESEARCH AND DEVELOPMENT STATION (S.C.D.A.) SUCEAVA

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SUMMARY

The introduction in the crops of the next potato varieties: Atral, Magic, Victoria and Claudiu makes possible the diversification of the assortment of the potato varieties tilled in the area.

The results obtained in the respect of the resistance to some unfavourable biotic factors and in respect of productivity, write down the new genotypes to varieties with high yielding capacity.

Keywords: potato, new variety, yield capacity, rezistance to viruses.

INTRODUCTION

In the structure of crops from north and north – west of Moldova region, the potato has a considerable weight, by surface and economic importance. This fact is constant by the variety of climate conditions and soil, which offer most propitious breeding conditions to a huge assortment of potato varieties.

Bettering the assortment of potato varieties with more superior new genotypes, is one of the most efficient way of increasing yield, quality and yielding stability. (D. Bodea, 2001).

The admission in the crops of a big number of varieties leads to high genetic variety and to the possibility of choosing the best potato varieties that can adapt easier to yielding conditions and which suffer less from unfavourable factors. (I. Fodor, 1982).

In this situation, the obtaining of bumper crops and stable to, require a rational zoning of the crops and a good cognition of the varieties, those that have a high yield capacity and increased resistance to the attack of diseases and pests.

The material and intellectual effort made in a constant way in the potato breeding programme from the Agricultural Research and Development Station of Suceava made possible the homologation of a number of ten potato varieties between the years 2000–2004.

Depending on the performances of the new varieties there were chosen and promoted in the national seed potato production 4 varieties: Astral, Magic, Victoria and Claudiu.

The present paper wants to present a physiological, productive and qualitative characterization of the new varieties mentioned above.

MATERIALS AND METHOD

The varieties Astral (2001), Magic (2001), Victoria (2002) and Claudiu (2003) were created at the Agricultural Research and Development Station of Suceava in the potato breeding programme, using as method, the sexed hybridization, followed by the individual cloning selection.

The major objective had in view in the potato breeding programme from Suceava is obtaining early and middle early varieties with high potential yield and with qualities of resistance to the principal biotic and abiotic factors which limit yield.

The characterization of the new varieties is made on the results from field and laboratory analyses, after ecological testing.

RESULTS AND DICUSSIONS

Physiological qualities

The varieties Astral, Magic, Victoria and Claudiu are placed in the group of middle early varieties, with the vegetation period between 85-95 days.

As for the resistance qualities, the remarks made during the experimentation years, place the new varieties between the genotypes with high resistance to the action of risk, biotic and abiotic factors.

Diseases resistance. The gradual diminuation of yielding potato is determined by diseases produced by viruses (virosises), which lead to the unsettle of the plant metabolism and also to anatomico-morphological changes as: mosaification, plant illness caused by viruses, curly leaf, inclusive to the shorten of the vegetation period, to reducing yield and depreciation of tuber qualitie.

The level of reducing yielding of plants infected with viruses is determined, mostly, by the species and the strain of the virus, the tolerance of the potato variety and climatic and technological conditions.

The research proved that at a secondary infection of 100%, the yield is decreased with 5-15% in the case of viruses which have easy symptoms (viruses X, S, M, A) and 50-80% in case of viruses which have serious symptoms (Y virus and the virus of curly leaf) (C. Draica, 2003).

With these reasons in table 1. are presented the medium results obtained in four testing cycles, focused on the resistance of the new varieties to the serious potato virosis made by Y virus (Solanum virus 2) and the virus of curly leaf (Solanum virus 14), comparative with the witness varieties Desiree and Kondor and even the variety Sante, the most used in crops.

Table 1

The evaluation of the resistance to the infection PVY^0 and PLRV

Variety	PVY^0 virus		PLRV	
	Average grade	Rating	Average grade	Rating
Astral	8,7	Very high resistance	8,3	High resistance
Magic	9,0	Very high resistance	7,0	Moderat resistence
Victoria	9,0	Very high resistance	8,7	Very high resistance
Claudiu	9,0	Very high resistance	7,5	Moderat resistence
Desiree (Witness L.)	8,0	High resistance	**2,0**	**Very sensitive**
Kondor (Witness Y^0)	**3,2**	**Sensitive**	6,8	Middle sensitive
Sante	9,0	Very high resistance	6,5	Middle sensitive

Writing down the results from table 1. shows the superiority of the new varieties, regarding the resistance to the infections brought about the Y^0 virus and the virus of curly leaf, comparative with the witness varieties and also with the variety Sante. If we try to make a classification from this point of view the order would be next: Victoria, Astral, Claudiu, Magic, Sante.

These resistance qualities of the new varieties recommend them for crop because it is made possible the yield of seed without so much difficulties.

In table 2. are showen the results regarding the behaviour of the varieties to the late blight (*Phytophthora infestans*) attack; the resistance to the black scab of potato (*Synchytrium endobioticum*); the resistance to the golden nematod (*Globodera rostochiensis* Woll) and the resistance to the common scab (*Streptomyces scabies*).

Table 2

The evaluation of the resistance to:
late blight, black scab, common scab and golden nematod of potato

Variety	Resistance to late blight (Phytophthora infestans)	Resistance to black scab (Synchytrium endobioticum)	Resistance to common scab (Streptomyces scabies)	Resistance to golden nematod (Globodera rostochiensis)
Astral	MS	R	R	R
Magic	MS	R	MR	S
Victoria	MS	R	R	R
Claudiu	MR	R	MS	S
Desiree	MS	R	S	S
Sante	MS	R	MR	R
Ostara	S – MS	R	MS	S

S–sensitive; MS–middle sensitive;
MR–middle sensitive; R–resistant.

In respect of the reaction of the new varieties to the late blight attack it can be seen that the varieties are placed in the middle sensitive varieties group, with a exception from the variety Claudiu which behaved as tolerant to the attack of this disease. It was established that the variety Claudiu is characterized by a obvious field tolerace to the late blight attack, fact which allows it to keep a good part of the foliar apparatus in active condition untill maturity

A very important fact is that the varieties which were analised had a bigger resistance to late blight attack at tuber, so this fact leads to the limitation of the process of multiplication of the virus.

From this point of view it can be said that by introducing in the crop of the varieties: Astral, Magic, Victoria and Claudiu doesn't require a bigger number of treatments comparative with those that have to be done to those varieties that are already established in crop.

As concerns the resistance to black scab (Synchytrium endobioticum) the varieties proved to be resisting to the biotype DI of the disease. The differences between varieties can be noticed regarding their behaviour to the attack of the pathogenic agent Streptomyces scabies that causes common scab. The varieties Astral and Victoria show to be resisting, the variety Magic middle resisting and Claudiu middle sensitive.

The reaction of the new varieties at the attack of the golden nematod (*Globodera rostochiensis* Woll) is different in the way that the varieties Astral and Victoria are resisting to the palotype Ro_1, and the varieties Magic and Claudiu behaved as sensitive to the attack of this pest.

Yielding capacity

In respect of yield, the new genotypes are placed in the group of potato varieties with high potential yield.

The evaluation of the maximum potential yield (biological capacity) was made in the condition from Big Island of Brăila.

The data wrote down in table 3., strenghter the previous affirmation in the way that they certify the high yielding capacity of the new varieties.

Table 3

The evaluation of the maximum potential yield of new varieties in the condition from Big Island of Brăila

Variety	Yield/Years (t/ha)			Average yield (t/ha)	Rank after potential yield
	I	II	III		
Astral	55,5	71,3	76,1	67,6	III
Magic	85,9	70,5	65,8	74,1	II
Victoria	75,4	63,8	63,0	67,4	III
Claudiu	80,4	83,6	86,8	83,6	I
Ostara	54,4	34,1	38,9	42,5	V
Desiree	65,1	49,9	56,7	57,2	IV
Sante	57,7	50,1	65,8	57,9	IV

After the potential yield the new varieties are clearly superior comparative with the variety Ostara and also the varieties Sante and Desiree even if they don't belong to the same group of maturity. From this point of view it worthes being established the variety Claudiu which realized in average on three cycles of testes 83,6 t/ha. Remarkable at this variety is besides the high potential yield the yield stability.

In table 4. are wrote down the results obtained after the ecologic testing in four different localities from the areas very favourable to potato. The results are showen as average values obtained in three years of testing .

A closely analyse of the yielding realized allows to make the affirmation that at all varieties the average yield realized represents only 40-50% of the biological potential yield of the varieties. The responsible factors must be searched in the technological and ecological conditions offered to the crop. With all these it can be said that the new middle early varieties vie even with the middle late varieties Sante and Desiree reaching yield values equal or even bigger, as the variety Victoria.

Table 4

The evaluation of yield capacity of the new varieties in the areas very favourable to the crop

Variety	Yield/Localities (t/ha)				Average yield (t/ha)	Rack after yielding capacity
	Suceava	Braşov	M.Ciuc	Tg. Secuiesc		
Astral	35,7	30,0	30,6	33,4	32,4	III
Magic	35,3	32,2	34,1	32,1	33,4	II
Victoria	34,8	39,9	28,9	34,8	34,6	I
Claudiu	30,3	40,4	29,8	30,3	32,7	III
Ostara	21,6	21,0	23,2	30,0	24,0	IV
Desiree	33,5	40,3	27,7	29,3	32,7	III
Sante	32,0	41,0	29,0	31,3	33,3	II

Because the new varieties are placed in the middle early group their yield capacity was tested in the thermic and hydrological stress area, areas for yielding early and summer varieties.

In table 5. are showen the results from five Centers of experimentation early and middle early varieties.

Table 5

The evaluation of the yield capacity of the new varieties in the areas with thermic and water stress
(average in three years)

Soiul	Yield/Localities (t/ha)					Average yield (t/ha)	Rack after yielding capacity
	Calafat	Oltenița	Ovidiu*	Sibiu	Târgoviște		
Astral	18,0	27,8	40,1	18,0	20,4	24,9	II
Magic	15,0	28,2	37,9	22,3	17,7	24,2	III
Victoria	21,1	28,0	43,8	25,8	15,0	26,7	I
Claudiu	16,1	18,9	29,7	26,0	22,6	22,7	IV
Ostara	17,5	26,9	28,4	23,2	17,7	22,7	IV

* - irrigation conditions

The yield of the new varieties in these ecological areas are comparative with those from the early variety Ostara. The results from Ovidiu, in irrigation coditions established the fact that the varieties Victoria, Astral, Magic had a favourable response to this technological intensification factor.

Comparing the yield data in these ten ecological areas it was noticed that the new varieties have a high yield capacity in the areas favourable to potato, and in areas with thermic and hydrological stress have a favourable reaction with the water from the irrigation system.

Quality features

Cosumption potato quality is reprezented by the entire features and extern and intern characters of the tubers, and also the nutritive and keeping values. After Van Der Zaag (1992) the „quality" term includes all of the characteristics of the poatto, that make it utilizable in all purposes.

Physiological qualities of the yielding, at the new varieties is praised by potatoes with regular shape from oval-flat to oval-elongat shape, with superficial-middle dept eyes with godson yellow or red colored skin.

The culinary quality reprezents a complex feature defined by the boiling behaviour. Culinary quality is determened of a complex of features: the smashing at boiling, the firmness, the mealyness, the moisture and the structure of starch. (S. Mureşan and colab., 1974).

Table 6

The evaluation of the culinary quality of new varieties

The character	Variety					
	Astral	Magic	Victoria	Claudiu	Ostara	Desiree
Boiling aspect (1-4)	2,7	2,5	3,0	2,0	2,5	2,0
Taste (1-4)	2,2	2,2	3,0	3,0	2,2	2,0
Color (1-6)	5,5	5,0	5,0	3,0	4,0	4,0
Smashing at boiling (1-4)	2,5	2,2	2,5	1,5	2,0	2,0
Firmness (1-4)	2,5	2,0	2,5	2,0	2,0	2,0
Mealyness (1-4)	2,0	2,0	2,5	2,0	2,0	2,0
Moisture (1-4)	2,0	2,0	2,5	1,5	2,0	2,0
Structure of stach (1-4)	2,0	2,0	2,5	2,0	2,0	2,0
Quality class	B	B	B	A/B	A/B	A/B
Raw color	4,3	3,6	3,0	2,6	3,6	5,0
Physique starch content	14,1	15,3	14,0	11,8	16,0	16,0

The results obtained by the new genotypes in the culinary features aspect are written down in table 6.

The values obtained after laboratory analyses are completely illustrating for the culinary quality of the new creations. These allow placing it from this point of view in the rang of valuable varieties. Regarding some features as: boiling aspect, color, smashing at boiling, moisture and raw color, the variety Claudiu is the best from all the varieties that were tested, having superior values.

CONCLUSIONS

1.The potato varieties Astral, Magic, Victoria and Claudiu are in the group of intensive middle early varieties, having a high potential yield, associated with some superior agronomic features.

2.Very good resistance to serious viruses makes possible the multiplication of seed without any difficulties.

3.Middle early varieties Astral, Magic, Victoria and Claudiu are recommended for favourable and very favourable areas for potato, and in areas with thermic and hydrological stress only in irrigation condition.

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SOIURI NOI DE CARTOF CREATE LA SCDA SUCEAVA

Rezumat:

Introducerea în cultură a noilor soiuri de cartof: Astral, Magic, Victoria, şi Claudiu face posibilă diversificarea sortimentului de soiuri.

Rezultatele obţinute cu privire la rezistenţa la unii factori abiotici care afectează producţia recomandă soiurile menţionate ca având o capacitate ridicată şi constantă de producţie.

Cuvinte cheie: cartof, soi nou, capacitate de producţie, rezistenţă la virusuri.

Tabele

1. Evaluarea rezistenţei soiurilor la infecţia cu virusul Y şi cu virusul răsucirii frunzelor;
2. Evaluarea rezistenţei soiurilor la mană, râia comună, râia neagră şi nematozii cu chişti;
3. Evaluarea potenţialului maxim de producţie în condiţiile din Insula Mare a Brăilei;
4. Evaluarea capacităţii de producţie în zone foarte favorabile pentru cartof.
5. Evalurea capacităţii de producţie a soiurilor noi în zona cu stres termic şi hidric.
6. Evaluarea calităţii culinare a noilor soiuri.

NOI SOIURI DE CARTOF CREATE LA STAȚIUNEA DE CERCETARE–DEZVOLTARE PENTRU CARTOF TG.SECUIESC

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REZUMAT

În cadrul Stațiunii de Cercetare-Dezvoltare pentru Cartof Tg. Secuiesc, specializată pe crearea de soiuri pentru consum și industrializare, s-au înregistrat în *Lista Oficială a Soiurilor* în ultimii ani patru soiuri de cartof, și anume: **Redsec, Coval, Nemere și Luiza**.

Se prezintă descrierea și rezultatele obținute după testarea acestor soiuri timp de 3 ani, în 7 centre ale Institutului Național de Testare și Înregistrare a Soiurilor (ISTIS)

Toate cele patru soiuri sunt productive, au un conținut în amidon cuprins între 17-20%, sunt rezistente la nematozii cu chiști din genul *Globodera rostochiensis*, la râia neagră (*Sinchitrium endobioticum*) și la viroze. Soiurile au fost create prin hibridare sexuată, urmată de selecție clonală individuală. La stabilirea genitorilor s-a ținut cont de conținutul în substanță uscată, rezistența la nematozi, rezistența la viroze și, nu în ultimul rînd, de capacitatea de producție.

După stabilirea genitorilor s-a urmat schema clasică pentru ameliorarea cartofului în câmpul de la Tg. Secuiesc și schema selecției de menținere în câmpul de la Apa Roșie.

Cuvinte cheie: cartof, ameliorare, hibridare sexuată, selecție clonală, soi.

INTRODUCERE

Crearea soiurilor de cartof a constituit un obiectiv prioritar încă de la înființarea SCDC Tg. Secuiesc, în anul 1980. Activitatea de creare a soiurilor noi de cartof a fost amplificată după anul 1990 (Draica și colab., 1996), fiind coordonată de Institutul de Cercetare-Dezvoltare pentru Cartof și Sfeclă de Zahăr (ICDCSZ) Brașov. Folosind metoda hibridării sexuate, urmată de selecția clonală individuală, s-au creat și înregistrat în *Lista Oficială a Soiurilor Cultivate în România* un număr de 11 soiuri (Mike și colab. 2000; Mike, 2001).

În această lucrare se prezintă descrierea și rezultatele privind producția, calitatea și rezistența la boli a ultimelor 4 soiuri înregistrate în Lista Oficială: **Redsec, Coval, Nemere și Luiza.**

MATERIALUL ŞI METODA DE CERCETARE

Toate soiurile au fost obţinute prin hibridare sexuată urmată de selecţie clonală individuală, conform schemei clasice de ameliorare la cartof. (Bozeşan, 2002).

Principalele etape ale metodei de lucru au fost:

➢ stabilirea genitorilor din punct de vedere al calităţilor tehnologice şi fiziologice funcţie de scopul de folosinţă al soiului nou creat.

➢ hibridarea sexuată şi în continuare urmărindu-se toate etapele clasice: seminceri, populaţii vegetative, descendenţi, culturi comparative de orientare, culturi comparative de concurs, trei ani de testare în reţeaua ISTIS.

➢ omologarea şi înregistrarea

REZULTATE ŞI DISCUŢII

Soiul REDSEC - a fost înregistrat în *Lista Oficială a Soiurilor* în anul 1999.
Genealogia soiului Redsec: M.P.I. 61-516-20 x CERTO

Caracterele morfologice:

Tufa: dezvoltată, bogată in frunze cu număr mare de tulpini
Rădăcina: răsfirată, de culoare alb maronie.
Tulpina muchiată, talie mare, semierectă, cu numar mare de tulpini
Frunza: semicompactă, cu foliole mari, de culoare verde închis
Inflorescenţa: cimă simplă, cu peduncul dezvoltat, corola de culoare violet deschis, cu flori mari, antere de culoare galben deschis, cu polen mult.
Tubercul: rotund, culoarea cojii roşie, culoarea pulpei galbenă, ochi superficiali
Colţii crescuţi la lumina difuză: au forma oval alungită de culoare violacee, cu perozitate abundentă.
Perioada de vegetaţie: 90 – 100 zile. Se încadrează în grupa soiurilor semitârzii

Soiul COVAL - a fost înregistrat în *Lista Oficială a Soiurilor* în anul 1999
Genealogia soiului Coval: BOBR x SUPER

Caraceterele morfologice:

Tufa: mijlociu dezvoltată, rarefiată, cu numar mediu de tulpini.
Radacina: rasfirată, de culoare alb-maroniu
Tulpina: dezvoltată, de talie mare, cu port semierect.
Frunza: este semicompactă cu foliole de mărime mijlocie, de culoare verde clar.
Inflorescenţa: este cimă simplă, cu flori mari albe.

Tuberculii: au forma rotund – ovală, mari, bine conturați. Culoarea cojii si pulpei este galbenă, cu ochi superficiali.

Colți: la începutul dezvoltării de formă globulară, ulterior de forma butoiului, mugurele terminal mic, închis și de culoare roșu-violaceu, cu ramificații laterale lungi.

Perioada de vegetație: este de 95 zile încadrîndu-se în grupa soiurilor semitârzii.

Soiul NEMERE - a fost înregistrat în Lista Oficială a Soiurilor în anul 1999
Genealogia soiului Nemere: M.P.I. 61-516-20 x Certo

Caractere morfologice:

Tufa: dezvoltată, foarte bogată în vreji, cu port semierect.
Tulpina: viguroasă, bogată în frunze.
Frunza: este compactă, de mărime mijlocie, verde închis
Inflorescența: cimă simplă, corola de culoare albă cu flori mari, antere de culoare galben deschis, cu polen mult.
Rădăcina: răsfirată, de culoare alb maroniu.
Tubercul: rotund, culoarea cojii galbenă, culoarea pulpei galbenă, cu ochi semiadanci.
Perioada de vegetație: 85-95de zile.Se încadrează în grupa soiurilor semitârzii.

Soiul LUIZA - a fost înregistrat în Lista Oficială a Soiurilor în anul 2000
Genealogia soiului Luiza: FANAL x OMEGA

Caractere morfologice:

Tufa: dezvoltată, cu număr mediu de tulpini.
Rădăcina: foarte dezvoltată, de culoare alb-maroniu.
Tulpina: viguroasă, semierectă, de culoare verde-deschis.
Frunza: de mărime mijlocie de culoare verde deschis.
Inflorescența: cimă simplă cu peduncul dezvoltat, corola de culoare albă, cu flori mari, cu antere de culoare galben deschis.
Tubercul: oval, mare cu ochi superficiali, coaja galbenă, pulpa galbenă.
Colții: de mărime mijlocie, la începutul dezvoltării lor de formă conică, ulterior de formă cilindrică, mugurele terminal de culoare roșie-violacee, cu ramificații laterale scurte.

Perioada de vegetație: 85-100de zile, se încadrează în grupa soiurilor semitârzii.

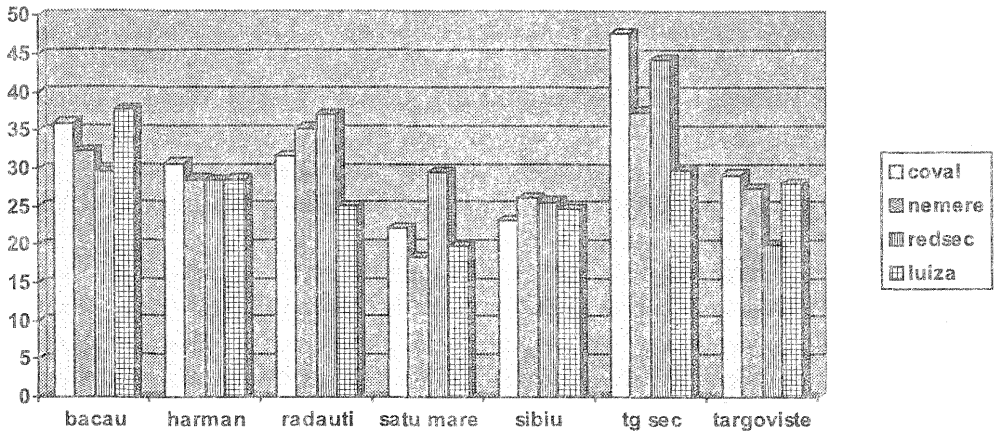

Figura 1: Capacitatea de producţie a soiurilor: Redsec, Coval, Nemere, Luiza

Tabelul 1. Calitatea culinară a soiurilor: Redsec, Coval, Nemere, Luiza

Caracterul	Soiul				Observatii
	Redsec	Coval	Nemere	Luiza	
Aspectul (1-4)	1,5	1,0	2,0	1,5	1-aspect corespunzator 4- aspect necorespunzator
Gustul (1-4)	1,0	2,5	3,0	2,5	1- gust foarte bun 4- gust necorespunzator
Culoarea (1-6)	2,8	3,0	3,5	3,0	1- neschimbata 6- complet schimbata
Sfărâmarea la fierbere (1-4)	2,1	2,0	2,5	2,0	1- tuberculi intacti 4- complet sfaramati
Consistenţă (1-4)	2,0	2,0	2,5	1,5	1- moale, untoasa 4- tare
Făinozitate (1-4)	3,2	2,0	2,8	2,0	1- fina 4- grosiera
Umiditate (1-4)	3,0	3,0	2,0	2,0	1- lipseste apa 4- apatos
Structura amidonului (1-4)	1,9	2,0	2,0	1,8	1- fina 4- grosiera
Clasa de calitate	A/B	A/B	C	B	A- consistent D- foarte făinos
Colorarea crudă (1-9)	3,0	4,3	3,8	3,5	1- necolorat 9- înnegrit
Amidon fizic	17,0	18,6	17,5	19,5	-

Cele 4 soiuri, ca de altfel toate soiurile româneşti şi străine au fost testate în 7 centre ale Institutului de Stat pentru Testarea şi Înregistrarea Soiurilor (ISTIS), pe o perioadă de 3 ani. Rezultatele sunt prezentate în fig. 1.

➢ La soiul **Redsec** s-a obținut o producție maximă de 44,3 t/ha și o producție medie de 29,1 t/ha.

➢ La soiul **Coval** s-a obținut o producție maximă de 47,7 t/ha, și o producție medie de 29,9 t/ha.

➢ La soiul **Nemere** s-a obținut o productie maximă de 37,4 t/ha, și o producție medie de 29,4 t/ha.

Tabelul 1: Calitatea culinară a soiurilor: Redsec, Coval, Nemere, Luiza

➢ La soiul **Luiza** s-a obținut o producție maximă de 29,6 t/ha, și o producție medie de 27,6 t/ha.

Conform datelor prezentate în tab. 1, noile soiuri se caracerizează astfel:

➢ Soiul **Redsec** se încadrează în clasa de calitate A/B.Are calități culinare superioare, consistență mijlocie, fiind pretabil pentru majoritatea preparatelor culinare și pentru obtinerea de chips. Acest soi se poate folosi atît pentru consum, cât și pentru industrializare.

➢ Soiul **Coval** se încadrează în clasa de calitate B, având calități culinare bune. Poate fi folosit atît pentru consum cât și pentru industria producătoare de preparate culinare ca: chips, pommes-frities și chiar în industria amidonului.

➢ Soiul **Nemere** se încadrează în clasa de calitate C, are calități culinare superioare, gust bun, la fierbere tuberculii se crapă puțin, dar nu se sfărâmă și se comportă bine la prepararea de chips. Poate fi folosit atît pentru consum cât și pentru industrializare.

➢ Soiul **Luiza** se încadrează în clasa de calitate B. Are calități culinare bune, gust bun, se comportă bine la prepararea de chips. Se pretează atât pentru consum cât și pentru industria amidonului.

Tabelul 2. Rezistența la boli și dăunători a soiurilor Redsec, Coval, Nemere, Luiza

Soiul	Virusul Y^0		Virusul răsucirii frunzelor		Mană	
	Nota medie	Calificativ	Nota medie	Calificativ	Nota Medie	Calificativ
Redsec	9	Rezistenta foarte ridicata	9	Rezistenta foarte ridicata	6	Relativ rezistent
Coval	9	Rezistenta ridicata	8	Rezistent	5	Mijlociu sensibil
Nemere	6,5	Rezistenta mijlocie	7	Rezistenta moderata	6	Relativ rezistent
Luiza	8,5	Rezistenta foarte ridicata	8,5	Rezistenta foarte ridicata	6	Relativ rezistent

Note: 1-2 - foarte sensibil
9 - foarte rezistent

Datele prezentate în tabelul 2 caracterizează noile soiuri din punct de vedere al rezistenţei la boli:

➢ Soiul **Redsec** are o rezistenţă mijlocie la virusul Y şi la virusul răsucirii frunzelor, mijlociu rezistent la mana pe frunze şi tuberculi, rezistent la râia neagră, rezistent la nematodul cu chişti.

➢ Soiul **Coval** este rezistent la râia neagră, mijlociu de rezistent la mana pe frunze şi tuberculi, cu rezistenţă mijlocie la virusul Y şi PLRV

➢ Soiul **Nemere** este rezistent la râia neagră, mijlociu de rezistent la mana pe frunze şi tuberculi, cu rezistenţă mijlocie la virusurile Y şi PLRV, rezistent la nematozi.

➢ Soiul **Luiza** este mijlociu de sensibil la mana pe frunze şi tuberculi, foarte rezistent la virusul Y şi virusul răsucirii frunzelor,şi rezistent la nemtodul cu chişti.

CONCLUZII

Soiurile nou create la SCDC Tg. Secuiesc au o capacitate bună de producţie, sunt valoroase din punct de vedere al rezistenţei la degenerarea virotică, ceea ce pentru etapa actuală este de o importanţă majoră, avînd în vedere fărîmiţarea fondului funciar, nerespectarea rotaţiei culturilor şi cultivarea cartofului de persoane mai puţin calificate.

Prin conţinutul mare de substanţă uscată, soiurile sunt pretabile pentru industrie şi industrializare care pot fi cultivate în sistem intensiv.

În vederea promovării în producţie, s-au organizat loturi demonstrative în diferite localităţi din România.

În vederea promovării ca soiuri pentru industrializare (fulgi, chips, amidon) s-au înfiinţat loturi demonstrative în zona Făgăraş şi la SC ROCLIP SA - Făgăraş.

În prezent se dispune de material pentru plantare din categoria biolgică prebază I, şi s-a reluat ciclul menţinerii la Centrul Apa Roşie.

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NEW POTATO VARIETIES BRED AT POTATO RESEARCH AND DEVELOPMENT STATION, TG. SECUIESC

Abstract

The Potato Research and Development Station Tg. Secuiesc, specialized in breeding potato varieties for consumption and processing, has developed and registered 4 new potato cultivars in the *Official List of Varieties* in the last years, i.e: **Redsec, Coval, Nemere** and **Luiza**.

The paper presents the description and the results achieved after 3 years testings in 7 centres of the National Institute for Variety Testing and Registration (ISTIS).

All 4 varieties showed good yield, have a starch content between 17-20%; they are resistent to cyst nematodes (*Globodera rostochiensisi*), to black scurf (*Sinchitrium endobioticum*) and to virus diseases. These cultivars were bred by sexual hybridization, followed by clonal slection. In establishing th genitors, we took account of dry matter content, resistance to nematodes, resistance to virus infections and yield potential.

After setting the genitors, we followed the classic scheme of variety breeding in the field at Tg. Secuiesc and the scheme of maintaining selection in the field at Apa Roşie.

Keywords: potato, breeding, sexual hybridization, clonal selection, new varieties

Tables:

1: Culinary quality of varieties: Redsec, Coval, Nemere, Luiza

2: Resistance to pest and diseases of varieties: Redsec, Coval, Nemere, Luiza

Figures:

1: Yield capacity of varieties Redsec, Coval, Nemere, Luiza

ROZHEN – A NEW BULGARIAN POTATO VARIETY SUITABLE FOR FRESH CONSUMPTION AND PROCESSING

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SUMMARY

The variety is bred in the Maritsa Vegetable Crops Research Institute, Plovdiv as a result of inbreeding in line 1186 (Katadin x S. sysimbrifolium) followed by an individual clone selection. It is approved by the Executive Agency for Variety Testing, Approbation and Seed Control, Sofia in 2004.

The variety forms from 12 to 14 tubers per hill. The tubers are long-oval with red skin, shallow eyes and yellow flesh, with very good cooking and market properties. They possess russet gene determining their high adaptability for industrial processing. Mid-late variety suitable for mid-early and late production. It is characterized with high potential for yield (over 3000 kg/dka). Suitable for mechanized cultivation and harvesting.

It has moderate resistance to virus diseases, high resistance to leaf and tuber blight (Phythophtora infestans) and very high resistance to common scab (Streptomyces scabies) and rhizoctoniose (Rhizoctonia solani). The dry matter content is within 21–22%, starch 16–17% and reducing sugars 0.15–0.20%. It possesses excellent taste qualities. The variety is suitable for fresh consumption, chips and French-fried potatoes. It is stored very well during winter-spring season.

Key words: potato, breeding varieties, characters, resistance

INTRODUCTION

Potatoes are traditional and economically important crop for Bulgaria. This crop has been carried in our country from Rumania in 1825 (Staikov, 2002). The next years is characterized with considerable expansion of potato crop – gradual area augmentation and total production increase. At present the areas, which are occupied by potatoes in Bulgaria are over 500 000 dka, with a tendency for an increase. The main directions of their production are early, medium and late, cultivation as a catch crop by summer planting, production of seed material. The early production is done by cultivation in the plains, along the river valley and around the big towns and the mid-early and late ones – in hilly and upland zones.

The diverse and often extreme climatic conditions (Petkova, Nacheva, 2001) of the individual regions, the high infectious background in the country (Muletarova, Nacheva, 1995) and the low propagation coefficient of the crop impose the use of a great set of

varieties. The variety structure of our potato production is presented mainly by Dutch and German breeding, while the Bulgarian varieties are under 10 per cent.

The area augmentation and potato consumption in Bulgaria, the increased requirements of growers, consumers, processors and the limited set of Bulgarian varieties for the particular production directions imposed the development of new potato varieties for consumption and industrial processing with high biological potential for yield and quality, resistant to biotic and abiotic factors of stress and meeting the national peculiarities, demanding buyer's taste (Nacheva, 2002).

The purpose of the present study is to be performed agrobiological and economic evaluation of the characters and qualities of the new variety Rozhen, bred in the Maritsa Vegetable Crops Research Institute.

MATERIAL AND METHODS

The variety Rozhen is bred in the Maritsa Vegetable Crops Research Institute, Plovdiv, from author team – research worker Dr, Stephka Mouletarova, research worker Dr. Emilia Nacheva and senior research worker Stoil Kalfov. It is developed as a result of inbreeding in line 1186 (Katadin x S. sysimbrifolium) and followed individual clone selection. Morphological characteristics of the new variety includes characters grounded on the methods of the Executive Agency for Plant Variety Testing, Approbation and Variety Maintenance for Distinction, Homogeneity and Stability which is harmonized with the UPOV requirements. For testing of the productive potential of the variety Rozhen is set three-factor field experiment by block method in four replications at drilling distance 75/30 cm and size of the experimental plot 250 m^2. The following factors were studied:

A - genotypic differences with 2 treatments: variety Rozhen and a control for the mid-late group of maturity variety Agria.

B – year of study: 1998 – 2000

C – ecological regions with three classes: Plovdiv's region, located in the Highthracian plain, along the Maritsa river valley, altitude 160 m; region of the village of Pavelsko, located in Rodopes mountain at altitude 600 m; the region of peak Pashaliitsa, situated in Rodopes mountain at altitude 1600 m.

The planting in the individual ecological zones is carried out in the beginning of March, April and the second half of May, respectively, with planting material received from our upland base in the village of Pavelsko and the harvesting was done during July, September and October. During the vegetation are made observations for the occurrence of the main phenophases of potato plants and is estimated the continuation of vegetation period from planting to drying of above-ground mass. The response of susceptibility at natural background for infestation to fungal diseases leaf and tuber blight (Ph. Infestans), common scab (Streptomyces scabies), rhizoctoniose (Rhizoctonia solani) by recording the extent of damages by 0-4 scale (Mckiney) was studied. The field resistance to viral diseases PLRV (potato leaf roll virus), PVX (potato virus X), PVY (potato virus Y) is determined by recording the index of damage (0-9 scale).

At harvesting of the treatments are recorded the characters tuber number per hill, tuber weight per hill (kg), tuber shape (length x 100/ diameter), eye depth (1-9 scale), standard and total productive (kg/dka), percentage standard produce.

Of an average sample from 20 tubers is determined dry matter contents (by weight), starch (calculated by Reiman) and reducing sugars (Shoorl - Reggenbogen) from each treatment are prepared chips, French fries and boiled potatoes to which is made a panel test on the indices appearance, aroma, colour, texture and taste.

All data are processed statistically (Lakin, 1990).

RESULTS AND DISCUSSION

The results from the balance of the potato produce in Europe, where over 41% of it is intended for industrial processing (Reust et al, 1997) and in Bulgaria, where prior to this moment there are no own specialized varieties for chips and French fries indicate the necessity from breeding activity for improvement of chemical and technological as well as organoleptic qualities of Bulgarian varieties. With regard to this as starting material for the Rozhen breeding are used the variety Katadin and the species S. sysimbrifolium. The mother form (Katadin) is included in the pedigree of the new variety (Fig. 1) mainly because of its excellent taste qualities, adaptability for processing in chips and French fries, resistance to drought, viruses X, Y, A, S and the red colour of its skin. It is distinguished by high productivity, adaptability and storability for the soil and climatic conditions of Bulgaria. A part of the shortcomings of this variety – susceptibility to leaf and tuber blight (Ph. infestans), common scab (Streptomyces scabies), rhizoctoniose (Rhizoctonia solani) and the leaf roll virus PLRV we have tried to improve by including of the S. sysimbrifolium species. The previous studies carried out in the Maritsa Vegetable Crop Research Institute showed that it is characterized with resistance to potato late blight, viruses X and Y and high resistance to freezing (up to – 12°C). The received as a result of hybridization between these two parents F_1 progeny is distinguished with reach diversity of forms having different productivity and combination of the characters required by us. With the most favourable combination of morphological, economical, chemical and technological, and organoleptic qualities is characterized line 1186 in the inbreeding progeny of which is selected the variety Rozhen.

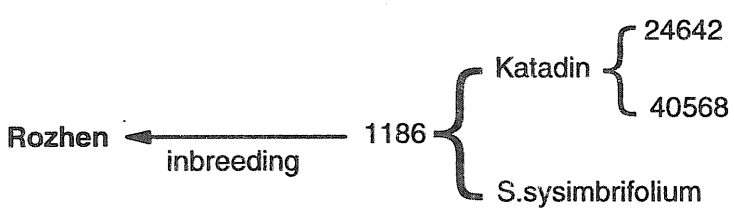


Fig.1. Origin of Rozhen

The sprout of the new variety is mid-large, widely-cylindrical, red-purple, with medium intensity of anthocyanin discolouration and weak pubescence in the base. The tip is small, open and medium length of the lateral shoots. The plant is medium high to high, erected, leafy. The stems are thick, vital, with strong anthocyanin discolouration. The leaves are large, green, medium open silhouette and curly, with anthocyanine pigmentation of the midrib and the young leaflets. The midrib, terminal leaflet and the lateral leaflets are characterized with comparatively high frequency of the secondary leaflets. The variety Rozhen is characterized with medium to high intensity of the blossoming depending on the soil and climatic conditions, red-violet flowers and typical anthocyanine pigmentation along the bud, the flower stalk and the inner part of the coloured flower. Frequently produce berries with specific conic shape and strongly tapered tip, which is one of the main characters for variety distinction. The root system is well developed, tuber-bearing shoots are short and the cluster tidy. The variety forms 12 to 14 tubers per cluster. The tubers are large, uniform in shape, long-oval with shallow eyes and yellow flesh with very good culinary and market qualities. The skin is red, slightly rough with the presence of russet gene, which is correlatively related with the high suitability of Rozhen for industrial processing and is one of the characters for variety distinction.

The summarized data from agrobiological study of the varieties Rozhen and Agria show considerable differences in the expression of some principle morphological characters (Table 1). In comparison with the control Rozhen distinguishes by greater number of stems per plant (4.6) and greater tuber number per stem (2.7) as a result of which in one cluster forms 4 tubers more than Agria but with lower average weight (74.3 g). Excluding the character stem number per plant variation coefficients of the remaining are lower in variety Rozhen, which is an indication for its relatively higher stability in the change of the environment conditions. The average tuber weight per cluster in variety Rozhen is by 133 g higher compared to the control. Because of the genotypic homogeneity of the potato varieties follow that the recorded comparatively high variability of this character in both varieties (CV = 29.1 – 32.1%) is due to the effect of the ecological factors and the genotype x environment interaction. In this way the observed phenotypic variability by years and ecological zones of the character total yield could be also explained (Fig. 2). The proof for the made supposition is found in the results from the performed three-factorial analysis of variance (Table.2). Data from the analysis of the variance show that the differences in the productivity are defined by the different inheritance potential of both varieties. The strength of influence of this factor is 12.7%. Despite of the genotypic determination of the studied character a considerable effect on it exert the environment conditions. The phenotypic variation of the productivity in tested varieties is due to a great extent to soil and climatic differences in the regions of cultivation (51%) and the interaction of the genotype with the factors year and ecological zone (9.7%). The conditions of year though proved are characterized by lower strength of influence (4.5%).

Table 1

Morphological characteristics of varieties Rozhen and Agria

Characters	Rozhen		Agria	
	x	CV%	x	CV%
Number of stems per plant	4.6	14.1	4.0	12.5
Number of tubers per plant	2.7	11.1	2.1	11.9
Number of tubers per hill	12.4	13.7	8.4	15.5
Standard tuber number per hill	9.5	12.6	6.8	13.2
Non-standard tuber number per hill	2.9	10.3	1.6	12.5
Average tuber weight (g)	74.3	21.5	82.4	30.3
Average tuber weight per hill (kg)	0.756	29.1	0.623	32.1
Shape of tubers (index)	152.6	15.7	140.1	20.7
Shallowness of eyes (scale 0-9)	7.8	17.9	8.2	11.0

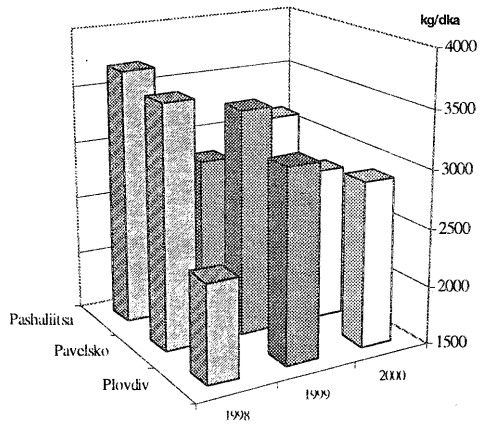
Table 2

Three-factorial analysis of variance of total yield

Source of	df	Mean square	F-value	Influence %
Total	71			
Genotype	1	3.41	87.23***	12.7
Year	2	0.61	15.48***	4.5
Ecological zone	2	6.84	174.85***	51.0
Genotype x year	2	0.05	1.28	-
Genotype x ecological zone	2	0.80	20.47***	6.0
Year x ecological zone	4	0.51	13.11***	7.6
Genotype x year x ecological zone	4	0.65	16.69***	9.7
Error	54	0.04		8.0

*** p Ł 0.001

Rozhen



Agria

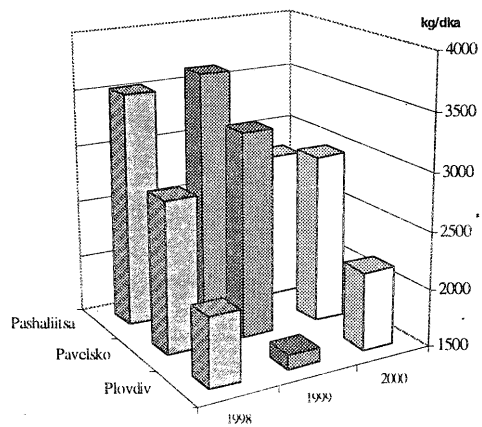


Fig 2. Total productivity of varieties Rozhen and Agria

In comparison of the values of the arithmetical means of both varieties (Table 3.) are established differences not only in total but also in their standard productivity. Rozhen is distinguished by higher percentage of standard produce (93.4%) as a

result of which surpasses the total yield of the control by 17.3% and the standard one by 21.9%. The advantage of the new variety is the higher resistance to fungal diseases – common scab (Streptomyces scabies), leaf and tuber blight (Ph. Infestans), rhizoctoniose (Rhizoctonia solani) (0.9, 0.83, 0.95 and 0.67) compared to the control (3.85, 1.95, 1.07, 2.1) and relatively high field resistance to viral diseases.

The results from the chemical analysis of the tubers (Table 4.) show that Rozhen is characterized by insignificant lower content of dry matter (22.6%) and starch (16.9%) than Agria (23.1; 17.3%). The recorded values of both indices completely meet chemical and technological requirements for the production of chips and French fries and classify the varieties as suitable for industrial processing. An additional advantage of the new variety is the triple lower of reducing sugars (content 0.16%) compared to the control (0.48%) as a result of which the obtained in frying potato products are distinguished by intensively golden yellow color and receive excellent organoleptic evaluations (4.44, 4.35). The performed sensory analysis of boiled potatoes show higher panel test mark (4.07) for variety Rozhen appearing a consequence of lower expressed flouriness and very good taste qualities.

Table 3

Economic characteristics of varieties Rozhen and Agria

Characters	Rozhen	Agria
	x ± sd	x ± sd
Duration of vegetation period	124.3 ± 9.7	127.5 ± 10.8
Standard yield (kg/dka)	2989 ± 521	2452 ± 549
Total yield (kg/dka)	3200 ± 609	2728 ± 731
% standard produce	93.4 ± 2.1	89.9 ± 2.2
Standard yield compared to control	121.9	100
Total yield compared to control	117.3	100
Resistance to rhizoctoniose	0.67 ± 0.30	2.10 ± 0.25
Resistance to common scab	0.90 ± 0.10	3.85 ± 1.30
Resistance to leaf blight	0.83 ± 0.07	1.95 ± 0.47
Resistance to tuber blight	0.95 ± 0.05	1.07 ± 0.10
Resistance to PLRV	7.7 ± 1.05	5.8 ± 1.8
Resistance to PVX	7.1 ± 0.65	8.2 ± 1.10
Resistance to PVY	7.3 ± 0.60	8.2 ± 0.95

Table 4

Chemical-technological and organoleptic characteristics of varieties Rozhen and Agria

Characters	Rozhen	Agria
	x ± sd	x ± sd
Dry matter contents (%)	22.6 ± 2.32	23.1 ± 2.94
Starch contents (%)	16.9 ± 1.44	17.3 ± 1.57
Reducing sugar contents (%)	0.16 ± 0.024	0.48 ± 0.082
Quality of boiled potatoes	4.07 ± 0.61	3.60 ± 0.55
Quality of chips	4.44 ± 0.53	4.13 ± 0.48
Quality of French fries	4.35 ± 0.58	3.95 ± 0.47

CONCLUSIONS

The agrobiological evaluation made of the potato variety Rozhen show that is bred an original genetic plasm characterized with valuable morphological characters. The higher productive potential of the new variety, its resistance to some economically important for the country diseases and the improved chemical and technological, as well as taste qualities give us a reason to guarantee its competitive power on Bulgarian market.

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ROZHEN – UN NOI SOI BULGĂRESC DE CARTOF PENTRU CONSUM ŞI INDUSTRIALIZARE

Rezumat

Soiul Rozhen a fost creat la Institutul de Cercetări pentru Legume Maritsa, Plovdiv, ca rezultat al hibridării în linia 1186 (Katadin x S. sysimbrifolium) urmată de selecţia clonală individuală. Soiul a fost aprobat de către Agenţia pentru Testarea şi Certificarea Soiurilor şi Controlul Semințelor, Sofia în anul 2004.

Soiul formează între 12 şi 14 tuberculi la cuib. Tuberculii sunt oval alungiţi cu coajă roşie, ochi superficiali şi pulpa de culoare galbenă, cu proprietăţi culinare excelente şi pretabili la comercializare. Gena *russet* determină o mare adaptabilitate la prelucrare industrială.

Soiul este semitardiv, pretabil pentru producerea cartofului în sezonul semitimpuriu până la târziu. Este caracterizat printr-un mare potenţial de producţie (peste 30 to/ha). Este corespunzător pentru cultivare şi recoltare mecanizată.

Soiul are rezistenţă moderată la virusuri, rezistenţă ridicată la mana foliară şi a tuberculilor (*Phythophtora infestans*) şi o mare rezistenţă la râia comună (*Streptomyces scabies*) and rizoctonioză (*Rhizoctonia solani*). Conţinutul de substanţă uscată se situează între 21–22%, amidon 16–17% şi zaharuri reducătoare 0.15–0.20%. Are calităţi excelente de gust. Soiul este pretabil pentru consumul în stare proaspătă, fabricarea chipsului şi pommes-frites. Se păstrează foarte bine pe perioada sezonului iarnă-primăvară.

Cuvinte cheie: soi, consum, industrializare, rezistenţă

Tabele:

1. Caracteristicile morfologice ale soiurilor Rozhen şi Agria
2. Analiza trifactorială a variaţiei producţiei totale
3. Caracteristici economice ale soiurilor Rozhen şi Agria
4. Caracteristici chimico-tehnologice şi organoleptice ale soiurilor Rozhen şi Agria

Figuri:

1. Originea soiului Rozhen
2. Productivitatea totală a soiurilor Rozhen şi Agria

SANSORY ANALYSIS OF EARLY BULGARIAN POTATO LINES FOR PROCESSING

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SUMMARY

The organoleptic properties of seven early lines of potatoes, processed in three treatments – boiled, French fries and chips were evaluated. The sensory analysis was performed by the following characters: *colour*, *aroma*, *texture* and *taste*. For boiled potatoes the characters *external appearance*, *friability* and *starch taste* were also added. The best complex evaluation of boiled potatoes was obtained in line E 292, which was distinguished by homogeneous yellow colour, strong aroma and taste, having chestnut nuance, uniform, melting during consumption texture and lack of starch taste. The tubers were not friable and their surface remained smooth after peeling of the skin. The above-mentioned line as well as the lines E 78 and E 686 obtained high total sensory evaluation in processing as French fries. The colour of the slices was intensively yellow, burning free and the texture was tender without a dividing line between a core and surface. A Line E 112 was the most suitable for chips. It had uniformly golden pigmentation, very frail and crisp texture. The best lines at least in one of both experimental years from the three variants of heat treatment did not differ in total sensory evaluation from the control cultivar for quality Sante. The correlation between the dry matter content and sensory evaluation for chips was significant ($r = 0.669$) while in boiled potatoes and French fries it was insignificant. A relationship between the reducing sugars content and total sensory evaluation for the three treatments of potato tuber processing was not established.

Key words: boiled potatoes, French fries, chips, organoleptic evaluation

INTRODUCTION

The breeding program of potatoes for industrial processing in Maritsa Vegetable Crops Research Institute is directed to creation of cultivars with complex properties, satisfying concurrently all participants at the market. The producers wishing to cultivate high yielding cultivars with defined morphological properties resistant to unfavourable biotic and abiotic factors are on the one hand. Their purpose is a sure profit after produce selling to be obtained. The consumers are on the other hand. Their requirements are directed mainly to the health safety (toxic elements free), nutritive value and taste properties of the potato tubers.

The potatoes are used for consumption both for incoming wholesome components in the human body and for the pleasure which they provoke by their aroma, colour and taste after processing in chips, French fries, potato puree and other products. Good sensory properties ensure stable realization as a raw material for different directions of the food industry.

The high organoleptic level reaching is possible only when the sensory analysis is considered as a compulsory element in the potato breeding. The organoleptic properties of potato tubers are evaluated in comparative late stage of the breeding process. The procedures is made after finishing of the selections by tuber productivity, shape and weight, flesh colour, resistance to economically important diseases etc. In this aspect the work of taste panelists is rather précised and responsible. On the basis of their evaluations it is depending to a great extent whether a specific line will be realized as a cultivar or as a result of insufficient taste properties it will be included again in the breeding process as a parent component for improvement of other valuable characteristics of potatoes.

Depending on the direction of processing different properties of potato tubers are evaluated. Four primary characters obligatory present in sensory analysis of boiled potatoes, French fries and chips. These are colour, texture, aroma and taste (Holm et al., 1994; Lovatti et al., 1999). Some researches look for a relation between the instrument and sensory evaluation of these characters (Segnini et al., 1999; Thybo and Martens, 1998). Others investigate their inheritance in hybrid progenies (Dale and Mackay, 1994). The ambition of all is one - development of potato cultivars which in fuller extent to meet the taste requirements of the great diversity of consumers.

The purpose of the present study was to be performed sensory analysis of seven early potato lines, grown in high mountain conditions of Bulgaria and to be evaluated their adaptability for processing in boiled potatoes, French fries and chips.

MATERIALS AND METHODS

The experiment was carried out during the 2002-2003 period with early potato lines D 112, E 78, E 419, E 112, E 292, E 606, E 686 and the control cultivar for quality Sante, cultivated at altitude 1600 m in the countryside Pashaliitsa in Rodopes mountain range, a base of Maritsa Vegetable Crops Research Institute. From each treatment were prepared boiled potatoes, French fries and chips. The sensory analysis was performed by the following characters: *colour, aroma, texture and taste.* For boiled potatoes the characters *external appearance, friability* and *starch taste* were also added. A five-point scale with 0.25 step was used. The total organoleptic evaluation of each one of the five taste panelists was formed on the basis of their complete perception but not as an arithmetic average from evaluations for individual sensory characters. One and the same panelists have participated during the both experimental years.

The results for total sensory evaluation were processed by Duncan's multiple range test (1955) using "synthetic standard method" for preliminary preparation of data

(Pevichrova and Manuelyan, 1995). The correlation coefficients and the coefficients of variability were calculated (Lakin, 1990).

RESULTS AND DISCUSSION

In both experimental years the studied potato breeding lines distinguished by homogenous and intensive *colour* after boiling of tubers (Table 1). This sensory character was evaluated the highest. Comparatively high were also the average values for the character *friability*. Great amplitudes were observed during the period of investigation – from 2.70 to 4.10 for line E 78 and from 2.95 to 4.10 for line E 112. The variation in values of this character most probably is due to the relationship genotype x environment. The most stabile was the expression in lines E 419 and E 292 in which irrespective of climatic conditions of cultivation the tubers after boiling remained with smooth surface and with preserved shape. *Aroma* in individual lines showed by non-typical or slightly caught to typical, strongly expressed. Taste panelists were unanimous that line L 292 the most properly meets their requirements in this respect.

Table 1. Sensory characters of boiled potatoes

Line	External appearance	Colour	Aroma	Friability	Texture	Starch taste	Taste	Total sensory evaluation
	2002							
D 112	3.65	4.10	3.35	3.45	3.90	3.90	3.75	3.75
E 78	4.20	4.30	3.70	4.10	4.15	3.90	4.03	3.80
E 419	4.55	4.60	4.15	4.65	3.65	3.80	4.17	3.65
E 112	3.20	3.45	3.35	2.95	3.95	3.50	3.44	3.60
E 292	4.65	4.60	4.30	4.75	4.00	3.50	4.25	3.85
E 606	4.05	4.00	4.10	4.30	3.80	3.65	3.97	3.75
E 686	4.20	3.95	3.60	4.50	3.35	3.55	3.79	3.35
Sante	4.00	4.20	3.65	4.20	4.00	3.90	4.00	4.05
Mean±sd	4.06±0.47	4.15±0.38	3.78±0.37	4.11±0.62	3.85±0.25	3.71±0.18	3.72±0.20	3.99±0.12
CV (%)	11.54	9.04	9.68	15.04	6.51	4.92	5.46	3.19
	2003							
D 112	4.00	4.40	4.40	3.90	4.25	4.00	4.05	4.10
E 78	3.00	4.15	4.05	2.70	3.55	3.45	3.65	3.60
E 419	4.85	4.90	3.30	5.00	4.25	4.20	3.85	3.85
E 112	3.95	3.85	3.95	4.10	3.50	3.75	3.55	3.70
E 292	5.00	4.85	4.15	5.00	4.70	4.65	4.50	4.50
E 606	4.15	4.15	3.85	3.95	4.00	3.85	3.90	3.85
E 686	4.70	4.55	3.95	4.80	4.40	4.35	4.20	4.09
Sante	3.90	4.30	4.10	3.45	3.75	3.70	4.00	3.85
Mean±sd	4.19±0.65	4.40±0.36	3.97±0.32	4.11±0.81	4.05±0.43	3.99±0.39	3.96±0.30	3.94±0.28
CV (%)	15.47	8.28	7.99	19.61	10.52	9.75	7.62	7.19

CV – coefficient of variability; sd – standard deviation

The sensation for *starch taste* during consumption of boiled potatoes is an undesired element, which carries low evaluations in realization of panel taste. In the studied from us lines the starch taste was slightly expressed without establishment of sharp deviations With the character *texture* the lines did not differ considerably which was confirmed also from the low values of coefficients of variability for both experimental years (Table 1). As a whole the texture was uniform, with low firmness. The coefficients of variability for the character *taste* were also low. Regardless of the close values line E 292 exceeded the other lines while in 2003 also the control cultivar Sante. It distinguished by specific, uniform, very pleasant *taste* with chestnut nuance.

Data for *total evaluation* showed that the studied lines are very close in sensory qualities (Fig. 1). The single statistical difference was proved between E 112 and E 292, which came up as a leader in this group. The proved by Duncan's multiple range test insignificance of six lines and cultivar Sante, which we accepted for favourite in respect to the quality, is an indicator for the presence of good organoleptic characteristics. Further realization of the lines will depend to a great extent from their productive and morphologica' potential.

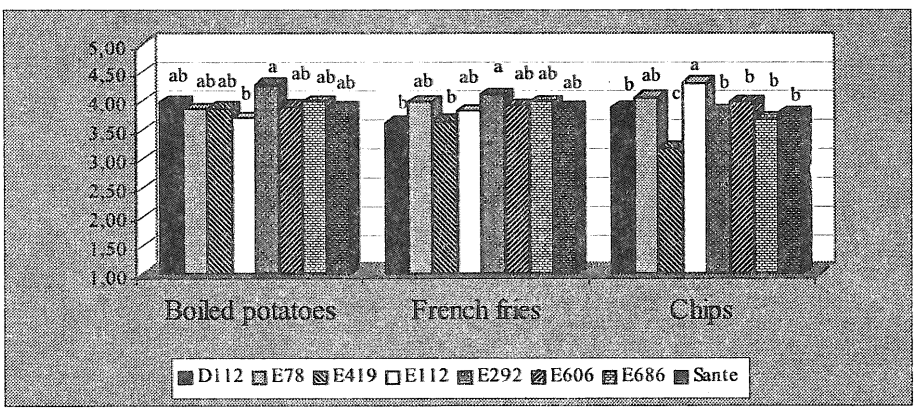

Figure 1. Total sensory evaluation of processed potatoes

The *texture* was the lowest varying character in processing of the lines in French fries. The coefficients of variability between the individual samples were with values under 6.10 % in both experimental years (Table 2). The highest evaluations took lines E 292, E 78 and E 686 in which the *texture* was tender, without limit between core and surface. Comparatively low was the variation between the lines also by the character *taste.* Greater diversity was observed in *colour.* The slices for line E 292 distinguished by intensive and homogeneous golden yellow colour, while in the other lines including also the control cultivar Sante there were burns of the ends. The *total organoleptic evaluation* determine line D 112 and S 419 as more unsuitable for processing in French fries, while from the other line as leaders came up E 292, E 78 and E 686 (Fig. 1).

Table 2. Sensory characters of French fries

Line	Colour	Aroma	Texture	Taste	Total sensory evaluation
	2002				
D 112	3.30	3.15	3.65	3.60	3.50
E 78	3.75	3.65	3.50	3.55	3.60
E 419	3.10	2.90	3.30	3.20	3.15
E 112	4.05	4.00	3.65	3.75	3.65
E 292	4.30	4.10	3.90	3.70	3.75
E 606	3.80	3.90	3.90	3.80	3.85
E 686	3.75	4.05	3.65	3.80	3.80
Sante	3.95	3.90	3.95	4.10	3.95
Mean±sd	3.75±0.39	3.71±0.45	3.69±0.22	3.69±0.26	3.66±0.25
CV (%)	10.38	12.05	6.05	6.98	6.84
	2003				
D 112	3.95	3.75	3.85	3.70	3.75
E 78	4.50	4.40	4.20	4.15	4.40
E 419	4.15	3.85	4.10	4.20	4.25
E 112	3.75	4.05	3.80	3.70	3.85
E 292	4.30	4.60	4.35	4.30	4.35
E 606	4.25	4.25	4.05	4.05	4.00
E 686	4.15	4.10	4.25	4.00	4.15
Sante	3.75	3.45	3.80	3.75	3.80
Mean±sd	4.10±0.27	4.06±0.37	4.05±0.21	3.98±0.24	4.07±0.25
CV (%)	6.49	9.12	5.28	5.96	6.26

CV – coefficient of variability; sd – standard deviation

An impression is made that in 2003 the evaluations for all sensory characters are higher compared to these in 2002. Most probably this is due to the used for frying cooking oil. In the first year was used palm oil, which after cooling became solid and formed film on the surface of the slices and in a sense, created difficulties for the taste panelists. The cooking oil "Olineza" eliminated these shortcomings in 2003.

For the same reason in 2003 the sensory evaluations of the lines after processing of their tubers in chips are higher (Table 3). The lowest is the variation of the character *aroma*. The thin potato rings in frying take a great part of the fat aroma, which disguise the real aroma of the chips. As a result the taste panelists failed to catch the significant differences between samples in this character.

The *colour* is the most important sensory characteristics in production of chips. An intensive, golden-yellow, uniform *colour* without burns of the ends, in the core or radially is preferred. The most completely to these requirements responded lines E 112, E 78 and

D 112. However, lines D 112 and E 78 had insufficiently tender and crisp *texture* which has reflected on the evaluation for *taste* and finally on *total sensory evaluation* (Fig. 1). It is interesting to be mentioned that the line E 112, which has obtained the lowest evaluations in panel test in boiled tubers is a leader in the group for making chips.

The sensory characters of the potato products depend to a great extent of the chemical composition of tubers. In the production of French fries and chips the cultivars with minimum reducing sugars content are preferred in reference to saving of the colour homogeneity. The dry matter content should be higher which warrants for taking of lower oil absorption and saving of slice texture in frying.

The reducing sugars in the studied early potato lines were with low values (Table 4). During 2003 there was a great drought, which resulted in prolongation of the vegetation period and made conditions for conversion of the reducing sugars into starch.

Table 3. Sensory characters of chips

Line	Colour	Aroma	Texture	Taste	Total sensory evaluation
	2002				
D 112	3.80	3.90	3.65	3.85	3.70
E 78	4.25	4.05	4.05	3.90	4.05
E 419	3.45	3.00	2.70	2.75	2.75
E 112	3.90	3.85	4.40	4.35	4.15
E 292	3.80	3.80	3.30	3.50	3.60
E 606	3.70	3.40	3.95	3.90	3.75
E 686	4.05	3.65	3.35	3.50	3.70
Sante	4.00	3.85	3.00	3.00	3.30
Mean±sd	3.87±0.24	3.69±0.38	3.55±0.57	3.59±0.52	3.62±0.44
CV (%)	6.25	9.16	16.04	14.52	12.14
	2003				
D 112	4.45	4.15	4.20	4.20	4.10
E 78	4.15	3.90	4.40	4.20	4.05
E 419	3.95	3.40	4.35	3.90	3.70
E 112	4.30	4.15	4.60	4.35	4.50
E 292	4.25	4.05	4.45	4.30	4.10
E 606	4.10	3.70	4.35	4.10	4.00
E 686	3.90	3.15	3.80	3.80	3.65
Sante	4.20	4.20	4.45	4.35	4.35
Mean±sd	4.17±0.19	3.84±0.39	4.33±0.24	4.15±0.21	4.06±0.29
CV (%)	4.51	10.13	5.56	4.95	7.11

CV – coefficient of variability; sd – standard deviation

It was not established a significant correlation between the *total sensory evaluation* and reducing sugars content after processing in French fries, chips and boiled potatoes (Fig. 2). According to Rodriguez-Saona and Wrolstad (1997) reducing sugars did not completely explain and predict colour quality, when it was presented in low concentrations (about < 60 mg/100 g). Similarly to other authors (Sirtautaite et al., 1999) a correlation between the dry matter content and total sensory evaluation in chips was established (Fig. 3). During both experimental years the correlation coefficients were with high values ($r > 0.760$) and logically the total correlation coefficient ($r = 0.669$) defined the correlation as a significant one.

Table 4. Dry matter and reducing sugar content in raw potatoes

Components	Mean		Min - Max	
	2002	2003	2002	2003
Dry matter (%)	20.84	22.50	18.74 – 23.84	19.06 – 25.47
Reducing sugars (%)	0.37	0.10	0.12 – 0.78	0.03 – 0.17

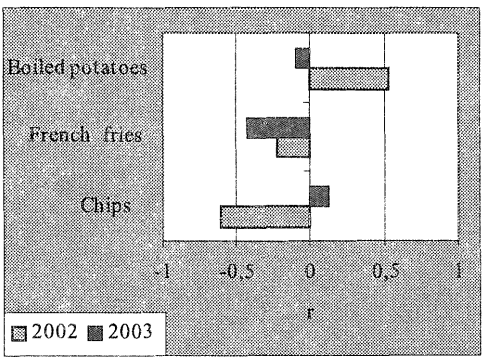

Figure 2. Correlation between total sensory evaluation of processed potatoes and reducing sugars content of raw material

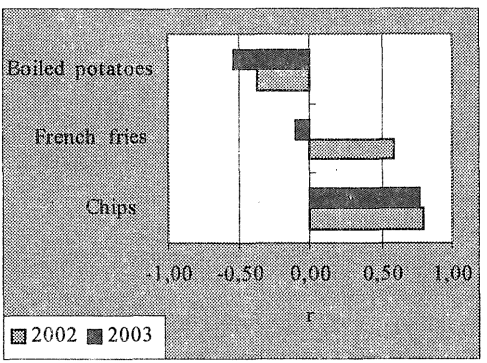

Figure 3. Correlation between total sensory evaluation of processed potatoes and dry matter content of raw potatoes

CONCLUSIONS

On the basis of the study the conclusion that there are cultivar differences in taste could be made. It is the best, when the organoleptic properties of potato tubers are estimated in different directions of processing. This is very important for the breeding process, where is worked with a great number of clones, lines and cultivars and a loss of valuable genotypes in one-sided evaluation of the sensory properties is possible. The performance of panel test only of one processed product (for example chips) could eliminate variants suitable for another kind of processed product (for example boiled potatoes or puree). The role of the sensory analysis is to be covered possibly more aspects of visual, olfactory and gustatory perceptions of the consumers. Only in this way it will really support the breeding and will contribute for the complete evaluation of the newly released potato lines for industrial processing.

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ANALIZA SENZORIALĂ A SOIURILOR TIMPURII DE CARTOF PENTRU INDUSTRIALIZARE DIN BULGARIA

Rezumat

Au fost evaluate proprietățile organoleptice a șapte linii de cartof prelucrate în trei moduri – fierți, pommes-frites și chips. Analiza senzorială a avut următoarele elemente: *culoarea, aroma, textura* și *gustul*. Pentru cartoful fiert, s-au adăugat caracteristicile: *aspect exterior, sfărâmare* și *gustul amidonului*. Cea mai bună evaluare completă a cartofilor fierți s-a obținut la linia E 292, care s-a distins prin culoarea galbenă omogenă, savoare și gust deosebit, cu aromă de castane, prin textura uniformă, care se topește în timpul consumării și prin lipsa gustului de amidon. Tuberculii nu au crăpat iar suprafața lor a rămas netedă după îndepărtarea cojii. Linia mai sus menționată precum și liniile E 78 și E 686 au avut o evaluare senzorială totală cu parametri de calitate ridicați în ceea ce privește prelucrarea sub formă de pommes-frites. Culoarea feliilor a fost galben intens, fără înnegire iar textura a fost moale fără o linie de demarcație între coajă și pulpă. Linia E 112 a fost cea mai potrivită pentru fabricarea chipsului. A demonstrat o pigmentare uniformă în auriu, o textură foarte fragilă și crocantă. Cele mai bune linii din cel puțin unul dintre anii de experiență cu cele trei variante de tratament termic nu au fost diferite în ceea ce privește evaluarea senzorială completă față de soiul martor Sante. Corelația dintre conținutul de substanță uscată și evaluarea senzorială în cazul chipsului a fost semnificativă ($r = 0.669$) în timp ce pentru cartoful fiert și pommes-frites a fost nesemnificativă. Nu s-a stabilit o relație între conținutul de zaharuri reducătoare și evaluarea senzorială totală pentru cele trei moduri de preparare termică a tuberculilor de cartof.

Cuvinte cheie: cartof fiert, pommes frites, chips, evaluare organoleptică.

Tabele

1. Caracteristici senzoriale ale cartofului fiert
2. Caracteristici senzoriale ale pommes-frites-ului
3. Caracteristici senzoriale ale chips-urilor
4. Conținutul de substanță uscată și de zaharuri reducătoare la cartoful crud

Figuri

1. Evaluarea senzorială totală a cartofilor preparați: fiert, pommes-frites, chips.
2. Corelația dintre evaluarea senzorială totală a cartofilor prelucrați și conținutul de zaharuri reducătoare din materia primă
3. Corelația dintre evaluarea senzorială totală a cartofului prelucrat și conținutul de substanță uscată din cartoful crud

INVOLVING SOLANUM BULBOCASTANUM BY CREATION OF AN BASIC SELECTION MATERIAL OF A POTATO WITH HIGH CONTENTS OF STARCH

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SUMMARY

On an extent 2000-2002 determined perspectivity of allocation forms with highly contents of starch among backcrosses composite interspecific hybrids of a potato with participation of wild mexican species Solanum bulbocastanum Dun. Presence of a materia, with the contents of starch is higher than at the best varieties - standards in all years of realization of researches testifies to high value of the received hybrids. At the same time, only the small amount of the created forms (7,5-12,2%) has the contents of starch of 14% and is lower. The wide genetic basis of the created material has allowed to allocate the hybrids combining the high contents of starch with other agronomical properties, for example: sresistance to virus illnesses, high productivity, marketability of a crop, bigger number of tubers perplant and others.

Keywords: potato, contents of starch, interspecific hybrids, agronomical properties.

INTRODUCTION

One of the basic agronomical properties of varieties of a potato is the contents of starch (Pyskun G.I., 2003). However, as it is established by many researchers complexity of creation highly starch varieties grades it is caused by the polygenic control of him, tetraploid a nature of varieties, low his contents at S.tuberosum and some other cause (Ross H., 1986) Taking into account that numerous wilds and cultivated species are characterized by the increased and high contents of starch, their involving in selection practice allows to create varieties with its high contents (Podgayetskiy A.A., 1993).

MATERIAL AND METHOD

In research use six-specific hybrids and then backcrosses: [| {(S.acaule x S.bulbocastanum) x S.phureja} x S.demissum | x S.andigenum] x S.tuberosum; five-specific hybrids - | {(S.acaule x S.bulbocastanum) x S.phureja} x S.demissum | x S.tuberosum; four-specific - [(S.demissum x S.bulbocastanum) x S.andigenum] x S.tuberosum; three-specific - (S.demissum x S.bulbocastanum) x S.tuberosum. The contents of starch productivity, marketability weighing of all tubers and commodity with simultaneous count determined on densities, them to virus illnesses visual supervision.

RESULTS AND DISCUSSION

As a result of ours recearch created new basic selection material with participation of many wild and cultivated species, in particular such to which the high contents of starch. The received data evidence to his high display among this material (tab. 1).

Table 1.Distribution of multispecific hybrids according to the contents of starch

Material	Appreci-ated	Part (%) material with contents of starch, %						
		14,0 and less	14,1-16,0	16,1-18,0	18,1-20,0	20,1-22,0	22,1-24,0	24,0 and more
2000 p.								
Multispecific hybrids and them brckcosses	334	7,5	12,0	23,1	25,7	22,5	6,9	2,3
Standard varieties								
Mavka					18,1			
Lvovyanka						21,1		
Zarevo							22,3	
2001 p.								
Multispecific hybrids and them brckcosses	278	12,2	14,7	26,6	20,2	18,0	4,3	4,0
Standard varieties								
Mavka					18,7			
Lvovyanka							23,1	
Zarevo							23,2	
2002 p.								
Multispecific hybrids and them brckcosses	456	8,1	13,8	37,9	25,5	10,8	3,5	0,4
Standard varieties								
Mavka					18,0			
Lvovyanka						19,8		
Zarevo						21,9		

Only the insignificant quantity of hybrids has rather contents of starch (14% and are lower). The received data testify, that distribution a material on display of property on years not identical. A modal class in 2000 was 18,1-20,0, and in the following - 16,1-18,0%. Various display of property for this period have also standards varieties and only at varieties Mavka conotents of starch was approximately identical. As opposed to stated, practically irrespective of external conditions rather high and high contents of starch (it is more than 18%) characterizes numerous interspecific hybrids. On years it has accordingly made: 57,4; 46,5; 40,2%. For meteorological a complex optimum for accumulation of starch was 2002.

It is especially necessary to note, that some part creating a material has above the contents of starch than the best in this respect the standard variety the Zarevo which is the standard on display property. In percentage certain quantity amount of forms with such characteristic probably and small (on years accordingly 2,3; 4,0; 3,9%), however actually it makes 8, 11, 18 beckcrosses. We shall note, what exactly in adverse for accumulation of starch of 2002 select the greatest quantity amount of a material with high display of property.

Until recently was considered, that the high contents of starch is difficult for combining with some other agronomical property. In particular concerning a material of an interspecific origin to us such researches are unknown. And therefore, the analysis of the contents of starch in a material which has the various characteristic is carried out.

It is established, that in conditions of 2000 (tab. 2) have the best average contents of starch hybrides nursery of resistance to late blight forms. It is possible to explain epiphytosis disease in this year, therefore the appreciate material of nursery has in most cases finished vegetation by natural dying of vegetable that cannot be noted concerning a material with high display of other properties, wich in correspond with the purpose of researches did not process fungicides.

Table 2. Distribution of a material of separate nurseries an the contents of starch (2000)

Nurseries of forms	Appre-ciated	Starch content, %	Part (%) material with contents of starch, %						
			14,0 and less	14,1-16,0	16,1-18,0	18,1-20,0	20,1-22,0	22,1-24,0	>24,0
Resistance against late blight	141	19,8	6,4	10,6	16,3	26,2	27,1	10,6	2,8
Resistance against dry rot	38	17,1	18,4	15,8	26,3	26,3	10,6	2,6	0
Resistance against potato nematode	47	18,0	2,1	12,8	23,4	34,1	23,4	2,1	2,1
Multitubers	12	17,8	8,3	8,3	33,4	25,0	25,0	0	0
Other nurseries	96	17,7	7,3	12,5	30,2	20,8	19,8	6,3	3,1

A little on other there was a distribution of an appreciaty material in conditions 2001 where the maximal average display property is marked among multitubers forms and a little bit less - resistance of nematode hybrids. Value of a modal class has changed this year also. Especially it concerns to resistance of late blight to a material. If in 2000 a modal class for forms of this nursery were 20,1-22,0%, in the following only 16,1-18,0%. The similar data are received in 2002 Exception makes specially generated nursery highly starches forms. Average value of display of property at this material was 18,9%, and a modal class - 18,1-20,0%. Only a few less results are received on multitubers to forms.

For three years the average contents of starch (20% and more) had 69 hybrids. The maximal display of an property had backcross 90.730/5 with an origin 87.791s5 ő

Lvovyanka - 23,8%. Yet four hybrides have exceeded behind the contents of starch variety standart the Zarevo. That is, among the created material search form with high contants of starch is possible.

The analysis of the received data allows to assert about significant value for singling out backcrosses with the high contents of starch of some parent forms. For example, only in one combination 90.691 (85.368s17 ő Gitte) four hybrids high display of property. Similar concerns to a population 81.386s41 (77.277/3 ő P55/102), among study progeny is allocated such three forms. At four combinations frequency hybrides with high contants of starch has made on two.

It is established, that separate backcrosses compound interspecific hybrids allow to allocate forms with high display of an property irrespective of pollinater, that testifies to presence at them balanced genom the control of the high contents to starch. For example, with participation backcrosses 85.568s9 it is allocated eight of 69 forms, or 11,6%. Similar concerns to backcrosse 85.368s17. On four it is with high contents starch of hybrides it is received with participation of hybrids 81.459s15 and 91.651s2. That is, only at involving in crossing of four backcrosses it is received 34,8% allocated on the propety of hybrids. It is necessary to note, that due to the effective genetic control of property of parent forms - interspecific hybrids, obtain valuable forms occurs irrespective of varieties pollinaters. For example, pollinaters at crossing is higher mentioned backcrosse 85.568s9 were varieties: Gitte, Nemeshaevska 10 times, Volovetska - six times, and with 85.368s17: Gitte - 3 times, Volovetska - 2, Lvovyanka, backcrosse an interspecific hybrid - on one. It is necessary to note high phenotypical display high contents of starch among parent forms-backcrosses 85.568s9 and 85.368s17, accordingly 20,4 and 20,9%.

Among 69 allocated hybrids frequency of varieties - pollinaters following: Volovetska - 34,8; Gitte - 24,6; Lvovyanka - 5,8%. Others as components of crossing meet much less often.

It is established, that is with high contents of starch obtain forms in progeny of six-specific hybrids with an origin: [| {(S.acaule x S.bulbocastanum) x S.phureja} x S.demissum | x S.andigenum] x S.tuberosum - 40 forms (58% from all allocated to an property), five-specific hybrids - | {(S.acaule x S.bulbocastanum) x S.phureja} x S.demissum | x S.tuberosum (8,7%), four-specific - [(S.demissum x S.bulbocastanum) x S.andigenum] x S.tuberosum (17,4%), three-specific - (S.demissum x S.bulbocastanum) x S.tuberosum (15,9%). The degree backcrosse the mentioned secondary interspecific hybrids was: B1, B2, B3 and even B4.

Allocation is forms with high contents of starch possible not only with use backcrossing, but also at use self-pollination. The received data testify, that the part of the allocated material is received with use last method. Moreover F2 may be the form of mother: hybrids 83.33s27, 83.58s52, 83.192s5, 83.752s5 or as population a material for selections: backcrosses 88.1450s2, 88.1439s6, 88.1450s3, 88.1431s44, 90.683/31 and others.

It is known, that the contents of starch changes on external factors. However, these changes in the certain measure are caused by a genotype. So, among an appreciate material there are forms with significant variability of an propety (the coeffitient of variations makes about 20%). It concerns to such hybrids: 83.3327, 83.192s5, 91.318-2, 91.765/15 and some other. However, fluctuations in display of an propetyat a level of - standard varieties Lvovyanka (V =7,8%) had such backcrosses: 81.397s50, 83.433s6, 85.368s17, 89.721s81, 97.448s1 and others. Feature of the standard variety the Zarevo not only in existance the form with high contents of starch, but also related stability display of property on years (V = 3,0%). Among appreciate material the similar characteristic have: 90.662/15, 90.674/12, 85.4568s9, 96.977/3 and others, and at separate forms the variation contents starch of tuber on years even was lower than at a variety the Zarevo. These are such backcrosses: 90.666/15, 90.676/140, 98.1431s44.

In table 3 the presenta data displays at form with high contents of starch of other agronomical properties. Except for two hybrids: 81.386s41 and 91.318-2 the presentation material is characterized high resistance against virus diseases (the supreme than at standards varieties). More half of submitted material (51,4%) has such characteristic, and once backcrosse 90.676/140 within three years had no symptoms of virus diseases.

The combination in one hybrid high contents of starch and yield is very important. The received data evidence, that with use of a material of an interspecific origin it possible to be made. At the maximal display of productivity among standards varieties at - the 488g/plant, only 7 hybrids among present in the table have lower display of property. At the same time, 13 hybrids are characterized by yield more a 600g/plant. That is, in a material of an interspecific origin the combination in one form point out propety is possible.

Marketability of a yield is the important property of varieties of a potato from technological, consumer and other sides. Therefore value of an basic selection material, varieties may be limited low display of her. The received data testify, that only one hybrid exceeds marketability of a yield the best in this respect standard variety Lvovyanka (93%). Two more hybrids: 86.293s47, 92.9s28 characterize similar display of property. However, it is necessary to note, that about half selected for high contents of starch of a material has marketability of a yield of 90% and more, and it is higher than at other two standards varieties.

Despite of use of saturational crossings for the most part of hybrids it is peculiar multitubers which is inherited from wild and cultural species. The received data evidence about to rather easy combination in one form of this property and the high contents of starch. And, at 10 hybrids the quantity tubers on a plant has made 20 and more, that almost is twice higher than at standards varieties.

Opposite it is observed concerning average ware tuber weight. In this respect any hybrid has not exceeded the standard variety the Zarevo and only two: 89.721s81 and 97.448s1 have close value.

It is established, that behind a complex of agronomical properties the best are the following with high contents of starch backcrosses: 85.291c12, 89.721c81, 90.663/22, 90.676/140, 91.51-52, 91.765/31, 96.963/30, 97.448s1 and some other.

The characteristic of the best a complex of agronomical properties with highly contants of starch multispecies hybrids (2000 – 2002)

N hybrid	Origin	Resistance against virus diseases, point	Starch content,- %	Yield, g/plant	Marketa-bility, %	Number of tubers per plant, pcs	Average ware tuber weight, g
81.386s41	77.277/3 x 55/102	7,5	22,1	433	78	12	44
81.386s65	Those same	8,6	22,1	622	78	24	38
81.397s50	- « -	8,7	21,5	519	69	22	52
81.406s27	77.277/0 x 65/26	8,3	20,2	578	85	16	55
83.58s52	80.45s5 x Mavka	8,7	22,9	456	80	10	57
83.192s5	80.35s21 x Gitte	8,9	22,4	926	85	24	51
83.433s6	14-2s18 x Gitte	8,9	21,6	421	79	14	51
84.202s15	81.386s28 x Gitte	8,7	20,8	540	77	15	55
85.291s12	?. 70.486/112 x 81.386s103	8,6	20,7	809	91	15	61
85.368s17	81.1686/8 x Gitte	8,8	20,9	491	78	16	47
86.293s47	81.377s1 x Gitte	8,5	20,5	472	93	10	62
86.563s4	81.785s12 x Hybridna 14	8,3	21,0	518	90	12	63
88.730s3	84.209s15 x Aguti	8,7	20,9	588	74	20	51
88.1431s44	F2 85.19s10	8,8	20,5	554	77	23	41
88.1450s3	F2 83.2419s26	8,7	20,1	635	87	22	43
89.721s81	85.1591s7 x Byelorussian 3	8,6	21,1	567	95	10	79
90.662/15	80.24s14 x Nemeshaevska 10	8,4	20,9	664	91	14	59
90.663/22	80.24s14 x Volovetska	8,6	21,5	571	92	12	67
90.666/25	81.386s97 x Volovetska	8,8	21,9	678	87	21	46

continuare table 3							
N hybrid	Origin	Resistance against virus diseases, point	Starch content,-%	Yield, g/plant	Marketability, %	Number of tubers per plant, pcs	Average ware tuber weight, g
90.673/37	85.568s9 x Gitte	8,6	21,5	573	92	13	55
90.675/25	85.568s9 x Nemeshaevska10	8,4	20,5	442	71	22	43
90.676/140	81.459s15 x Volovetska	9,0	21,2	615	83	17	57
90683/31	F2 81.1498s6 x Volovetska	8,8	20,4	423	76	21	40
90.691/1	85.368s17 x Gitte	8,3	21,3	659	88	13	61
90.691/9	Those same	8,7	21,9	575	86	13	59
90.729/14	87.791s5 x Volovetska	8,7	20,6	504	88	14	55
90.811s1	80.24s14 x Volovetska	8,4	21,6	406	91	9	51
90.817s4	85.568s9 x Volovetska	8,7	22,3	544	92	12	59
90.827s5	85.368s17 x Volovetska	8,8	21,9	525	72	20	54
91.15-52	88.1288s2 x Prolisok	8,4	22,1	649	92	13	68
91.318-2	83.752s7 x Gitte	7,6	22,0	515	90	12	62
91.765/31	85.568s9 x Volovetska	8,5	20,1	646	89	15	64
92.9s28	85.368s17 x 87.791s4	8,9	22,1	531	93	12	57
96.963/30	81.386s65 x Volovetska	8,6	20,9	527	92	12	56
96.965/45	81.459s19 x Gitte	8,7	20,3	808	75	27	50
96.977/92	91.651s2 x Volovetska	8,3	22,0	625	91	16	55
97.448s1	90.673/17 x Volovetska	8,7	21,1	621	90	11	77
Standart	Mavka	7,8	18,3	488	83	13	69
Those same	Lvovyanka	7,5	21,3	455	93	10	57
Ť « Ť-	Zarevo	7,6	22,5	447	89	10	80

CONCLUSIONS

Thus, the received data evidence, that for years of realization of researches only the insignificant part of difficult interspecific hybrids has rather low contents of starch (up to 14%). It confirms special value creation in this respect. Separate forms are characterized by good transfer of property progeny, that allows to recommend them for practical selection use. It first of all backcrosses: 85.568s9 and 85.368s17. It is established, that forms with high contents of starch can be created backcrosses secondary interspecific hybrids (more often) or with use of self-pollination, crossing backcrosses among themselves. Behind a variation of the contents of starch on years the material considerably differs among themselves, however at some forms display of an propety stably (V = 3% and are lower). The opportunity of a combination in one form of the high contents of starch and resistance to virus, high yield multitubers resistance to late blight and other properties both separately, and in aggregate is proved.

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IMPLICAREA SPECIEI SĂLBATICE *SOLANUM BULBOCASTANUM* ÎN CREAREA UNUI MATERIAL DE SELECȚIE LA CARTOF CU UN CONȚINUT RIDICAT DE AMIDON

Rezumat

După o perioadă de cercetare de 3 ani (2000-2002) am determinat perspectiva de alocare a formelor cu conținut ridicat de amidon dintre hibrizii interspecifici încrucișați ai cartofului cu participarea speciei sălbatice din Mexic *Solanum bulbocastanum* Dun. Prezența materialului cu conținut mare de amidon este mai importantă decât la cele mai bune soiuri standard în toți anii de studiu, ceea ce demonstrează valoarea ridicată a acestor hibrizi. În același timp, doar un număr mic din formele create (7,5 – 12,2%) au un conținut de de amidon de 14% sau mai mic. Baza genetică diversă a materialului creat a permis alocarea hibrizilor prin combinarea conținutului de amidon cu alte proprietăți agronomice, de exemplu: rezistența la bolile virotice, productivitatea, posibilitatea de vânzare, numărul de tuberculi per plantă și altele.

Cuvinte cheie: cartof, conținut de amidon, hibrid interspecific, caracteristici agronomice.

Tabele:

1. Distribuția hibrizilor interspecifici după conținutul de amidon;
2. Distribuția materialului după rezistența la boli, dăunători, și după conținutul de amidon;
3. Caracteristicile agronomice ale hibrizilor interspecifici cu conținut ridicat de amidon.

EVALUAREA CALITATIVĂ ŞI STRUCTURA PRODUCŢIEI LA UNELE SOIURI DE CARTOF ÎN CONDIŢIILE CLIMATICE SPECIFICE ZONEI BRAŞOVULUI

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REZUMAT

În lucrare se prezintă date privind calitatea culinară şi potenţialul productiv a opt soiuri de cartof (româneşti şi străine), cultivate la Braşov, în perioada 1997-2002, cu încadrarea soiurilor pe categorii de folosinţă şi evidenţierea diferenţelor calitative şi productive dintre soiuri în funcţie de condiţiile climatice din anii de cultură.

Domeniul calităţii fiind foarte vast, nu vom putea epuiza toate aspectele. Ne vom referi numai la: calitatea culinară (încadrarea soiurilor în grupe de folosinţă), pretabilitatea la industrializare (culoare, randamentul de obţinere pentru chips) şi productivitatea soiurilor luate în studiu.

Clasificarea pe grupe de folosinţă (consum, industrializare, sămânţă, furajare), are drept scop evidenţierea soiurilor cu însuşiri valoroase şi astfel orientarea producţiei spre segmentul de piaţă corespunzător.

Cuvinte cheie: cartof, soi, condiţii climatice, productivitate, calitate culinară, calitate chips.

INTRODUCERE

Termenul de calitate la cartof cuprinde totalitatea însuşirilor fizice, chimice, culinare şi se raportează atât la pretenţiile consumatorilor cât şi la destinaţia producţiei. După Organizaţia Mondială pentru Standardizare (ISO) calitatea este definită ca totalitatea însuşirilor şi caracteristicilor unui produs care are capacitatea de a satisface cerinţele dorite sau implicite (www.iso-9000-2000.com).

În general, atributele calitative sunt clasificate astfel:

- externe (aspect, consistenţă, defecte);
- interne (miros, gust, textură);
- ascunse (stare fitosanitară, valoare nutritivă, siguranţă alimentară).

Atributele calităţii externe joacă un rol important în decizia consumatorilor de a alege. Împreună cu însuşirile calităţii interne determină acceptarea unui produs. Cel de-al treilea tip de atribute este mai greu de măsurat şi ajută la diferenţiere (Kramer şi Twigg, 1970; Pattee, 1985; Shewfelt, 1987).

Referitor la cartof, calitatea este exprimată în funcţie de trei caracteristici principale:

- calitatea fizică (cuprinde însuşiri legate de formă, culoare, dimensiuni, vătămări, boli, care determină aspectul tuberculului în general);
- calitatea culinară şi tehnologică (cuprinde însuşiri legate de comportarea tuberculilor la fierbere şi prăjire);
- valoarea biologică (compoziţia chimică).

Importanţa acestor însuşiri variază în funcţie de scopul de folosinţă. Astfel, pentru industrializare ponderea mai mare o au următoarele caracteristici: defectele, vătămările interne, înverzirea, înnegrirea enzimatică, substanţa uscată şi cantitatea de zaharuri reducătoare, în timp ce pentru consumul direct au o importanţă majoră următoarele aspecte: defectele, vătămările externe, înverzirea, valoarea nutritivă, înnegrirea după fierbere, gustul (Dale şi Mackay, 1994).

Textura poate fi considerată una dintre cele mai importante aspecte calitative în ceea ce priveşte cartoful de consum. Textura este un temen complex şi se referă la: făinozitate, umiditate, sfărâmare la fierbere, consistenţă, structura amidonului.

Definirea noţiunii de calitate la cartof este strâns legată de valorificare. De aceea este esenţială cunoaşterea cerinţelor calitative şi clasificarea soiurilor pe grupe de folosinţă, pentru a răspunde exigenţelor consumatorilor legate în principal de aspect, calitate culinară, sensibilitate la înnegrire.

MATERIAL ŞI METODĂ

A fost luat în studiu un număr de opt soiuri de cartof (cinci româneşti şi trei străine), aparţinând grupelor de precocitate: timpurii-semitimpurii (Ostara, Roclas, Christian, Dacia) şi semitardive (Amelia, Nicoleta, Desiree, Sante), cultivate la Braşov şi analizate în perioada 1997-2002.

Datele meteorologice (regimul termic şi pluviometric) au fost înregistrate la I.C.D.C.S.Z. Braşov (tabelul 1). Climatul zonelor montane din România este răcoros şi cu precipitaţii bogate. Condiţiile întâlnite aici sunt favorabile culturii cartofului, care necesită o sumă a precipitaţiilor de cca. 600 mm anual şi temperaturi de 19 – 21°C pentru creşterea părţii aeriene a plantei şi 16 – 17°C pentru creşterea tuberculilor.

Datorită condiţiilor ecologice specifice zonelor montane, este posibilă evitarea stresului hidric şi termic, degenerarea fiziologică fiind redusă la minim. Altitudinile mari şi prezenţa unor bariere naturale, care crează condiţii de izolare a culturilor, reduc şi răspândirea bolilor virotice.

Capacitatea de producţie a soiurilor analizate s-a determinat prin cântărirea tuberculilor de cartof recoltaţi din câmp.

Analizele de calitate culinară s-au realizat organoleptic, aprecierea indicilor de calitate făcându-se după sistemul de notare propus de: Lugt şi Goodijk, 1959 (tabelul 2).

Tabelul 1

Variaţia unor condiţii climatice în perioada 1997 – 2002 la Braşov

Lunile	Temperaturi medii (°C)				Suma precipitaţiilor (mm)			
	min	max	med	CV %	min	max	med	CV %
IV	3.4	10.8	8.4	32.1	18.0	98.2	46.4	73.1
V	12.7	15.3	13.9	6.8	25.9	78.3	55.6	41.3
VI	15.8	18.1	17.4	4.7	27.8	118.4	74.5	50.8
VII	17.3	20.5	19.2	6.3	54.3	128.0	85.8	34.0
VIII	16.5	19.3	18.2	6.2	16.9	148.1	80.2	69.3
IX	11.5	14.8	13.1	8.5	23.6	102.6	65.4	44.2
Perioada de iarnă (X-III)	0.2	2.9	1.1	84.4	109.6	283.6	180.5	34.8
Perioada de vegetaţie (IV-IX)	13.3	15.8	15.0	6.0	150.8	435.9	341.2	33.7

Tabelul 2

Schema de apreciere a calităţii culinare la cartof

Însuşiri	Trepte de bonitare			
	1	2	3	4
Aspectul general	foarte aspectuos	aspectuos	puţin aspectuos	neaspectuos
Sfărâmarea la fierbere	rămâne întreg	se sfărâmă puţin	se sfărâmă tare	se sfărâmă foarte tare
Consistenţa pulpei	consistent vârtos	puţin consistent	mijlociu consistent	neconsistent
Făinozitatea	nefăinos	slab făinos	făinos	puternic făinos
Umiditatea	umed	puţin umed	destul de uscat	uscat
Structura amidonului	fină	potrivit de fină	grosieră	foarte grosieră
Gustul	excelent	foarte bun	bun	mai puţin bun

Culoarea: alb = 1; alb lăptos = 2; alb murdar = 3; gălbui = 4; gaben = 5; galben intens = 6

Testele organoleptice sunt utilizate pentru determinarea calităţii culinare a cartofilor. Caracteristicile sunt repartizate pe 4 trepte de bonitare cu note de la 1–4, unde 1 reprezintă valoarea maximă, iar culoarea este notată de la 1–6. Testările se fac pe tuberculi curăţaţi şi fierţi direct în apă, în vase speciale. Timpul de fierbere variază în funcţie de soi.

Metoda de producere a chips-ului constă în curăţarea tuberculilor de coajă, tăierea în felii de 1,75 mm, spălarea de amidon sub un jet de apă, eliminarea surplusului de apă, prăjirea feliilor în baia de ulei la 160°C, timp de 2-3 minute şi eliminarea surplusului de ulei. Randamentul se determină prin cântărire (Mureşan, 1999).

Notele pentru culoarea chips-ului s-au apreciat după indexul de colorare pentru evaluarea calităţii chips-ului de la Institutul pentru Păstrarea şi Prelucrarea Produselor Agricole, Wageningen – Olanda.

Conţinutul de amidon s-a determinat gravimetric.

Repartizarea soiurilor pe clase de folosinţă s-a făcut însumând valorile obţinute pentru: sfărâmarea la fierbere, consistenţă, făinozitate, umiditate şi structura amidonului, astfel:

7 – 7,5 = A
7,6 – 10,0 = A/B
10,1 – 12,5 = B
12,6 – 15,0 = B/C
15,1 – 17,0 = C
17,1 – 20,0 = C/D

Pe baza multiplelor însușiri calitative, cartoful prezintă 4 clase de calitate:

Clasa A – cartoful pentru fierbere. Tuberculii nu se sfărâmă la fiert, sunt consistenți, destul de umezi, iar structura amidonului este fină.

Clasa B – cartoful pentru salată. Nu se sfărâmă la fiert, sau crapă numai puțin, este consistent, uneori umed, iar amidonul are o structură fină.

Clasa C – cartoful făinos, pentru piure. Tuberculii sunt făinoși, crapă la fiert, au o consistență redusă, sunt uscați, iar structura amidonului este destul de grosieră.

Clasa D – cartoful pentru industrializare. La fiert tuberculii se sfărâmă complet, consistența este foarte redusă, sunt uscați, iar amidonul are structură grosieră.

Datele obținute au fost prelucrate și interpretate statistic.

REZULTATE ȘI DISCUȚII

În urma studiilor efectuate s-a evidențiat o variație a însușirilor calitative analizate și a capacității de producție, atât între soiuri, cât și în cadrul aceluiași soi, în funcție de condițiile climatice ale anilor de cultură.

Capacitatea de producție

Producția medie a variat în cei șase ani între 18,8 t/ha (Ostara) și 29,6 t/ha (Dacia), cu valoarea minimă înregistrată la soiul Ostara (7,0 t/ha) în anul 2000 și cea maximă obținută la soiul Nicoleta (41,1 t/ha) în anul 2001. Menționăm că anul de cultură 2000 a fost un an deosebit, caracterizat prin temperaturi excesive și precipitații reduse.

Tabelul 3

Producția înregistrată la cele opt soiuri în perioada 1997 – 2002

Soiul	Producția (t/ha)					
	1997	1998	1999	2000	2001	2002
Soiuri timpurii și semitimpurii (70 – 100 zile)						
Ostara	18,7	23,0	26,5	7,0	21,2	16,3
Roclas	27,3	39,1	41,0	11,9	24,6	27,0
Christian	20,8	24,4	30,4	11,2	28,1	25,9
Dacia	22,7	28,3	36,2	11,8	38,3	40,1
Soiuri semitardive (100 – 110 zile)						
Sante	27,5	31,5	40,5	13,4	30,9	22,2
Desiree	21,5	27,6	35,8	17,3	27,3	21,6
Amelia	25,0	28,0	34,1	15,8	35,8	22,4
Nicoleta	22,6	29,1	36,9	13,4	41,1	29,3

Calitatea culinară

Complexitatea, dar şi caracterul subiectiv al calităţii culinare fac ca această noţiune să se preteze cu greu la un studiu direct. Este deci necesară o corelare cu o însuşire ce poate fi determinată obiectiv. Am ales în acest caz conţinutul de amidon. Astfel, s-a observat faptul că sfărâmarea se corelează semnificativ cu: consistenţa, făinozitatea, structura amidonului şi conţinutul de amidon.

Tabelul 4

Matricea de corelaţie a indicilor de calitate culinară şi tehnologică la soiurile studiate (n=24)

	Sfărâmare	Consistenţă	Făinozitate	Struct. amidon	Amidon %
Sfărâmare	1,000	0,759**	0,818**	0,774**	0,670**
Consistenţă		1,000	0,749**	0,770**	0,719**
Făinozitate			1,000	0,935**	0,790**
Struct. amidon				1,000	0,797**
Amidon %					1,000

** corelaţie semnificativă (0,01%) * corelaţie semnificativă (0,05%)

Aceste relaţii între indicii de calitate culinară trebuie privite în contextul fenomenelor ce au loc în timpul fierberii. Influenţa preparării asupra texturii este complexă şi include o serie de procese interne: degradarea pereţilor celulari, permeabilizarea membranelor celulare, schimbul ionic, coeziunea intercelulară (N. Van Marle şi colab., 1993). Aceasta din urmă este puternic corelată cu conţinutul în amidon al tuberculului (Ludwig şi colab., 1978). Soiurile: Ostara, Christian şi Desiree aparţin clasei de calitate A/B, fiind pretabile pentru fierbere şi salată.

Încadrarea soiurilor în grupe de folosinţă a fost diferită, în funcţie de condiţiile climatice. Putem susţine această afirmaţie exemplificând comportamentul la fierbere a soiurilor: Christian şi Amelia. Astfel, în anul 2000 soiul Christian s-a încadrat în clasa de calitate A/B, cu specificarea că acest an a fost unul secetos, în timp ce într-un an normal din punct de vedere climatic (1998), soiul respectiv s-a încadrat în clasa A de calitate. Soiul Amelia a corespuns în anul 2000 clasei de calitate A/B, iar în anul 1998, s-a încadrat în clasa B de calitate. Aceasta arată că încadrarea medie a soiurilor studiate în clasele de calitate A/B sau B, în funcţie de condiţiile din diferiţi ani, se poate deplasa spre clasele învecinate la soiurile cu mare variabilitate a caracterelor culinare.

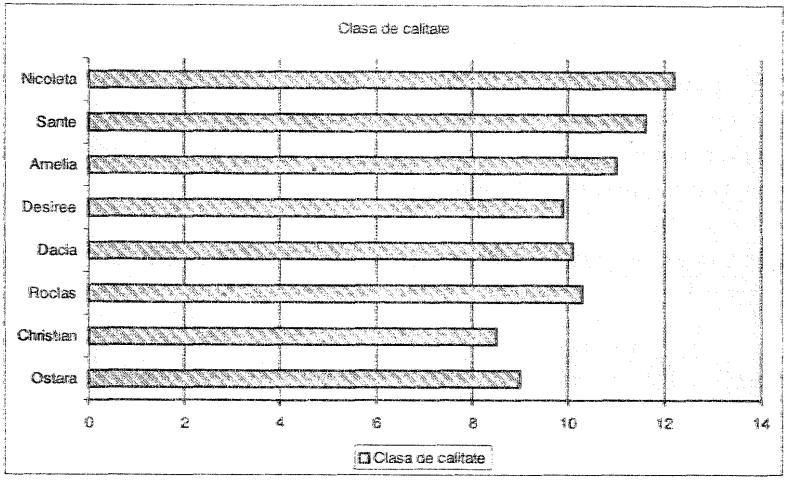


Fig. 1 - Repartizarea soiurilor pe clase de calitate

Conținutul mediu în amidon a variat între 13,9 (Christian) și 18,5 % (Nicoleta), cu valoarea minimă înregistrată la soiul Ostara (12,0 %) în anul 2000 și cea maximă obținută de soiul Nicoleta (23,0 %) în anul 1997. Ca și în cazul producției, temperaturile excesive și precipitațiile reduse din anul 2000 au afectat conținutul de amidon din tuberculi.

Tabelul 5

Soiul	Amidon (%)			
	minim	anul	maxim	anul
Soiuri timpurii și semitimpurii (70 – 100 zile)				
Ostara	12.0	2000	17.0	1997, 1998
Roclas	14.0	2002	18.0	1997,1998
Christian	13.0	1999	16.0	1997
Dacia	15.9	2001	20.0	1998
Soiuri semitardive (100 – 110 zile)				
Sante	14.0	2002	20.0	1997
Desiree	12.4	2002	19.0	1998
Amelia	14.0	2000	21.0	1997
Nicoleta	15.8	2001	23.0	1997

Variația conținutului de amidon în funcție de condițiile climatice

Din tabelul 6 reiese faptul că, pe parcursul celor șase ani de cultură, soiul Ostara a variat cel mai mult în ceea ce privește conținutul în amidon (CV = 17,1%) urmat de soiul Desiree (CV = 16,0%).

Tabelul 6

Comportarea soiurilor de cartof în perioada 1997-2002, la Braşov

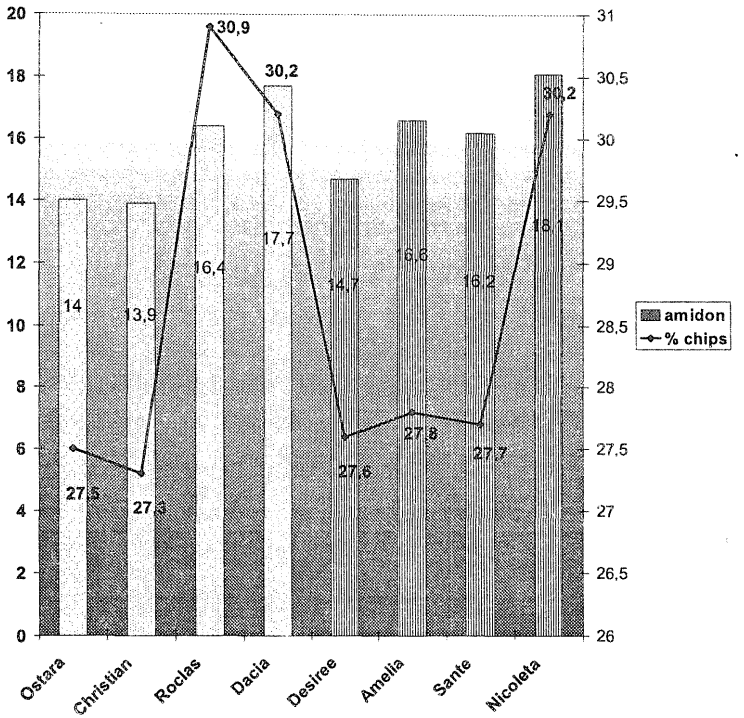
Soiul	Producţia t/ha				Amidon %				Randament chips %				Culoare chips				Clasa*			
	min	max	med	CV %	min	max	med	CV %	Min	max	med	CV %	min	max	med	CV %	min	max	med	CV%
Soiuri timpurii şi semitimpurii (70 - 100 zile)																				
Ostara	7,0	26,5	**18,8**	36,0	12,0	17,0	**14,0**	17,1	23,5	30,0	**27,5**	8,3	7,0	7,5	**7,2**	3,6	6,9	10,0	**9,0**	13,9
Roclas	11,9	41,0	**28,5**	37,3	14,0	18,0	**16,4**	9,9	25,5	34,0	**30,9**	10,2	7,0	8,0	**7,8**	5,4	8,5	12,5	**10,3**	16,5
Christian	11,2	30,4	**23,5**	29,2	13,0	16,0	**13,9**	8,0	19,5	31,0	**27,3**	15,2	6,0	8,0	**6,9**	11,5	7,5	9,1	**8,5**	8,3
Dacia	11,8	40,1	**29,6**	36,9	15,9	20,0	**17,7**	9,8	27,0	32,0	**30,2**	7,4	8,0	9,0	**8,5**	3,7	7,5	13,5	**10,1**	24,2
MEDIA	**25,1** (CV=37,8%)				**15,5** (CV=15.2%)				**29,0** (CV=11.3%)				**7,6** (CV=10.2%)				**9,5** (CV=18.2%)			
Soiuri semitardive (100 - 110 zile)																				
Sante	13,4	40,5	**27,7**	33,3	14,0	20,0	**16,2**	13,2	24,5	30,0	**27,7**	9,3	7,5	8,0	**7,8**	3,3	9,1	14,5	**11,6**	16,3
Desiree	17,3	35,8	**25,2**	25,8	12,4	19,0	**14,7**	16,0	23,0	30,0	**27,6**	9,5	7,0	8,0	**7,7**	5,3	8,5	11,0	**9,9**	10,1
Amelia	15,8	35,8	**26,9**	27,8	14,0	21,0	**16,6**	15,1	25,5	30,0	**27,8**	5,6	7,5	9,0	**8,0**	6,9	10,0	12,5	**11,0**	10,5
Nicoleta	13,4	41,1	**28,7**	34,6	15,8	23,0	**18,5**	15,8	27,0	35,0	**30,2**	9,8	8,0	8,5	**8,3**	3,3	11,0	15,0	**12,2**	12,4
MEDIA	**27,1** (CV=29.3%)				**16,5** (CV=16.4%)				**28,3** (CV=9.0%)				**7,9** (CV=5.4%)				**11,2** (CV=14.1%)			

Clasa* A/B = Ostara, Christian, Desiree;
B = Sante, Roclas, Dacia, Amelia, Nicoleta.

Calitatea tehnologică

În prezent există o preferință în creștere a consumului de produse industrializate de cartof, care sunt gustoase, hrănitoare și mai ușor de preparat.

Pentru calitatea tehnologică s-au urmărit: randamentul de obținere pentru chips și culoarea produsului finit. Calitatea cartofului, ca materie primă, este esențială pentru obținerea unui randament bun și a unei culori atrăgătoare.



Randamentul de prelucrare a soiurilor studiate a fost de cca. 30 %. Conținutul în amidon este corelat direct cu un randament eficient.

Fig. 2 Corelația dintre conținutul de amidon și randament

Un conținut ridicat de amidon determină realizarea unui randament sporit de prelucrare, de aceea în procesul de fabricație sunt preferate soiurile cu un conținut ridicat de amidon. Soiurile: Sante, Roclas, Dacia, Amelia și Nicoleta aparțin clasei de calitate B, fiind recomandate pentru salate și chips.

Factorul hotărâtor în alegerea soiului îl constituie culoarea produsului finit. Culoarea chips-ului este direct influențată de cantitatea de zaharuri reducătoare din tubercul. Acestea, prezente într-un procent mai ridicat, conferă o culoare neplăcută, brună, respinsă de consumatori, care preferă o culoare aurie.

Acumularea de zahăr reducător este rezultatul mai multor factori: soi, condiţii de cultivare şi păstrare, aplicarea fertilizanţilor, gradul de maturitate a tuberculilor (Carci şi colab., 1999; Groza şi colab., 1999). Reglarea nivelului de carbohidraţi în tuberculii de cartof, prin practici corespunzătoare de producere şi păstrare, este foarte importantă pentru asigurarea unui chips de calitate superioară.

CONCLUZII

În ceea ce priveşte capacitatea de producţie, dintre toate soiurile analizate, Roclas şi Dacia (din grupa soiurilor semitimpurii), Nicoleta şi Sante (din grupa soiurilor semitardive) au înregistrat cele mai mari valori.

Pentru orientarea producţiei spre sectorul de valorificare corespunzător, este utilă încadrarea soiurilor pe categorii de folosinţă. Astfel, soiurile: Ostara, Christian şi Desiree, aparţin clasei de calitate A/B, fiind recomandate pentru fierbere şi salată, iar soiurile: Roclas, Amelia, Nicoleta, Dacia şi Sante aparţin clasei de calitate B, fiind pretabile pentru industrializare.

Analizând rezultatele obţinute, putem concluziona că dintre cele opt soiuri studiate, Roclas şi Dacia (din grupa soiurilor semitimpurii), Amelia şi Nicoleta (din grupa soiurilor semitardive) variază cel mai puţin în ceea ce priveşte capacitatea de producţie şi calitatea totală, fiind stabile în condiţiile climatice variate ale anilor de cultură.

Având în vedere tendinţa constantă de încălzire globală, identificarea şi cultivarea soiurilor rezistente la variaţia condiţiilor climatice, contribuie la evitarea pierderilor cauzate de aceste modificări ale mediului extern.

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QUALITATIVE EVALUATION AND PRODUCTION STRUCTURE OF SOME POTATO VARIETIES UNDER CLIMATIC CONDITIONS SPECIFIC TO BRAŞOV AREA

Abstract

The paper presents information regarding the culinary quality and the yielding potential of eight Romanian and foreign varieties of potatoes cultivated in Braşov between 1997 and 2002. The potato varieties are classified into categories of use and the differences among the varieties are pointed out, as far as quality and production are concerned, depending on the weather conditions during this period.

Since the quality field is extremely wide, we will not be able to exhaust all the aspects. The subjects dealt with herein are only the culinary quality (classifying the varieties into categories of use), the suitability for industrial processing (color, chips obtaining efficiency) and the yielding of the varieties under research.

The classification into categories of use (consumption, industrial processing, seed, fodder) has in view the pointing out the varieties with valuable qualities and, therefore, the directing of the production towards the proper market segment.

Keywords: potato, variety, weather conditions, yielding, culinary quality, chips quality.

Tables:

1. Variation of some climatic conditions between 1997-2002 in Braşov;
2. Assessment scheme of potato culinary quality;
3. Yield of the 8 potato varieties between 1997-2002;
4. Correlation matrix of culinary and technological quality indices in the studied varieties;
5. Starch content variation in dependence of climatic conditions;
6. Behaviour of potato varieties between 1997 – 2002 in Braşov.

Figures:

1. Variety clssification acoording to the quality;
2. Correlation between starch content and chips obtaining efficiency.

ACRYLAMIDE - A NEW CRITERION FOR POTATO VARIETY ASSESSMENT ?

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SUMMARY

New processing varieties like Panda, Lady Claire, Markies and others revealed lower acrylamide content in crisps and French fries due to their lower content of reducing sugars. N fertilization did not influence the acrylamide content in crisps in both seasons. Farmers will expand their production areas with these varieties while at the same time reducing considerably the exposure of Swiss consumers to acrylamide. Excellent raw material for processing will become even more important, because adaptations in processing techniques may result in changed product quality (e.g. blanching of crisps). Several Acrylamide projects in Switzerland may considerable contribute to minimize consumer's exposure to this harmful food contaminant and thus also maintain the high consumer acceptance of potatoes in the future.

INTRODUCTION

Acrylamide has been detected by the Swedish Public Health Authorities during the spring of 2002, mainly in roasted and fried potatoes and cereal products. This harmful product is formed by high temperature frying (over 120° C), particularly in potato crisps French fries and Röstis (hash brown). It is the result of a chemical reduction process of the asparagine, promoted by reducing sugars like fructose and glucose during the Maillard reaction. The concentration of these sugars depends largely on the potato variety, growing conditions, maturity, as well as the storage conditions. Complex interactions between all these factors may reduce homogeneity in the raw material.

The aim of this research is to minimize acrylamide content in roasted and fried potato products prepared in households and processing companies, by using suitable varieties and storage conditions. Reducing sugars are key components for browning reactions and the development of the typical roasted flavor, but also for the formation of acrylamide. Growing conditions influence internal tuber quality, and low temperature storage increases reducing sugars content markedly.

MATERIALS AND METHODS

Trials of potato varieties are located in the main growing regions of Switzerland and were used as raw material for the experimentation. Tubers of ware and processing varieties were sampled from two locations after harvest and stored at 8-9° C, as usual for processing. Two samples of 15 graded tubers per variety have been analyzed for reducing sugars, fructose, glucose and the amino acids asparagine and glutamine. Acrylamide has also been determined by the laboratory on the same samples after processing French fries, Crisps and Röstis, in autumn and spring using GC-MS-methodology.

RESULTS AND DISCUSSION

There was a good relationship between the crisps frying test (coloration) as used for processing potatoes by the processors, and acrylamide content in the products (Fig. 1). Clear golden crisps gave the lowest and dark brown crisps gave the highest acrylamide contents. Reducing sugars content varied about 0,2 g/kg fresh matter up to 10 g/kg depending on the variety and storage temperatures. One gram per kg or less reducing sugar content resulted in bright chips, while the acrylamide content was about 500 mg/kg or less. Sugar contents of 10 g/kg produced dark chips with acrylamide contents of about 3000 mg/kg. Of course, there was an important and consistent variability in reducing sugar contents between varieties, whereas processing and table varieties did not significantly differ in their asparagine and glutamine content. Processing varieties are selected for their low content in reducing sugars, while table potatoes may have higher contents. However, some of the more polyvalent varieties such as Agria and Victoria, also have very low sugar contents. Highly dehydrated products such as crisps (Fig. 2) also have higher acrylamide contents than French fries (Fig. 3) or Röstis. The objective of our Federal Health Authorities is to reduce the whole acrylamide intake, this means in the future ware potatoes should also have low reducing sugar contents. Different levels of nitrogen fertilization did not influence acrylamide content in crisps.

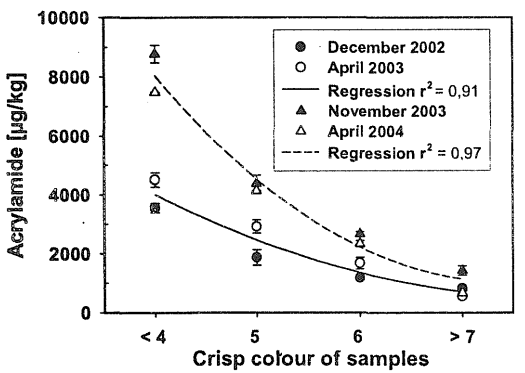

Fig. 1: Relationship between crisp color and acrylamide, crisp samples of different varieties from tubers harvested in 2002 and 2003 respectively, mean ±standard deviation from 2 samples backed at 170°C at the beginning and at the end of the storage periods (n=8 samples per crisp colour and year)

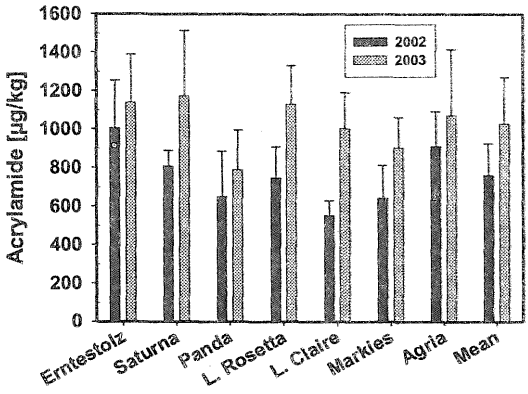

Fig. 2: Acrylamide content in crisps of different varieties from tubers harvested in 2002 and 2003 respectively, mean ± standard deviation calculated from 2 locations, 2 sampling dates (early, late within the storage period) and 2 samples per date, backed at 170°C (n=8 samples per variety and year)

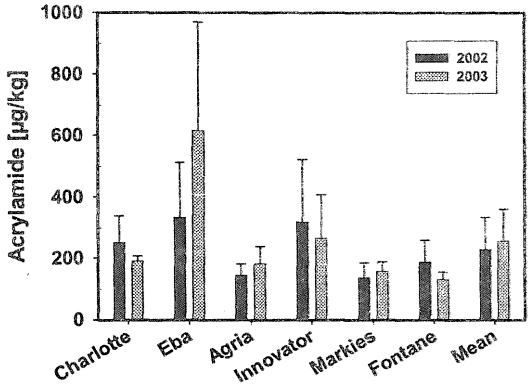

Fig. 3: Acrylamide content in French fries of different varieties from tubers harvested in 2002 and 2003 respectively, mean ± standard deviation calculated from 2 locations, 2 sampling dates (early, late within the storage period) and 2 samples per date, samples pre-fried at 150°C for 4 minutes and finished at 170 °C for 3 minutes, (n=8 samples per variety and year)

Temperatures for handling and storage after harvest are very important. To maintain low sugar content, most varieties should be stored not lower than 7–8° C, but there are also some cold tolerant cultivars which can be stored for long term at 4° C.

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ACRILAMIDA – UN NOU CRITERIU PENTRU SELECȚIA SOIURILOR?

Rezumat

Noile soiuri pentru industrializare precum Panda, Lady Claire, Markies şi altele, au prezentat un conținut mai scăzut de acrilamidă la chips şi pommes-frites datorită conținutului mai scăzut de zaharuri reducătoare. Fertilizarea cu azot nu a influențat conținutul de acrilamidă la chips în ambele sezoane de cultură. Fermierii îşi vor extinde suprafața de cultură cu aceste soiuri şi în acelaşi timp se reduce considerabil expunerea consumatorilor elvețieni la acrilamidă. Rolul materiei prime de calitate excelentă pentru industrializare va deveni şi mai important, deoarece modernizarea tehnicilor de prelucrare poate avea ca rezultat creşterea calității produselor (de ex: albirea chipsurilor). Mai multe proiecte elvețiene privind acrilamida pot contribui considerabil la minimizarea expunerii consumatorului la acest contaminant alimentar periculos şi, de asemenea, la menținerea şi în viitor a cartofului printre alimentele preferate de consumatori.

Cuvinte cheie: cartof, prelucrare, acrilamidă, consumator, calitate

Figuri:

1. Relația dintre culoarea chipsului şi acrilamidă; mostre de chipsuri din diferite soiuri, din tuberculi recoltați în 2002 şi respectiv 2003; deviation medie ± standard din cele 2 mostre ținute la 170°C la începutul şi la sfârşitul perioadelor de păstrare (număr=8 mostre per culoare şi an)

2. Conținutul de acrilamidă al chipsurilor din diferite soiuri din tuberculi recoltați în 2002 şi respectiv 2003, deviation medie ± standard calculată pentru 2 locații, 2 date de prelevare (timpurie, târzie în timpul perioadei de păstrare) şi 2 mostre per dată, ținute la 170°C (număr=8 mostre per soi şi an)

4. Conținutul de acrilamidă al pommes-frites din diferite soiuri din tuberculi recoltați în 2002 şi respectiv 2003, deviation medie ± standard pentru 2 locații, 2 date de prelevare (timpurie, târzie în timpul perioadei de păstrare) şi 2 mostre per dată, mostre pre-prăjite la 150°C timp de 4 minute şi apoi prăjite la 170 °C timp de 3 minutes, (număr=8 mostre per soi şi an).

INFLUENCE OF CULTURE MEDIUM COMPOSITION ON *IN VITRO* PRESERVATION OF POTATO VARIETIES BY MEANS OF MERISTEMPLANTS

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SUMMARY

In Research Center EVIKA we are preserving potato varieties as meristemplants *in vitro* in slow-growth conditions. All accessions preserved *in vitro* are disease-free and are tested on virus infection for several times. At present there are 417 potato varieties, breeding material, land-races and 574 meristem clones *in vitro* genebank. Slow-growth method slows the development of plants and limits the number of necessary sub-cultures.

The aim of our research was to study the influence of some medium components together with temperature and light reduction on the growth of meistemplants and the extent of the sub-culture interval. The EVIKA potato plant propagation medium was used as control. The medium components – potassium, nitrogen, kinetin and sucrose - were added into the propagation medium. The regeneration and preservation of plants were carried out in two different temperature and light conditions. Explants regeneration lasted 2 weeks in following conditions: 16h/22...24°C/2,4 Klux and 8h/18...20°C. After regeneration the plants were placed into preservation conditions (16h/3...4°C/1,2 Klux and 8h/3...4°C) for 40...42 or 87...89 days. In the test the following morphological characteristics of plant were evaluated: height of plants; number of internodes; number of roots and length of roots. 4 varieties with different *in vitro* behavior involved in tests.

Conclusively it was evident that by changing the medium composition, lowering temperature and light intensity and increasing preservation duration there was no negative influence on plant regeneration or morphological characteristics. Modifying EVIKA potato propagation medium by adding kinetin 0,2...0,3 mg/l, sucrose 20 g/l and KNO_3 4,0 g/l and maintaining plant material at the temperatures 3...4°C, 16h/8h, 1,2 Klux, the sub-culturing interval can be extended up to 100 days.

Keywords: in vitro multiplication, meristemplants, medium.

INTRODUCTION

Due to the changes in environmental conditions the highest losses of biological diversity are proposed to vegetatively propagated species. Potato is vegetatively

MATERIAL AND METHODS

Tests were carried out in Research Center EVIKA in 1999...2000. Potato meristemplants maintained at EVIKA gene bank were used as experimental material. The EVIKA potato plant propagation medium was used as control. The medium components – potassium, nitrogen, kinetin and sucrose - were added into the propagation medium.

C1 – Control - EVIKA propagation medium (Rosenberg, 1981).
C2 – Control + KNO_3 2 g/l
C3 – Control + kinetin 0,2 mg/l
C4 – Control + KNO_3 2 g/l + kinetin 0,2 mg/l
C5 – Control + KNO_3 2 g/l + kinetin 0,3 mg/l
C6 – Control + KNO_3 2 g/l + kinetin 0,3 mg/l + sucrose 10 g/l

In order to homogenize the initial plant material for the tests the propagation was started three weeks before realizing the tests. Every year the first cycle of the tests started at the beginning of February. 20 microcuttings in 4 replicates were placed into test tubes.

The regeneration and preservation of plants were carried out in two different light and temperature conditions (table 1). The day and dark regime (16h light / 8h dark) was the same in all 3 occasions. Explants regeneration lasted 2 weeks. After regeneration the plants were placed into plant preservation conditions (table 2).

Before planting into plastic rolls the following morphological characteristics of plant were evaluated: height of plants; number of internodes; number of roots; length of roots. There were 4 varieties with different *in vitro* behavior involved in tests: 'Varajane kollane', 'Ants', 'Saturna', 'Berber'.

Table 1. The plant regeneration and preservation conditions

Treat-ment	Regeneration		Preservation	
	Days	Conditions	Days	Conditions
I	14...15	16h 22...24°C, 2,4 Klux 8h 18...20°C	6...7	16h 22...24°C, 2,4 Klux 8h 18...20°C
II	14...15	16h 22...24°C, 2,4 Klux 8h 18...20°C	40...42	16h 3...4°C, 1,2 Klux 8h 3...4°C
III	14...15	16h 22...24°C, 2,4 Klux 8h 18...20°C	87...89	16h 3...4°C, 1,2 Klux 8h 3...4°C

Table 2. The time schedule of the *in vitro* tests

Action	Preservation treatment		
	I	II	III
Cultivation of microcuttings	05...07.05	03...05.04	14...16.02
Plants into preservation conditions	19...20.05	17...19.04	28.02...02.03
Preservation period (days)	6...7	40...42	87...89
Planting into plastic rolls	26...28.05	26...28.05	26...28.05
Time (days) from cultivation of micro-cuttings until planting into plastic rolls	20...22	53...55	100...102

RESULTS

In our preliminary study the effectiveness of the rapid propagation of potato plants *in vitro* the regeneration of plants was influenced by the composition of medium and by the genotype (Kotkas, 1994). To supply seed potato growers with healthy initial seed material the large number of *in vitro* plants are needed in a short period.

Preservation of potato varieties *in vitro* has to guarantee that the development of plants is inhibited but the morphological characteristics are preserved. Minimizing the number of sub-cultures by extending the interval between sub-culturing can do it.

In this work some plant morphological characteristics - the height of stems, the number of internodes and roots and the length of roots depending on the composition of medium were studied. Also the influence of plant preservation conditions and preservation duration on the plant morphological characteristics was tested.

The height of stems was significantly influenced by the content of medium. It decreased in all tested media compared with control (C1) (figure 1). The height of stems was more influenced by kinetin (C5, C6) than by potassium (C2) or sucrose (difference between C5 and C6).

The height of stems was significantly influenced by the preservation conditions, increasing in treatments II and III compared with control I. The plants were preserved at the temperatures 3...4°C for 53...55 (II) or 100...102 (III) days. During the preservation the development of plants was not completely inhibited. The height of plants was higher when the preservation duration was longer.

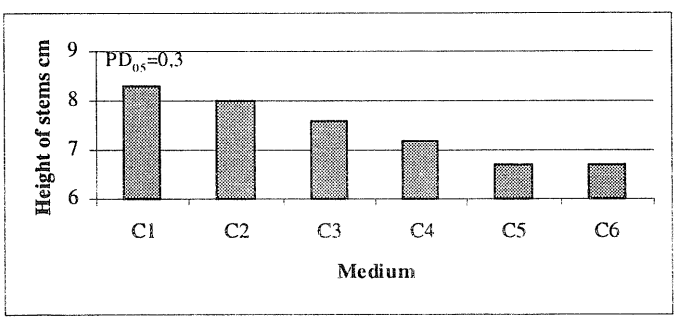

Figure 1. The average height of stems depending on medium content

The number of internodes characterizes the plant propagation rate. The plant propagation rate is correlated to the number of cuttings and internodes. In our previous study on different propagation methods the number of internodes per plant was influenced by genotype and propagation medium (Kotkas, 1994).

In this study we accounted the internodes with the minimum 5 mm distance between leaves. In case of shorter internodes it is complicated to obtain cuttings with optimal size for the propagation. The number of internodes per plant was significantly influenced by the medium, preservation conditions and duration. In tested media the number of internodes decreased compared with control medium (C1). The average number of internodes per plant varied between the cultivars and was mostly influenced by the mutual influence of kinetin and potassium. The preservation condition affected the number of internodes as well.

There was a positive correlation between the height of plants and the number of internodes on preserved plants but not on control plants. Higher plants had more internodes (table 3). This kind of correlation was not found between different media.

In the II preservation treatment the height of stems increased, depending on variety, from 0,6 cm ('Berber') to 1,5 cm ('Ants'). In the III preservation treatment the height of stems increased, depending on variety, from 1,7 cm ('Saturna') to 4,5 cm ('Varajane kollane). By extended preservation period *in vitro* the height of stems of the variety 'Varajane kollane' increased more compared with other varieties.

Table 3. The height of stems and the number of internodes depending on preservation treatment

Variety	Height of stems cm			Number of internodes		
	I	II	III	I	II	III
'Varajane kollane'	6,2	7,6	10,7	5,1	6,2	8,8
'Ants'	5,3	6,8	9,1	5,0	6,0	7,1
'Saturna'	6,3	7,6	8,0	5,3	6,5	7,1
'Berber'	6,2	6,8	8,3	4,6	6,1	7,1

The distance between the internodes (the height of stems / the number of internodes) characterizes the location of leaves on the stem and the height of stem cuttings. The longer the distance between internodes is the rarely the leaves are and the longer the stem cuttings are.

The distance between the internodes of the varieties 'Varajane kollane' and 'Ants' was longer in control medium C1 (1,28 cm and 1,34 cm) and shorter in medium C6 (1,11 cm and 1,05 cm). The distance between the internodes of the varieties 'Saturna' and 'Berber' was longer in medium C2 (1,35 cm and 1,27 cm) and shorter in medium C5 (1,08 cm 'Saturna') and in media C5, C6 (1,11 cm 'Berber').

By extended preservation period the height of stems increased. At the same time the distance between the internodes of varieties 'Ants' and 'Saturna' increased but varieties 'Varajane kollane' and 'Berber' decreased.

The number of roots characterizes the quality of root system and rooting of plants in plastic roll and in field conditions. KNO3 (C2) and kinetin (C3) separately reduced the number of roots per plant (figure 2). Mutual influence of KNO_3 and kinetin (C4, C5) increased the same characteristic. The best rooting was obtained when sucrose together with KNO_3 and kinetin was added into medium (C6).

The preservation conditions and duration had significant influence on the number of roots per plant. By increasing the preservation duration the number of roots increased.

The number of roots per plant of the varieties 'Varajane kollane' and 'Ants' was more influenced by the preservation treatment than by the medium. The number of roots per plant of the varieties 'Saturna' and 'Berber' was more influenced by the medium than by the preservation treatment. The number of roots per plant of all varieties was more influenced by the medium and preservation treatments than by the mutual treatment of medium and preservation conditions.

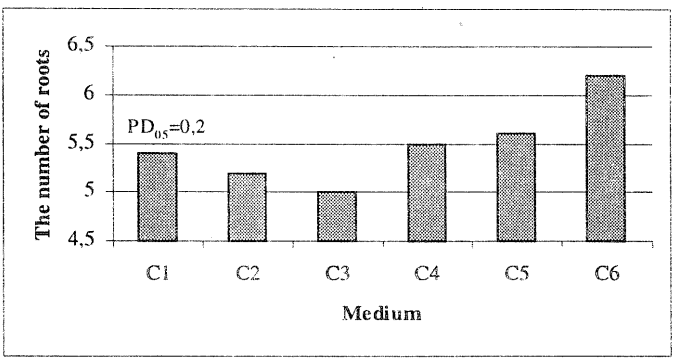

Figure 2. The average number of roots depending on medium content

The length of roots is important characteristic in the rapid propagation period of the initial seed production material and in growing the first tuber generation in the field. *In vitro* preservation the number of roots is more valuable characteristic than the length of roots.

The length of roots depended significantly on the medium content. Kinetin (C3) and kinetin + KNO_3 (C4, C5) decreased the length of roots (figure 3). In the case of high concentration of kinetin (C4, C5) or kinetin combined with sucrose (C6) the plants had short internodes of dark green color and many roots. In control (C1) and in media with KNO_3 (C2) plants were stretched out, had long internodes and pale tip-leaves. In all treatments, except control, there was a negative correlation between the number of roots and the length of roots (figure 2 and 3).

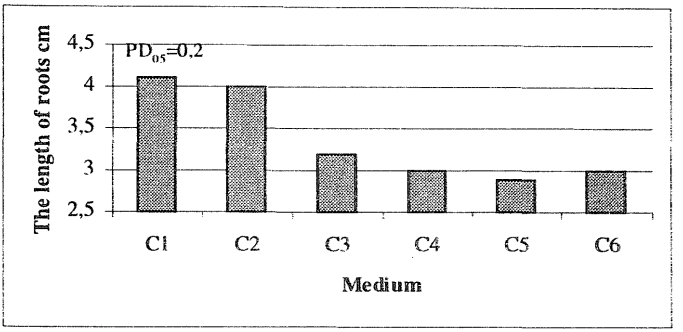

Figure 3. The average length of roots depending on medium content

The length of roots of all cultivars depended significantly on the preservation treatment. The number and length of roots increased by extended preservation period. Preserving plants at the temperature 3...4°C up to 100 days did not influence the number and length of the roots negatively.

It was evident that by changing the medium composition, lowering temperature and increasing preservation duration there was no negative influence on plant regeneration or morphological characteristics. The plant morphological characteristics were more influenced by preservation temperature and duration than by the medium components separately.

There was no correlation between earliness of variety and its development *in vitro*. First early variety 'Berber' and late variety 'Ants' had short stems and developed slowly *in vitro*. Second early variety 'Varajane kollane' and late variety 'Saturna' were tall, had long homogencous internodes and big leaves. Tendency was the same in all studied media and preservation conditions.

In the current study the plant sub-culturing intervals varied from 20...22, 53...55 to 100...102 days. Kinetin had clearly positive effect on plants' tolerance to low temperatures and long sub-culturing intervals. During the long preservation period the plants grown without kinetin (C1, C2) became elongated, tip leaves turned yellowish and dropped when planted out from test tubes.

The potato plants grown in medium with higher concentration of kinetin (C5, C6) had more short internodes and smaller leaves. The roots located close to medium surface and some roots were regenerated outside medium, especially in the case of 'Berber'. Also 'Berber' had callus on leaves and on stem. It is known that the appearance of callus is connected with the physiological changes caused by changes in environment (Benson *et al.*, 1989). It means the variety 'Berber' is more sensitive to lower temperatures than other tested varieties.

DISCUSSION

In vitro plants exhaust the nutrients in medium in 1...2 months. Therefore, the plants have to be transferred frequently to fresh medium. The activity of plant metabolism is closely correlated to temperature of ambient environment. The culture rooms for propagation generally have a temperature range similar to those needed to grow a crop in the field. Intervals between sub-cultures can be extended through growth rate reduction by changes in media components or modifications to the environment (Dodds, 1987).

Cytokinins are often used to stimulate growth and development. They usually promote cell division, especially when added together with auxins. In higher concentrations (1...10 mg/l) they can induce adventitious shoots formation, but root formation is generally inhibited (Novak, *et al.*, 1980). Kinetin is known to be one of the growth regulators involved in controlling apical dominance (Simko, 1993). The effect of kinetin on regeneration of meristems (Huang, Musahige, 1977; Novak *et al.*, 1980) and formation of microtubers *in vitro* (Mondolini *et al.*, 1993) is well documented. In blue light the kinetin increased the total fresh weight of plants and root/shoot ratio (Aksenova *et al.*, 1994). Rhizome initiation and development appear to be controlled by coordinated participation of endogenous plant hormones during the early events leading to tuber development *in vitro* (Escalante, Langille, 1995).

According on our results the addition of kinetin together with higher concentration of KNO_3 to the media had a beneficial effect on the inhibition of plant development. Kinetiin with KNO_3 reduced stem and roots length, but increased the number of roots. With increasing the concentration, kinetiin progressively inhibited growth, compact shoots with small leaves and short internodes being produced. Response of individual varieties varied somewhat while the growth trends mentioned above were consistent for all varieties.

The plant morphological characteristics and sub-culturing interval were more influenced by preservation temperature, light intensity and duration than by the medium components separately. The height of plants was higher with more internodes when the preservation duration was longer. The number and length of roots increased by extended preservation period.

Low temperatures slow the growth and development in a natural way, and limit the necessary sub-cultures (Dodds *et al.*, 1991). Reducing light intensity also affects growth rate by reducing photosynthetic requirements and therefore metabolism (Westcott, 1981).

The protocol for medium-term *in vitro* conservation of the potato collection at CIP is as follows. Accessions are conserved in a conservation medium containing 4% sorbitol at a temperature 6...8°C, and light intensity 1000 lux (Harding, 1994). After several years *in vitro* culture, plants can recover normal growth after one or two sub-cultures in propagation media.

In this work the plants were preserved at the temperatures 3...4°C and light intensity 1200 lux for 53...55 or 100...102 days. The treatment for storing plants at 3...4°C was

not successful in this experiment. The low temperature did not stop growth during storage. Kinetin had clearly positive effect on plants' tolerance to low temperatures and long sub-culturing intervals. During the longer preservation period the plants grown in medium without kinetin became elongated, tip leaves turned yellowish and dropped when planted out from test tubes.

CIP has investigated many tissue culture methods to safeguard potato genetic resources. To reduce *in vitro* maintenance costs, CIP preserves sweet potato germplasm in long-term storage with growth retardants such as sorbitol and reduced incubation temperature 18°C. The conservation temperature had no effect on the shoot length, the leaf area and the leaf number. The photosynthetic potentials were 4,7 times higher for the plantlets coming from the microtubers stored at 20°C than for the plants coming from the tubers stored at 4°C (Genoud *et al.*, 1993).

Our experiments show that cuttings sub-cultured from *in vitro* shoots of potato are sensitive to wide range of controllable factors comprising the nutrient environment of the cultures together with the light and temperature conditions. It was evident that by changing the medium composition, lowering temperature and light intensity and increasing preservation duration there was no negative influence on plant regeneration or morphological characteristics.

For the preservation of potato genetic resources there are different methods and each of them has its own demands on preservation, management and using of genetic material. Usage of the *in vitro* methods is the latest achievement and its importance is increasing (Lebot, 1992).

The storage of *in vitro* meristemplants is excellent for medium-term storage especially because samples are readily available. However, for the long-term storage of varieties not required for immediate use, cryopreservation, the storage in liquid nitrogen would seem to be advantageous because once frozen only regular filling of containers with liquid nitrogen would be required (Schäfer-Menuhr *et. al.*, 1996).

There are still a lot of problems connected with preservation of potato genetic resources *in vitro* as a meristemplants, microtubers or cryopreservation technique. Obviously, slow-growth techniques are in a more advanced state of development and should become more widely applied once their flexibility, simplicity and practicality are clearly demonstrated (Engelmann, 1997). This allows storage of healthy germplasm with extended sub-culture intervals, thus reducing time and costs for maintenance. And also it offers the possibility of exchanging germplasm in disease-free conditions. However, despite their potential, *in vitro* conservation techniques are currently used to the limited extent only. This is partly due to the fact that they are little known and partly because future research is still needed in some areas.

CONCLUSIONS

1. All tested medium components had an influence on the morphological characteristics of plants. Kinetin had a stronger effect than potassium or sucrose. In

treatments with kinetin (0,2 mg/l or 0,3 mg/l) the height of stems and the length of roots shortened, the number of internodes decreased and the number of roots increased.

2. Modifying EVIKA potato propagation medium by adding kinetin 0,2...0,3 mg/l, sucrose 20 g/l and KNO_3 4,0 g/l and maintaining plant material at the temperatures 3...4°C, 16h/8h, 1,2 Klux, the sub-culturing interval can be extended up to 100 days.

3. According to the present research it can be concluded that the medium-term preservation of potato varieties as meristemplants *in vitro* did not influence negatively the morphological characteristics of plants. By improving medium content and by lowering preservation temperature and light intensity the sub-culturing interval increased from 22 up to 102 days.

4. Our further experiments will concentrate on research of medium components and the optimum regeneration stage of plant material for preservation. Probably the most crucial step in the whole storage process that needs investigation is the post-preservation acclimatization before sub-culturing and/or before planting out *ex vitro* to the greenhouse.

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INFLUENȚA COMPOZIȚIEI MEDIULUI DE CULTURĂ ASUPRA CONSERVĂRII *IN VITRO* A SOIURILOR DE CARTOF PRIN INTERMEDIUL MERISTEMELOR

Rezumat

La Centrul de Cercetare EVIKA se conservă soiurile de cartof ca meristeme *in vitro* în condiții de creștere încetinită. Toate plantele conservate *in vitro* sunt libere de boli și sunt testate contra virusurilor de mai multe ori. La ora actuală există 417 soiuri de cartof, material pentru ameliorare și o bancă *in vitro* de gene cu 574 clone de meristeme. Metoda creșterii încetinite diminuează dezvoltarea plantelor și limitează numărul subculturilor necesare.

Scopul cercetării noastre a fost să studiem influența unor elemente componente ale mediului de cultură alături de reducerea temperaturii și luminii asupra creșterii meristemelor și lungimea perioadei de subcultură. Mediul de propagare EVIKA pentru planta de cartof a fost folosit ca și martor. Elementele mediului de cultură – potasiu, azot, kinetină and sucroză – au fost adăugate în mediul de propagare. Regenerarea și conservarea plantelor s-au desfășurat la două variante de temperatură și lumină. Regenerarea explantelor a durat 2 săptămâni în următoarele condiții: 16h/22...24°C/2,4 Klux și 8h/18...20°C. După regenerare, plantele au fost plasate în condiții de conservare (16h/3...4°C/1,2 Klux și 8h/3...4°C) timp de 40...42 or 87...89 zile. Au fost evaluate în timpul testului următoarele caracteristici morfologice ale plantelor: înălțimea plantelor; numărul de internodii; numărul de rădăcini și lungimea lor. Au fost testate 4 soiuri cu comportament *in vitro* diferit.

În concluzie, a fost evident că schimbarea compoziției mediului, scăderea temperaturii și intensității luminii și creșterea perioadei de conservare nu au avut nici o influență negativă asupra regenerării plantelor sau asupra caracteristicilor morfologice. Modificarea mediului de propagare EVIKA prin adăugare de kinetină 0,2...0,3 mg/l, sucroză 20 g/l și KNO_3 4,0 g/l și menținerea materialului la temperaturi de 3...4°C, 16h/8h, 1,2 Klux, intervalul de subcultură poate fi extins la 100 de zile.

Cuvinte cheie: înmulțire *in vitro*, meristeme, mediu de cultură

Tabele:

1. Condițiile de regenerare și conservare a plantei
2. Programarea testelor *in vitro*
3. Înălțimea tulpinilor și numărul de internozi în funcție de tratamentul de conservare

Figuri:

1. Înălțimea medie a tulpinii în funcție de conținutul mediului de cultură
2. Numărul mediu de rădăcini în funcție de conținutul mediului de cultură
3. Lungimea medie a rădăcinilor în funcție de conținutul mediului de cultură

RESEARCH OF POTATO MERISTEM CLONES

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SUMMARY

The yield, the dry matter and starch content in tubers, the morphological characteristics and disease resistance of plants of more than 500 meristem clones of 35 potato varieties has been studied over a long time period. In addition to the field trials the plants were tested *in vitro* for susceptibility to late blight with the isolates of *Phytophthora infestans* (Mont.) De Bary. The biosynthesis of potato viruses PVX and PVM in plants of meristem clones was studied as well. The results of our research showed that meristem clones differed by the yield, starch content, morphological characteristics and disease resistance. The variability in tuber yield was registered in all trials.

Keywords: seed potato, meristem clones, varieties

INTRODUCTION

Meristem method has been used as a tool for eradication of potato initial seed material from virus diseases for about 40 years. The method is principally the following: a slice of meristematic tissue is cut from the bud of a plant and cultivated in culture medium in the conditions that are favorable for the regeneration of the whole new plant. The exact method is varying according to the aim of cultivation process. Several treatments of plants or sprouts are used prior the cultivation of meristem, like thermotherapy, chemotherapy, x-rays etc. The composition of culture medium can vary as well as the size or location meristem explants. The meristematic tissue can be excised from sprout or shoot, it can be lateral or apical.

In Research Centre EVIKA a lot of factors that affect the virus eradication and regeneration of potato meristem plants are studied. As a result of the long-lasting research the technology for virus eradication was created according to which the meristem is excised only from lateral (or sometimes apical) buds from shoots of green plants that have passed through the thermotherapy treatment. The optimal size of meristem explant that guaranteed the highest regeneration percentage and the highest number of disease-free plants was 0,2–0,3 mm. The selection for the best plants starts already on the level of first regenerants. The offspring of all meristem explants is preserved and propagated separately, this way the meristem clones are formed. Before the selection for seed production is made, the meristem clones are evaluated in the fields. Simultaneously one part of each meristem clone plants preserved *in vitro* (Kotkas, Rosenberg, 1999).

The results of preliminary trials where the seed potato was propagated by conventional clone method demonstrated that some meristem clones differed from others by their yield and level of infection with late blight. The similar information was obtained from the districts of Moscow and Tomsk, where the seed potato propagated in EVIKA was compared to the potato eradicated in the Research Institute of Potato Management in Russia. These results inspired us to study the characteristics of meristem clones deeply and detailed. The goal was to find out if there was any correlation between the characteristics of meristem explant and the yield and/or some other quality of meristem clone. Interesting was also to know if the difference between meristem clones was constant phenomenon or random?

MATERIAL AND METHODS

The cultivation of meristem clones and preparation of test material

Meristem tissue of 0,2–0,3 mm in size was cut from apical or lateral buds of green plants that had passed through 6–8 weeks of thermotherapy treatment. Usually 20–30 explants were cut per variety. The explants were cultivated on modified Murashige-Skoog medium. The plants regenerated within 4–12 weeks. The speed of regeneration depended on genotype, but not always. Fast developed plants with stem-length 8–12 cm in height and developed root primordial were selected for further studies. Regenerants with chlorotic and abnormal leaf or stem shape that remained short and did not develop any roots were eliminated from tests. So the first selection was made at the stage of first meristem plants. The selected meristem plants were propagated *in vitro* by means of microcuttings. The progeny of each meristem plants was the basis for meristem clone. A part of the meristem clone plants remained *in vitro*, the others, usually 3 of each clone, were used for virus diagnostics. The ELISA-test was used for virus identification. The plants that did not react on ELISA-test were tested once again by indicator plants. The double-checked virus-free plants were selected for further trials. The plants of meristem clones were propagated *in vitro* and in plastic rolls and were used for cultivation of first generation tubers in the field.

Methods of field trials

The majority of field trials were conducted in the test field of Research Centre EVIKA in North-Estonia; some trials were set up in the test fields of Estonian Agricultural University in South-Estonia and some in Jõgeva Plant Breeding Institute in Central Estonia.

The trials of joint Nordic-Estonian Project were organized with one Estonian, one Danish and one Swedish variety simultaneously in Estonia, Denmark and Sweden. Only second-generation tubers that were propagated in Finland were used in trials. Every year a new material of second-generation tubers was planted into fields.

In EVIKA trials the first generation tubers were used for first year trials and every following year the second, third or fourth generation tubers were used respectively. In

the first years the trials were set in 4 replicas, 90 tubers per plot. Later on the trial methods were changed and 40 tubers were planted per plot.

The same agrotechnical procedures as in production fields were used in the trials. The potato was fertilized with complex fertilizer 500 kg/ha. The soil type was different every year. The planting time depended on weather and varied from May 8th to 25th as well as harvesting time – from September 2nd to 20th. The chemical weed control was made when needed and potato was hilled up 1–2 times during vegetation period. There was no chemical disease or pest control made in the test fields.

The potato plants were monitored during the whole growing period. The speed and quality of emergence, beginning and intensity of flowering, infection with late blight was evaluated. In some trials the number of stems on the plant was counted. The number of tubers per plant was counted and the weight of tubers was measured at harvesting; 2 months later the dry matter and starch content as well as the infection with rot diseases and rhizoctonia was analyzed.

The tests of meristem clones for tolerance to potato late blight

The infection of *in vitro* plants with pure cultures of various stems of *Ph. infestance* was tested in the lab. Pure cultures were cultivated on rye agar and the layer of fungus was washed with sterile water to make the suspension necessary for inoculation. The liquid was then filtrated through 2 layers of cheesecloth. The concentration of spores was determined under the microscope at 120-fold magnification. Plants developed *in vitro* from microcuttings were infected with suspension of conidia with the concentration of 25–50 conidia at the field of view of microscope. After inoculation the plants were maintained *in vitro* at temperature 20–21°C, photoperiod 18 hours. The level of infection was evaluated according the scale 0...3 points starting on the 3rd day after inoculation until the death of plants. In the field the infection of plants with *Ph. infestans* and its development was evaluated according to the scale 0...5 points. The percentage of infection was calculated according to the special formula.

RESULTS AND DISCUSSION

The potato meristem clones have been studied mainly for their agronomic characteristics. There were the newest but also some of the oldest Estonian varieties as well as foreign varieties included to the trials. Meristem clones of all varieties varied in yield but the range of variability differed between the varieties (table 1).

The data in table 1 show that the yield of all 16 varieties varied in rather wide range. Our previous studies had shown that some varieties do not express huge variation in yield but these results disproved our previous knowledge. For example, 12 meristem clones out of 13 of variety Ando produced similar yield in our earliest studies. Only one meristem clone cultivated in 1978 expressed significantly higher yield potential than the others. The 17 meristem clones presented in table 1 were re-cultivated from the last mentioned clone from year 1978 as mother plant.

Table 1. The yield variation of potato meristem clones in 1996

Variety	Number of clones	Yield variation
1. Ando	17	30,9...43,5
2. Ants	10	32,4...39,7
3. Berber	15	22,8...39,1
4. Bintje	8	26,4...41,2
5. Eba	11	25,1...46,7
6. Ere	26	26,8...35,0
7. Jõgeva kollane	11	25,9...35,8
8. Kondor	32	28,6...47,4
9. Nicola	22	35,0...50,4
10. Premiere	9	29,8...43,8
11. Prevalent	5	32,2...39,6
12. Procura	13	27,2...37,4
13. Sante	8	33,3...43,1
14. Sarme	7	36,5...44,3
15. Saturna	28	32,1...40,0
16. Varajane kollane	15	24,6...37,5

Special trials were conducted with variety Eba in order to study the correlation between the yield and characteristics of meristem clones; and correlations between characteristics of mother plant and progeny meristem clones (Rosenberg, 1995). Variety Eba was selected to trials because it expressed especially labile and varying properties in meristem culture in our earliest tests (table 2).

Table 2. Comparison results of meristem clones of the variety Eba

Number of clones	Year of cutting meristem	Size of meristem cut, mm	Yield, t/ha average of 3 years	Years of field tests
295	1981	0,5	28,5	1986, 1987, 1988
3373	1983	0,2	47,5	1986, 1987, 1988
3471	1983	0,5	44,0	1986, 1987, 1988
3373	1983	0,2	36,7	1989, 1990, 1991
996	1986	0,3	24,6	1989, 1990, 1991
999	1986	0,3	23,1	1989, 1990, 1991
1000	1986	0,3	23,5	1989, 1990, 1991
3373	1983	0,2	27,7	1995, 1996, 1997
3373/329	1991	0,3	24,3	1995, 1996, 1997
3373/330	1991	0,3	24,2	1995, 1996, 1997
3373/331	1991	0,3	27,0	1995, 1996, 1997
3373/333	1991	0,3	17,8	1995, 1996, 1997
3373/335	1991	0,3	18,7	1995, 1996, 1997
996	1986	0,3	16,8	1995, 1996, 1997
996/427	1991	0,3	27,3	1995, 1996, 1997
996/430	1991	0,3	17,2	1995, 1996, 1997
996/434	1991	0,3	28,5	1995, 1996, 1997
996/435	1991	0,3	16,9	1995, 1996, 1997

Meristem clone 295 was cultivated from heat-treated plant that was grown from the seed tubers received from the Netherlands. All other meristem clones were the offspring of clone no 295. The clones no 996, 999 and 1000 were the offspring of selected plant that was characterized by extremely high number of tubers (177 tubers per plat) in super-elite seed field. The clone numbers starting with 3373 and 996 are

indicating the number of mother plant the meristems were operated and the clone was started from.

The results in table 2 are indicating that in every group there are some clones that are expressing much higher yield capacity than others. There were no clear correlation between the characteristics of mother plant and the yield of meristem clone. Even the progeny of the above mentioned high-yielding plant (117 tubers) produced fewer tubers than clone 3373. Such kind of plants with giant yield was found among clones 3373 and 3471 grown in 2,8 ha field. The second-generation meristem tubers were planted to that field. Those 11 plants were characterized with numerous shoots and vigorous growth. At the harvesting 56–117 tubers were counted per plant.

In order to study the factors affecting the yield capacity of meristem clones the new meristems were operated from clones 3373 and 996. The new clones were propagated and these were compared to the mother plant. For this purpose *in vitro* propagated meristem plants were transferred to pots *ex vitro*. Acclimatized plants underwent 7 weeks of thermotherapy after which the new meristems were cultivated and well-developed microplants were selected for further trials.

The data given in table 2 show that the yield capacity varied within progeny of both mother plants. There was no positive correlation between the yield capacity of mother plant and its offspring. The yield of progeny of meristem clone of higher yield – 3373 – varied 17,8–27,0 t/ha while that of progeny of meristem clone of lower yield – 996 – varied 16,9–28,5 t/ha. It is remarkable that the clone no 3373 has retained its high potential over more than 10 years. This fact asserts that the trait of high yield capacity is persistent.

The yield level was registered to be lower in the last trial series compared to earlier trials. This was caused by the changes in trial conditions. We had to give over our previous trial area with better soil conditions and additionally the weather conditions were not favorable for potato growth in these last years of trial. In the last trial series the average yield of meristem clone 3373 was 27,2 t/ha and that of clone 996 was 16,8 t/ha. In the previous years the average yield had been 36,7 and 24,6 t/ha respectively.

Our results demonstrated also that there were no clear correlations between the size of excised meristem tissue and the yield of meristem clones. The same can be said about the location of excised meristems on the shoot. The yield of meristem clones was independent from the fact weather the meristem was operated from lateral or apical bud.

During the field monitoring it was observed that the plants of meristem clones with higher yield capacity had more shoots, uniformed bush and more intensive flowering than other clones. The plants of clone no 3373 emerged earlier, their shoots were stronger and leaves wider than on other plants. Nevertheless, the differences did not exceed the parameters of true-to-typeness. It was also assured by the owner of the variety who visited our fields – Dutch company Agrico.

The meristem clones of variety Eba differed also in the terms of starch content. The starch content of the seven tested clones varied from 16,3 to 17,6%. The starch content of meristem clone 3373 was 17,0%. The number of tubers per plant varied from 10,3 to 14,8 (3373). The plants' conditions varied according to the 5-point scale from 2,5 (373/333) to 5,0 (3373). At the Jõgeva Plant Breeding Institute the susceptibility of tubers to *Ph. infestans* were tested by artificial infection once. The susceptibility of four meristem clones of variety Eba varied from 2,24 to 3,06 points, the most susceptible being meristem clone 3373 (3,06 points). According to the same tests the susceptibility of 5 meristem clones of variety Premiere varied from 2,53 to 3,07; the 13 meristem clones of variety Vigri from 3,34 to 4,15 and the 5 meristem clones of variety Prevalent from 2,43 to 2,59.

We studied many varieties of different origin and age, new as well as old varieties. The special consideration was bestowed upon the old and widely grown variety in Europe – Bintje. The yield capacity of meristem clones was studied. The special attention was given to the tolerance of late blight since the variety is known to be especially susceptible to *Ph. infestans* infection. In table 3 there are the results of yield and visual evaluation of plants and in table 4 the estimation of resistance to *Ph. infestans* of 4 meristem clones of variety Bintje.

Table 3. The yield and visual evaluation of meristem clones of variety Bintje

Clone no	Yield t/ha	Tubers per plant	Dry matter content, %	Number of stems per plant	Overall of plants scale (1-5)
832	33,7	11,1	21,7	3,9	4,1
834	32,7	11,2	20,6	4,1	4,1
836	37,5	11,4	21,1	4,4	4,8
838	30,2	10,2	20,9	3,8	3,6

Table 4. The resistance of meristem clones of variety Bintje to *Ph. infestans in vitro* and in field

Clone no	Intensity of mycelium growth on *in vitro* plants, %					*Ph. infestans* in the field, %		*Ph. infestans* on tubers, %	
	4.	6.	13.	20.	31.*	1994	1995	1994	1995
832	55,8 0	77,7 22,1	100,0 77,7	0 100,0		0,72	3,8	40,0	2,5
834	22,2 0	33,3 11,1	66,7 45,0	100,0 100,0		0,88	3,8	17,5	0,0
836	33,3 1,1	44,4 33,3	77,8 55,5	88,9 100,0	100,0	0,53	1,0	10,0	2,5
839	33,3 0	66,7 22,2	100,0 78,9	88,9	100,0	0,42	0,9	20,0	5,0

* - 26 days after the inoculation with suspension of conidia

numerater – A stem; denominator – B stem

The results with variety Bintje demonstrated that the meristem clones were different in yield, in the morphological characteristics of plants and in the resistance to late blight. It needs to be pointed out that there were no pesticides against late blight used in the test field. The meristem clone 836 expressed higher yield capacity and was less susceptible to late blight infection as *in vitro* as in the field. When the plants were visually evaluated in the field it became evident that the clones differed from each other by the height. The meristem clones 832 and 834 were lower in stem height than the meristem clones 836 and 838. All meristemplants came from the same mother plant that had been cultivated *in vitro* and gone through thermotherapy.

Similar tests were conducted also with other varieties. Below are presented test results of Estonian variety Ants. This variety is characterized by high tolerance to late blight, especially in tubers.

Table 5. The yield and resistance to *Ph. infestans* of meristem clones of variety Ants *in vitro* and in field

Clone no	Disease index, % on *in vitro* plants		Mycelium evaluation %		Late blight in the field %		Yield, t/ha 2 years average
	A	B	A	B	plants	tubers	
1	66,7	0	100	100	8,6	0	45,0
4	33,3	0	100	33,3	3,8	0	51,8
5	33,3	0	100	0*	1,0	0	39,5
12	33,3	66,7	100	100	1,8	0	33,9
815	0	0	100	11,1*	1,4	0	38,1

* - 26 days after the innoculation with suspension of conidies, A, B – *Ph. infestans* stems

The studies with variety Ants showed that the test results *in vitro* were reliable since they matched to the results collected in the field. The meristem clone 1 was the most susceptible to *Ph. infestans in vitro* and also in the field. The meristem clone 815 was not infected by either of stem *in vitro*. However, in the field there was a slight infection on the leaves. Interestingly, 4 meristem clones of variety Ants were not infected by stem B while clone no 12 suffered from strong infection. The meristem clones of variety Ants derived from different mother plants.

The meristem clones of new Estonian variety – Piret - was tested years 2001–2003. The cultivation method of *in vitro* microplants differed from the meristem cultivation method applied in other varieties. On this variety the callus tissue was produced from meristems and the horizontal cuttings and buds formed on callus were cultivated on culture medium. The meristem clones are marked as follows: the first number symbolizes the meristem slice and the second number the shoot derived from its horizontal bud. For example, the meristem clones 78-1; -2 and -6 are all the offspring of one meristem cutting.

Tabel 6 The yield of the meristem clones of variety Piret average per 3 years

Clone no	Tubers per plant	Yield t/ha	Dry matter content %	Starch content %
74-1	7,8	34,5	19,2	13,0
78-1	8,8	38,4	20,3	14,0
78-2	7,8	32,9	20,1	13,8
78-6	6,7	33,9	19,0	12,8
81-1	6,6	34,5	19,7	13,4
81-3	7,9	34,5	19,8	13,5
81-8	8,3	36,6	19,7	13,4
82-9	8,5	33,8	20,5	14,3
83-2	8,0	33,3	19,9	13,6
83-8	8,3	33,7	19,9	13,6
Average	7,9	34,6	19,8	13,5
STDEV	0,7	1,0	0,4	0,4

Among 10 meristem clones of variety Piret some high yielding clones were found. Clone 78-1 is distinguishing by its especially high yield. Remarkable is that the clones of the highest (78-1) and the lowest (78-2) yield derived from the same meristem. Similarly, among the 3 progeny clones of meristem 81, one clone expressed higher yield capacity while the other 2 produced lower yield.

Meristem clones as the basic material for somaclonal variation and its application possibilities were studied together with the Jõgeva Plant Breeding Institute. The term "somaclonal variation" covers the phenotypic changes, which occur in plants regenerated from cultured cells or tissues. Somaclonal variation is a disadvantage in all used of plant tissue culture where true-to-type plants have to be produced. At the same time it is a tool that can be used by plant breeders to offer a rapid and easily accessible source of variation for use in breeding programmes.

The aim of research programme designed to study the possibilities of using somaclonal variation caused by meristem culture in potato breeding. We hope to find out genotypes which show greater variation in agronomic traits in use of meristem culture, to select best meristem clones with heritable character in agronomically impotant properties.

There were two varieties – Anti and Juku – and one breeding number J1488-88 in the tests. The results demonstrated that the highest variation in the agronomic characteristics occurred on variety Juku. The breeding number J1488-88 was characterized by the highest variation in resistance to *Ph. infestans*. This issue needs further investigation (Koppel *et al.*, 1999).

The intensity of virus biosynthesis and susceptibility to the viruses in meristem clones of the same vaiety as well as in the meristem clones regenerated from the meristem operated from different parts, apical and lateral buds of shoot, immature

flower bud the same plant, were studied. The biosynthesis intensity of PVX in 17 meristem clones of varieties Premiere, Eba and Kondor and PVM in 27 clones Vigri, Eba, Kondor and Premiere.

The higest relative resistance to PVX was found in the meristem clones Eba 3373; Kondor 1065; Premiere 804 and to PMV - in Eba 1000; Kondor 1; Premiere 356 and Vigri 918. The dependence of virus resistance of the meristem clones on the location of meristem in the plants was established. All varieties showed the higest degree of the intensity of virus biosynthesis and susceptibility to PVX and PVM in the meristem clones obtained from an apical buds of soot, the lowest one in the clones from a lateral bud of soot. In both experiments the inoculated plants and their second generation were analysed. In the 2nd year the degree of the intensity of virus biosynthesis and susceptibility to virus infection were higer than in the 1st generation, however, the relative differences between the meristem clones of the variety remained the same (Agur&Rosenberg, 1999).

CONCLUSIONS

The diverse studies of many varieties over a long period of time have evidenced that meristem clones can vary in a wide range by their agronomic traits. We did not register the deviation from morphological true-to-type characteristics.

In a production of high-quality seed potato the eradication of initial material is insufficient and inadequate. It is necessary to select the meristem clones with the best agronomical traits. In the ideal situation the *in vitro* tests are used to identify the most resistant meristem clones to late blight. We do not agree to N. S. Wright (1983) opinion that only one clone is needed to propagate the sufficient amount of seed potato. In the referred studies the productivity of meristematic progeny of 2–3 clones of 10 varieties collected from different regions was tested. The variations were registered among these clones but the author did not consider it important enough to cultivate higher number of meristem clones.

In 1999-2001 the field trials in Estonia, Sweden and Denmark were established to investigate of potato meristem clones at different geographic localities. Four varieties were established as meristem clones, ten of each. The results clearly show that significant clone differences do exist (Nielsen, *et al.*, 2002).

The studies of virus resistance provided us a lot of interesting data but this issue needs more detailed studies as well as the possibilities to use the somaclonal variation in plant breeding.

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CERCETĂRI ASUPRA CLONELOR DIN MERISTEME ALE CARTOFULUI

Rezumat

Au fost studiate productivitatea, conținutul de substanță uscată și de amidon al tuberculilor, caracteristicile morfologice și rezistența la boli a plantelor provenite de la peste 500 de clone din meristeme provenite de la 35 de soiuri de cartof, pe o perioadă lungă de timp. Pe lângă experiențele de câmp, plantele au fost testate *in vitro* în privința sensibilității la mană cu izolatele de *Phytophthora infestans* (Mont.) De Bary.

A fost studiată de asemenea biosinteza virusurilor cartofului PVX și PVM la plantele provenite din clonele din meristeme. Rezultatele cercetării au arătat că clonele din meristeme au diferit în funcție de productivitate, conținutul de amidon, caracteristicile morfologice și rezistența la boli. La toate testele s-a înregistrat variabilitatea producției de tuberculi.

Cuvinte cheie: cartof pentru sămânță, clone din meristeme, virus, mană, *in vitro,* soi.

Tabele:

1. Variația producției la clonele din meristeme ale cartofului în 1996
2. Rezultate ale comparării clonelor din meristeme din soiul Eba
3. Evaluarea vizuală și a producției de clone din meristeme din soiul Bintje
4. Rezistența clonelor de meristeme din soiul Bintje la *Ph. infestans in vitro* și în câmp
5. Producția și rezistența la *Ph. infestans* a clonelor din meristeme din soiul Ants *in vitro* și în câmp
6. Producția de clone din meristeme din soiul Piret; media pe 3 ani.

RESEARCHES ON GENOTYPE INFLUENCE ON POTATO MICROTUBERIZATION

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SUMMARY

Micropropagation techniques are the simpliest way for increasing the efficiency of a seed potato crop and so of ware potato crop. Microtubers are an important component, along with plantlets and minitubers, for seed potato production programs. Researches were effectuated on 4 Romanian varieties and 2 Dutch varieties. The microtuberization medium is a liquid medium and contains the same substances as MS medium but in half amount, Coumarin, Kinetin and sucrose (80-90 g/l). By analyzing the results of this experience, we can conclude that microtubers size, as well as microtubers number, is influenced by the genotype.

Keywords: *Solanum tuberosum* L, genotype, microtuber, *in vitro*.

INTRODUCTION

Potato *in vitro* microtuberization represents a transitory phase between *in vitro* multiplication of the healthy material and field multiplication. Microtubers are small size tubers (3-10 mm diameter), spherical shape, with 0,05 to 1,3 g weight. Microtubers smaller than 3 mm diameter are not useful. Under normal culture conditions, microtubers produce Prebasic tubers which can be used for Basic plants production.

Thanks to *in vitro* techniques, healthy microtubers can be produced during the whole year. After harvesting, microtubers can be stored at +2°C for 6-12 months. They can be used in international germoplasm exchange. Microtubers can be planted directly in the field, there is no need to acclimatize them (Rolot, 2004).

MATERIALS AND METHODS

Biological material utilized is represented by the Romanian varieties Amelia, Christian, Dacia, Roclas and Dutch varieties Ostara and Santé.

Researches have been divided in two steps:

a) in vitro plantlets multiplication (starting with pathogen agents free plantlets);

b) in vitro microtuberization.

In vitro multiplication

Potato plantlets were established from apical meristems of sprouted tubers. The plantlets have been fragmented in the view of obtaining uninodal cuttings (Dumont, 1983).

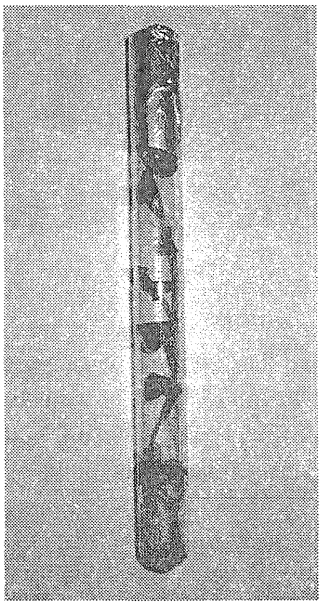

Figure 1 – Plantlet regenerated from meristem

We started with 25 plantlets for each variety. Each cutting has one leaf.

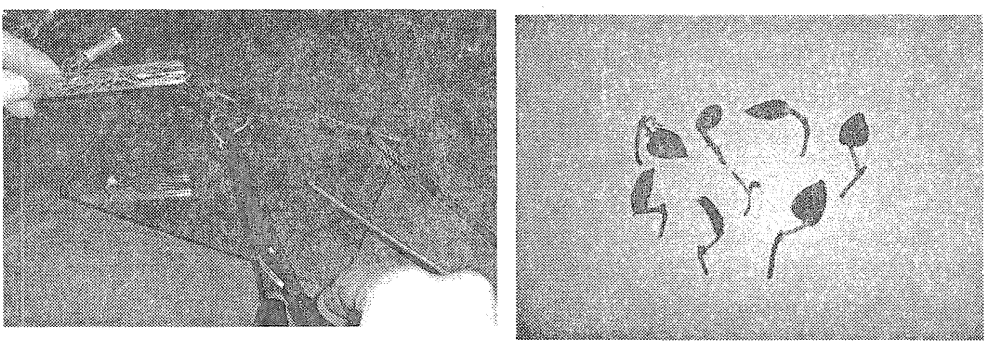

Figure 2 –Plantlet fragmentation

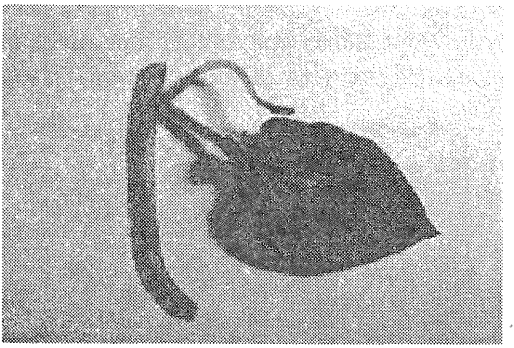

Figure 3 - Uninodal cuttings

Nutritive medium was Murashige-Skoog with micronutrients, macronutrients, vitamins, 3% sucrose and 0,7% agar. The pH of culture medium was adjusted to 5.9 before autoclaving at 121°C, 1,1bar for 20-25 minutes. In each plastic recipient (10-12 cm length, 8 cm height) 40 ml medium are poured. The minicuttings have been vertically inoculated in the medium, 20 minicuttings/plastic recipient. All the operations must be effectuated in aseptic conditions, in the laminary flow cabinet.

The growing conditions were: photoperiod of 16 hours of light, temperature of 20-22°C, 3000-6000 lux.

Shoots were subcultured every 21 days. Thus, the available quantity of plants is multiplied, every 3 weeks, with the factor 5 (one plant can be fragmented in approximately 5 minicuttings), and in a short period we can obtain a large quantity of healthy plants.

In vitro microtuberization

For this stage we have used the pathogen free plantlets obtained by multiplication.

The microtuberization medium is a liquid medium and contains the same substances as MS medium but in half amount, Coumarin, Kinetin and sucrose (80-90 g/l).

Stock solutions of Coumarin and Kinetin were prepared in this way:

Coumarin: - 500 mg in a 200 ml recipient;

- 25 ml ethanol are added;
- the solution is completed with distilled water.

Kinetin: - 200 mg in a 50 ml recipient;

- 20 ml NaOH 1N are added;
- the solution is completed with distilled water.

For 1 liter medium we add 200 ml stock solution of Coumarin and 12,5 ml stock solution of Kinetin. Microtuberization medium does not contain Agar. In every plastic recipient we poured 40 ml medium and then we placed the recipients in dark conditions for 6 weeks. We harvest the microtubers separately by variety. Microtubers are numbered to observe the microtubers number/plant. After harvest, we wash the microtubers with running water to remove all sucrose traces, we treat them 20 minutes with Benlate

solution (to protect microtubers against fungi), then we let them dry. After drying we can calibrate the microtubers (10 mm; 7,1 mm; 5 mm; 3,15 mm).

The microtubers can be stored at +2°C for many months.

RESULTS AND DISCUSSIONS

Table 1

Microtubers obtained from multiplied varieties

Variety	Multiplied plantlets	Harvested microtubers	Number of not infected recipients	Microtubers/ recipient average
SANTÉ	2380	1593	69	23,08
OSTARA	3160	3103	153	20,28
AMELIA	2720	1299	68	19,10
ROCLAS	2340	2271	108	21,03
CHRISTIAN	2140	1948	90	21,64
DACIA	2780	2720	121	22,48
TOTAL	15520	12934	609	21,23

In the same conditions, from foreign varieties, Santé had an average of with 23,08 , compared with Ostara variety wich had the average 20,28.

Concerning the Romanian varieties, Dacia evidence with a microtubers/recipient average of 22,48, followed by Christian and Roclas varieties with very near averages, the last variety being Amelia with 19,10 average.

The statistic interpretation has been made by Multiple Duncan test:

Averages error = 0.6500
Liberty degrees error = 603
Observations number = 609
LSD value= 0.09074
$s_{\bar{x}}$ = 0.03267 at a = 0.050

Original rank				Rank after testing			
Santé	1 =	23.09	A	Santé	1 =	23.09	A
Amelia	2 =	19.10	F	Dacia	6 =	22.48	B
Christian	3 =	21.64	C	Christian	3 =	21.64	C
Ostara	4 =	20.28	E	Roclas	5 =	21.03	D
Roclas	5 =	21.03	D	Ostara	4 =	20.28	E
Dacia	6 =	22.48	B	Amelia	2 =	19.10	F

From Duncan test we found out that Santé variety had the highest microtubers production efficiency, followed by Dacia, Christian, Roclas, Ostara and Amelia varieties.

Difference between Santé and Dacia varieties is significant, and the same is the difference between Dacia and Christian, Christian and Roclas, etc. There is a distinct significant difference between Santé and Christian varieties, and between Santé and Roclas the difference is very significant.

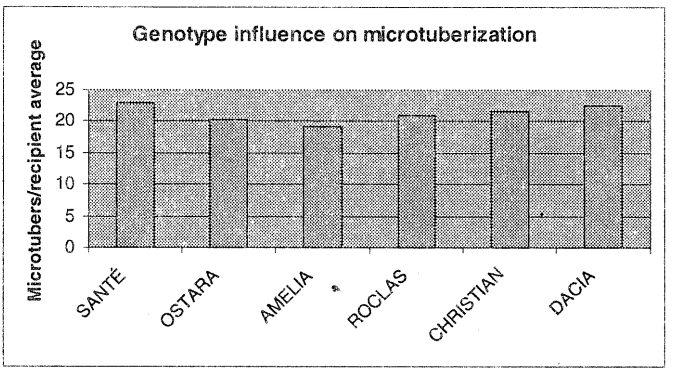

Figure 4 – Genotype influence on microtubers number

Table 2

In vitro obtained microtubers caliber

Variety	Caliber/Microtubers number			
	3,15-5 mm	5-7,1 mm	7,1-10 mm	>10 mm
SANTÉ	173	879	535	6
OSTARA	34	1653	1286	110
AMELIA	95	604	589	11
ROCLAS	89	1574	565	6
CHRISTIAN	28	1398	718	1
DACIA	89	1080	1268	48
TOTAL	**508**	**7188**	**4961**	**171**

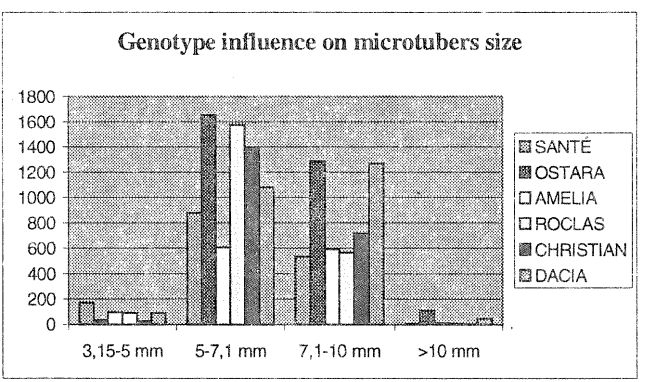

Figure 5 – Genotype influence on microtubers caliber

By analyzing the results presented in figure 5, we can say that microtubers size, as well as microtubers number, is influenced by the genotype. In respect to the fraction 3,15-5 mm, Santé formed the highest number of microtubers (173).

The highest number of microtubers from fraction 5-7,1 mm were formed by Ostara variety (1653), followed by Roclas (1574) and Christian (1398). The fewest microtubers from this fraction were harvested in Amelia variety.

The biggest quantity of 7,1-10 mm diameter microtubers was obtained from Ostara (1286) and Dacia (1268) varieties. The smallest quantity of this size was registered in Santé (535), Roclas (565) and Amelia (585) varieties.

We notice that in case of 10 mm fraction, Ostara produces the higher number of microtubers (110), and Christian, though it produces the biggest quantity of *in vitro* microtubers, just one microtuber has big caliber.

There is a similitude between the capacity of producing big size tubers in the field and *in vitro* in Ostara variety, compared with Christian variety which produces a high number of microtubers but with a middle-size, in field and *in vitro* too.

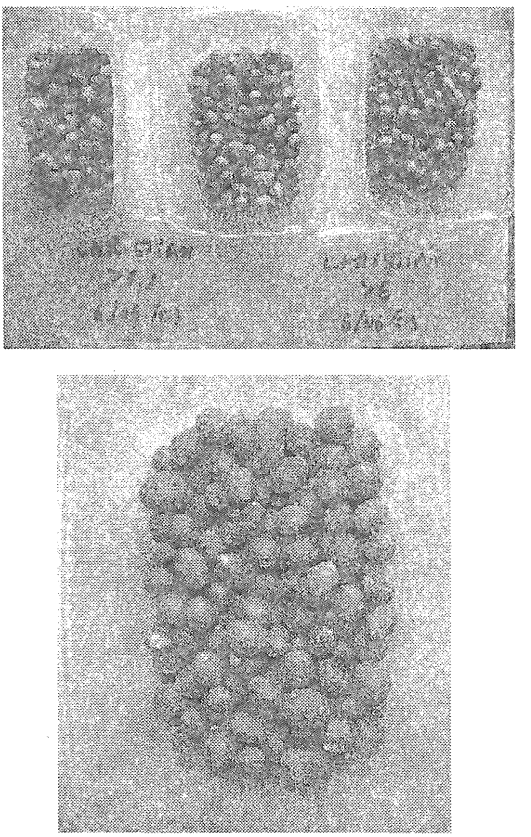

Figure 6 – Microtubers obtained from Christian variety

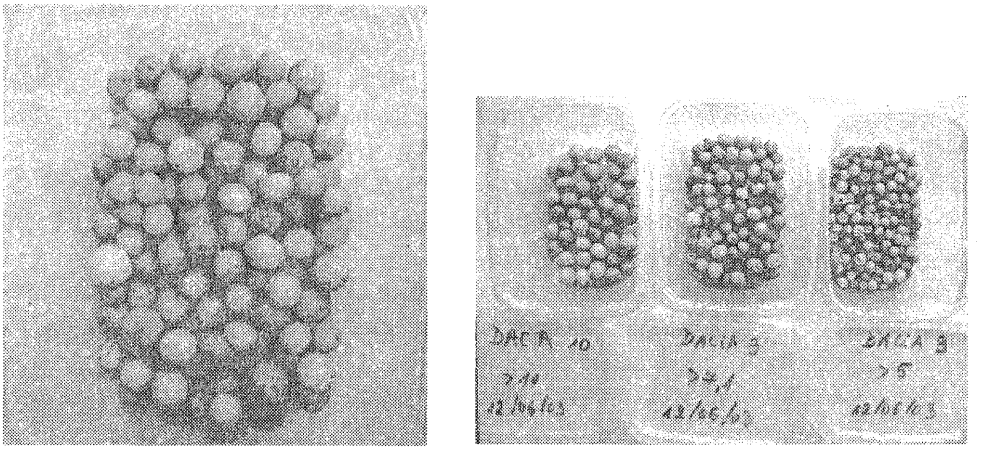

Figure 7 – Microtubers obtained from Dacia variety

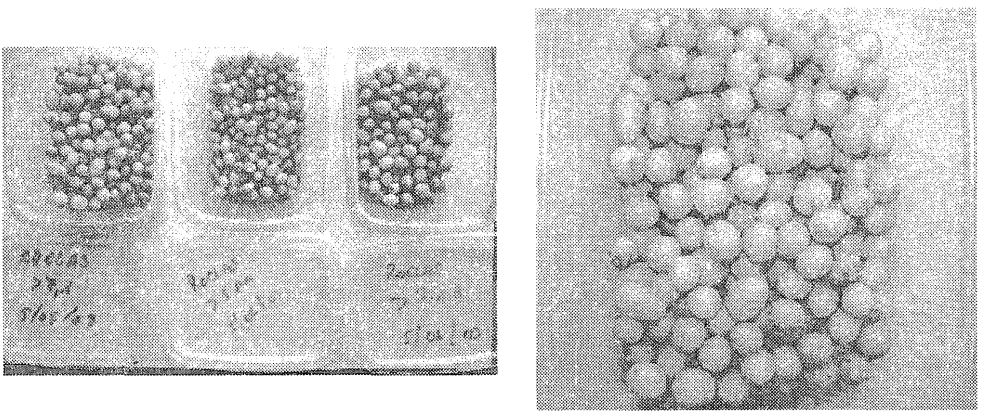

Figure 8 – Microtubers obtained from Roclas variety

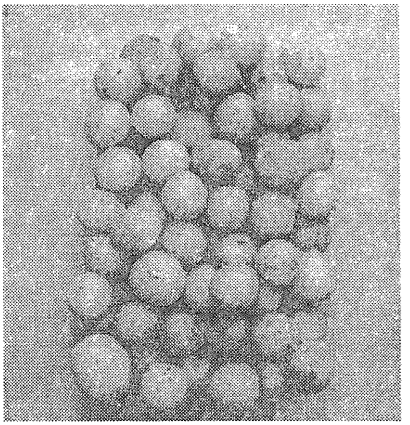

Figura 9 – Microtubers obtained from Ostara variety

CONCLUSIONS

¨ Microtuberization represents the transitory phase between *in vitro* multiplication of the healthy plants and field or green-house multiplication;

¨ For microtuberization we can use all virus-free minicuttings resulted from multiplication;

¨ From foreign varieties, Santé had the highest microtubers/recipient average (23,08);

¨ Regarding the Romanian varieties, Dacia registered the highest microtubers/ recipient average (22,48), but Christian, Roclas and Amelia had a near average;

¨ There is a similitude between the capacity of producing big or middle size tubers in the field and *in vitro*;

¨ Microtuberization is influenced by genotype;

¨ Like a general conclusion, we can say that microtubers production represents an efficient method of healthy material obtainment, which reduces the seed potato production process by 3-4 years.

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CERCETĂRI ASUPRA INFLUENȚEI GENOTIPULUI ÎN MICROTUBERIZAREA CARTOFULUI

Rezumat

Tehnicile de micropropagare constituie modul cel mai simplu pentru creşterea randamentului unei culturi de cartof de sămânță şi, implicit a producției cartofului de consum. Microtuberculii sunt o componentă importantă, alături de plantule şi minituberculi, a programelor de producere a cartofului pentru sămânță.

Cercetările s-au efectuat la 4 soiuri româneşti şi 2 soiuri olandeze de cartof. Mediul de microtuberizare este lichid şi conține aceleaşi substanțe ca şi mediul MS, dar în cantitate înjumătățită: cumarină, kinetină şi sucroză (80-90 g/l). Prin analiza rezultatelor acestei experiențe, putem trage concluzia că dimensiunea şi numărul de microtuberculi sunt influențate de genotip.

Cuvinte cheie: *Solanum tuberosum* L, genotip, microtuberizare, *in vitro*.

Tabele:

1. Microtuberculi obținuți din soiurile multiplicate;
2. Calibrul microtuberculilor obținuți *in vitro*;

Figuri :

1. Plantulă regenerată din meristem;
2. Fragmentarea plantulei;
3. Butaşi uninodali
4. Influența genotipului asupra numărului de microtuberculi;
5. Influența genotipului asupra calibrului microtuberculilor;
6. Microtuberculi obținuți din soiul Christian;
7. Microtuberculi obținuți din soiul Dacia;
8. Microtuberculi obținuți din soiul Roclas;
9. Microtuberculi obținuți din soiul Ostara.

EFFECTS OF MINITUBERS SIZE AND PLANTING DENSITY ON SEED POTATO YIELD OF ROMANIAN VARIETIES

Marius BĂRDAŞ[1]
[1]I.C.D.C.S.Z. Braşov

SUMMARY

Minitubers size and plant density influenced in a different manner the total yield and as well as seed potato yield (standard size: 30-55 mm diam.) in dependence of variety. The lowest total yield was achieved when planting minitubers sized 5-15 mm, diam., being of 16,5 to.ha^{-1} to 26 to.ha^{-1} in Roclas and Rustic varieties, and the highest total yield was obtained when planting tubers sized 25-35 mm diam, being of 31 to.ha^{-1} in Rustic variety and over 35 to.ha^{-1} in Runica variety.

Increasing planting density from 5 to 8 plants/m^2 is only reasonable in the case od minitubers sized 5-15 mm diam. and , respectively, 15-25 mm diam.

Keywords: seed potato, minitubers, stem, density, variety, field.

INTRODUCTION

Researches were done with the purpose of studying the potential use of minitubers planted directly in the field and their behaviour under the ecological condition from Lăzarea, Harghita county; the experiments were done in the clonal field of I.C.D.C.S.Z. Braşov, România.

These researchers join the world concernings regarding the optimum stem density of potato crops by directly field planting of minitubers (Lommen, W.J.M. şi Struik P.C.1995; 1996; Dolnicar, P.,1996 ; Roztropowicz, S., Szutkowska, M., Wierzejska, A., & Zarzynska, K., 1996).

This paper presents a synthesis of the main results obtained in the period 1998 – 2000 regarding the main stems number per hectare, seed yield, total yield and the total tubers number from Runica, Roclas, and Rustic varieties.

MATERIAL AND METHODS

The reseaches were done in the period 1998-2000 at The Centre for Clonal Material production from Lăzarea, Harghita County, affiliated to I.C.D.C.S.Z. Brasov.

The altitude of the experimental field was 1000 – 1200 m above sea level.

The soil type is a typical luvic brown very deep loamy with reasonable stone content.The physical aspect of the soil is normal and the the soil surface is covered by stones in a percentage of 10–20%.

Morphological specific features of the soil are influenced by a profile:

A – El – Bt – R very deep (25 – 150 cm up to the gravel level – R).

For researches, a multiple factorial experiment was achieved with an arrangement of split-plots of type 3A * 3B * 3C * 3R = 81 variants in which the following factors ranks were studied.

Factors A (Variety)

a_1 – Runica middle early variety, physiological maturity is achieved after approx. 75 vegetation days (Chiru, 1998);

a_2 – Roclas middle early variety, physiological maturity is achieved after approx. 80 vegetation days (Chiru, 1995);

a_3 – Rustic middle late variety, physiological maturity is achieved after approx. 108 vegetation days (Chiru, 1995).

Factors B (Planting density)

b_1 - 111000 plants/ha (75cm * 12,5cm) = 11,1 plants/ m^2

b_2 - 83000 plants/ha (75cm * 16,5cm) = 8,3 plants/ m^2

b_3 - 83000 plants/ha (75cm * 20,0cm) = 6,6 plants/ m^2

Factors C (minitubers size)

c_1 - 5 – 15 mm;

c_2 - 15 – 25 mm;

c_3 - 25 – 35 mm.

High vigour sprouted minitubers with appr 0,5 – 1,5 cm sprouts, were used for planting at approx. 5 cm depth. The minitubers were produced in the biotechnology laboratory of I.C.D.C.S.Z. Brasov.

The obtained data were processed by variant analysis method for all of the studied variables. To compare the studied variables multiple comparings method by Duncan test (DL 0,5%) was used.

RESULTS AND DISCUSSION

The number of main stems was variety specific due to tubers size planted and planting density, the differences were significant among varieties, tubers size used and planting density. For all three varieties, the highest number of main stems was obtained with the tuber size 25 – 35 mm.

The highest number of main stems was achieved at Roclas variety (286.000 main stems/ha), followed by Rustic variety (270.000 main stems/ha). Runica variety had the lowest 224.000 main stems/ha (table1).

The average main stems number achieved with 25 – 35 mm minitubers size was 335.000 main stems /ha, for 15 – 25 mm minitubers size the average, main stems was 263.000 and 182.000 main stems for 5 – 15 mm minitubers size (table1).

For all varieties, the main stems number increases in the same time with the increase of planting density, the maximum was recorded at 111.000 minitubers/ha. The statistical

significance of the differences caused by increasing in density at different tuber size is specific for each variety.

For studied varieties, when 25 – 35 mm minitubers size were planted, the increase in the number of main stems was significant for each used level of planting density. The 3 levels of planting density are between 66.000 and 111.000 plants/ha. The maximum main stems for each variety was recorded at 111.000 plants/ha, (419.000 for Runica variety, 410.000 for Roclas variety and 387.000 Rustic variety).

When planting was made with 15 – 25 mm minitubers, significant increases of the main stems number were achieved only by using a plant density of 111.000 plants/ha, the differences between levels of plant density (66.000 and 83.000 plants/ha) used were insignificant (table1).

The average accumulated **total yield** till the haulm killing date, end of July, begining of August, depending on croping year, was 32,7 to.ha^{-1} for Roclas variety, 30,0 to.ha^{-1}, for Rustic variety and 25,7 for Runica variety (table 2).

The average yields differed significantly in accordance with the size of minitubers and ranked between 22,9 to.ha-1 and 34,0 to.ha-1. The highest influence of minitubers size was on Runica variety yield (table 2).

The highest yields were recorded generally at higy densities without being significantly diferent.

The yields of seed were 19,8 to.ha-1 for Roclas variety 18,7 to.ha-1 for Rustic and 14,8 to.ha-1 for Runica (table 3).

The highest yield of seed size 30 – 55 was obtained when planting wa s made with minitubers size 25 – 35 mm.

Increasing the plant density did not positively affect the standard seed potato yield, the highest yieds were obtained at densities between 66.000 – 83.000 plants/ha.

The seed yield fo all the three varieties increases in the same time with minitubers size and nutrition area. The highest seed yields (Runica 23,1 to.ha-1, Roclas 25,7 to.ha-1Rustic 22,6 to.ha-1) were achieved by planting 25 – 35 mm size of minitubers. Also for Roclas and Rustic varieties the same levels of yields can be achieved with 15 – 25 mm size of minitubers (table 3).

The tubers number per unit area for studied variants varied between 36,5 and 130 tubers /m^2 due to planting density and the size of minitubers used for planting.

The highest tubers number per unit area was achieved at Roclas variety (104,5 tubers/m^2). For Rustic variety the average tuber number produced/m^2 was 91,0 and for Runica only 63,9 (table 4).

From big and middle size minitubers resulted in average 97,6 – 95,6 tubers/m^2, a significantly higher number than the variants in which small minitubers were used (66,3 tubers /m^2).

By increasing minitubers density per row in average the tubers number produced in average per unit area increases significantly. Different densities with different minitubers size results in different effects for each variety.

The seed tubers number has the same tendency with the total tubers number produced per unit area depending on the minitubers size used and planting density. The numbers of these tubers are 47 tubers/m^2 for Roclas, 43 tubers/m^2 for Rustic and 33,4 tubers/m^2 for Runica variety (table 4).

1. The influence of minitubers and size plant density on the number of main stems at all studied varieties / ha
(Lăzarea, Harghita county, mean values 1998 – 2000)

Size of planting material (mm)	Plant number /lm	Runica		Roclas		Rustic		Average	
		No of main stems/ha.	Duncan test	No of main stems/ha.	Duncan test	No of main stems/ha.	Duncan test	No of main stems/ha.	Duncan test
5-15	8	150.400	ef	268.100	c	225.900	de	214.800	e
	6	132.000	f	216.300	d	189.600	ef	179.300	f
	5	122.200	f	177.000	e	161.500	f	153.600	g
Average	**x**	**134.800**	**c**	**220.500**	**c**	**192.300**	**c**	**182.500**	**c**
15-25	8	256.300	c	348.900	b	362.900	ab	322.700	b
	6	200.700	d	281.500	c	265.200	cd	249.100	d
	5	175.000	de	248.900	cd	228.900	de	217.500	e
Average	**x**	**210.600**	**b**	**293.100**	**b**	**285.700**	**b**	**263.100**	**b**
25-35	8	419.300	a	410.400	a	387.400	a	405.700	a
	6	306.700	b	340.700	b	335.500	b	327.600	b
	5	257.800	c	283.700	c	276.300	c	272.600	c
Average	**x**	**327.900**	**a**	**344.900**	**a**	**333.100**	**a**	**335.300**	**a**
x	8	275.300	a	342.500	a	325.400	a	314.400	a
	6	213.100	b	279.500	b	263.500	b	252.000	b
	5	184.400	c	236.500	c	222.200	c	214.500	c
Average / variety	**x**	**224.400**	**b**	**286.200**	**a**	**270.400**	**a**		

DL 5% (b) - 25.130 tul/ha.
DL 5% (c) - 12.900 tul/ha.
DL 5% (d) - 12.900 tul/ha.

DL 5% (b x d) - 22.400 tul/ha.
DL 5% (c x d) - 22.400 tul/ha.
Dl 5% (b x c x d) – 38.800 tul/ha

The tubers number, size 30 – 55 is higher if planting is made with minitubers size over 15 mm. The tubers number of this size increases in the same time with plants density on row.

2. The influence of minitubers size and plant density on total production
(Lăzarea, Harghita County, mean values 1998 – 2000)

Size of planting material (mm)	Plant number / lm	Runica		Roclas		Rustic		Average	
		Total production	Duncan test	Total production	Duncan test	Total production	Duncan test	Total production	Duncan test
5-15	8	15.6	ef	28.6	bc	27.4	ab	23.9	c
	6	19.1	def	25.2	c	26.2	ab	23.5	c
	5	14.8	f	24.3	c	24.6	b	21.2	c
Average	x	**16.5**	**c**	**26.0**	**b**	**26.1**	**b**	**22.9**	**c**
15-25	8	27.3	bc	37.8	a	34.4	a	33.2	ab
	6	25.8	bcd	36.1	ab	32.9	a	31.6	ab
	5	23.1	cde	34.7	ab	32.1	ab	29.9	b
Average	x	**25.4**	**b**	**36.2**	**a**	**33.2**	**a**	**31.6**	**b**
25-35	8	37.0	a	36.8	a	32.1	ab	35.3	a
	6	36.9	a	36.2	ab	32.6	ab	35.2	a
	5	31.7	ab	34.6	ab	28.3	ab	31.5	ab
Average	x	**35.2**	**a**	**35.9**	**a**	**31.0**	**a**	**34.0**	**a**
x	8	26.6	a	34.4	a	31.3	a	30.8	a
	6	27.3	a	32.5	a	30.6	a	30.1	a
	5	23.2	a	31.2	a	28.3	a	27.6	b
Average / variety	x	**25.7**	**c**	**32.7**	**a**	**30.1**	**b**		

DL 5% (b) - 2.4 t/ha
DL 5% (c) - 2.4 t/ha
DL 5% (d) - 2.4 t/ha

DL 5% (b x d) - 4.1 t/ha
DL 5% (c x d) - 4.1 t/ha
Dl 5% (b x c x d) -7.1 t/ha

3. The influence of minitubers size and plant density on the seed yield
(Lăzarea, Harghita County, mean values 1998 – 2000)

Size of planting material (mm)	Plant number / lm	Runica		Roclas		Rustic		Average	
		Seed production	Duncan test	Seed production	Duncan test	Seed production	Duncan test	Seed production	Duncan test
5-15	8	6.1	g	13.5	e	13.4	d	11.0	f
	6	10.7	efg	16.0	de	16.0	bcd	14.2	e
	5	8.6	fg	18.6	bcd	18.5	abc	15.5	de
Average	**x**	**8.5**	**c**	**16.0**	**b**	**15.9**	**b**	**13.5**	**c**
15-25	8	13.0	def	17.6	cde	14.8	cd	15.1	de
	6	14.3	cde	22.6	ab	20.7	ab	19.2	bc
	5	15.6	cd	25.1	a	23.1	a	21.3	ab
Average	**x**	**14.3**	**b**	**21.8**	**a**	**19.5**	**a**	**18.5**	**b**
25-35	8	17.8	bc	17.3	cde	16.8	bcd	17.3	cd
	6	22.3	ab	22.0	abc	22.4	a	22.2	a
	5	23.1	a	25.7	a	22.6	a	23.8	a
Average	**x**	**21.1**	**a**	**21.7**	**a**	**20.6**	**a**	**21.1**	**a**
x	8	12.3	b	16.1	c	14.9	b	14.5	c
	6	15.7	a	20.2	b	19.7	a	18.6	b
	5	15.8	a	23.1	a	21.4	a	20.1	a
Average / variety	**x**	**14.6**	**b**	**19.8**	**a**	**18.7**	**a**		

DL 5% (b) - 5.6 t/ ha
DL 5% (c) - 2.7 t/ ha
DL 5% (d) - 2.7 t/ ha

DL 5% (b x d) - 4.6 t/ ha
DL 5% (c x d) - 4.6 t/ ha
Dl 5% (b x c x d) - 8.1 t/ ha

4. The influence of minitubers size and plant density on tubers number per area unit
(Lăzarea, Harghita county, mean values 1998 – 2000)

Size of planting material (mm)	Plant number / lm	Runica		Roclas		Rustic		Average	
		Total number	Duncan test	Total number	Duncan test	Total number	Duncan test	Total number	Duncan test
5-15	8	37.2	e	101.1	b	80.5	cd	72.9	c
	6	42.2	de	80.9	c	74.1	d	65.8	cd
	5	36.5	e	73.0	c	71.4	d	60.3	d
Average	**x**	**38.6**	**c**	**85.0**	**b**	**75.4**	**c**	**66.3**	**b**
15-25	8	72.6	bc	130.6	a	120.1	a	107.8	a
	6	56.6	cd	113.6	ab	102.6	ab	91.0	b
	5	71.8	bc	104.7	b	106.0	ab	94.2	b
Average	**x**	**67.0**	**b**	**116.3**	**a**	**109.6**	**a**	**97.6**	**a**
25-35	8	97.1	a	125.1	a	93.7	bc	105.3	a
	6	79.0	b	113.3	ab	93.0	bc	95.1	b
	5	82.5	ab	99.4	b	77.0	cd	86.3	b
Average	**x**	**86.2**	**a**	**112.6**	**a**	**87.9**	**b**	**95.6**	**a**
x	8	68.9	a	119.0	a	98.1	a	95.3	a
	6	59.3	a	102.6	b	89.9	ab	83.9	b
	5	63.6	a	92.4	c	84.8	b	80.3	b
Average / variety	**x**	**63.9**	**c**	**104.5**	**a**	**91.0**	**b**		

DL 5% (b) - 8.7 buc/mp.
DL 5% (c) - 5.6 buc/mp.
DL 5% (d) - 5.6 buc/mp.

DL 5% (b x d) - 9.7 buc/mp.
DL 5% (c x d) - 9.7 buc/mp.
Dl 5% (b x c x d) – 16.8 buc/mp.

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EFECTUL MĂRIMII MINITUBERCULILOR ŞI A DENSITĂŢII DE PLANTARE ASUPRA PRODUCŢIEI DE SĂMÂNŢĂ LA SOIURILE ROMÂNEŞTI

Rezumat

Mărimea minituberculilor şi densitatea plantelor au influenţat diferit producţia totală şi producţia de sămânţă STAS (30-55 mm Í), în funcţie de soi.

Cea mai mică producţie totală s-a realizat la plantarea minituberculilor de 5-15 mm, fiind cuprinsă între 16,5 to/ha şi 26 to/ha la soiurile Roclas şi Rustic, iar cea mai mare s-a realizat la plantarea tuberculilor de 25-35 mm Í, fiind cuprinsă între 31 to/ha la soiul Rustic şi peste 35 to/ha la soiul Runica.

Creşterea densităţii de la 5 la 8 plante/m^2 se justifică numai în cazul minituberculilor de 5-15 mm Í şi, respectiv, 15-25 mm Í.

Cuvinte cheie: cartof pentru sămânţă, minituberculi, tulpină, densitate, câmp

Tabele:

1. Influenţa mărimii minituberculilor şi a densităţii de plantare asupra numărului de tulpini principale realizabile la ha (Lăzarea, judeţul Harghita, valori medii 1998-2000)

2. Influenţa mărimii minituberculilor şi a densităţii de plantare asupra producţiei totale (Lăzarea, judeţul Harghita, valori medii 1998-2000)

3. Influenţa mărimii minituberculilor şi a densităţii de plantare asupra producţiei de sămânţă (Lăzarea, judeţul Harghita, valori medii 1998-2000)

Influenţa mărimii minituberculilor şi a densităţii de plantare asupra numărului total de tuberculi la unitatea de suprafaţă (Lăzarea, judeţul Harghita, valori medii 1998-2000)

INFLUENȚA CONDIȚIILOR METEOROLOGICE ASUPRA EVOLUȚIEI POPULAȚIEI DE AFIDE (VECTORI AI VIRUSURILOR), LA S.C.D.A. SUCEAVA (1997 – 1999)

Ioan GONTARIU[1], Daniela DONESCU

REZUMAT

Calitatea recoltelor de cartof sunt influențate direct de calitatea materialului de plantat. Majoritatea speciilor de afide care transmit virusurile cartofului în zona de nord a Podișului Sucevei se dezvoltă pe gazde diferite.

Asupra frecvenței zborului afidelor (total specii) un rol important îl au condițiile meteorologice, de care depind înmulțirea acestora cât și facilitatea deplasării lor. Au fost luate în studiu un număr de 6 specii de afide și anume: *Myzus persicae, Aphis frangulae, Aphis nasturtii, Aphis fabae, Acyrtosiphon pisum și Rhopalosiphum sp.*.

Determinările realizate pe parcursul celor trei ani, evidențiază că zborul afidelor a avut o frecvență sporită în anii 1997–1999, când temperaturile medii decadale din a doua jumătate a lunii iunie și prima jumătate a lunii iulie au fost mai mari de 18°C, când nivelul de umezire pluvială (i.u.p.) nu a depășit de două ori necesarul de precipitații.

Cuvinte cheie: afide, virusuri, cartof sămânță, condiții climatice.

INTRODUCERE

Afidele constituie cel mai mare grup de vectori virotici, deoarece transmit un număr mare de virusuri fitopatogene. De aceea principalul obiectiv al producătorilor de cartofi pentru sămânță nu constă doar în a combate afidele deja instalate în culturi, ci mai ales de a găsi cele mai eficiente mijloace de prevenire a eliminării acestora (DONESCU, 1997).

Între afide și virusuri există o relație strânsă, în sensul că afidele sunt mijloace de răspândire a virusurilor, iar virusurile îmbunătățesc calitatea plantelor ca suport de hrană pentru afide.

Încă de la începutul secolului XX au fost întreprinse cercetări cu privire la identificarea agenților transmițători de boli virotice. Botjes (1920) considera afida verde a piersicului (*Myzus persicae Sulz.*) ca principal transmițător al virozelor la cartof și în special al virusului Y (streack), al virusului răsucirii frunzelor de cartof (PLRV) și a virusului A, fapt confirmat ulterior prin numeroase cercetări asupra biologiei vectorului și a modului de transmitere a virusurilor (MAN și colab., 1969).

Frecvența infecțiilor primare cu virusul M la soiurile rezistente s-a corelat pozitiv numai cu zborul speciilor *M. persicae* și *Macrosiphum euphorbiae* din perioadele

mai – iunie, când plantele de cartof erau tinere. La soiurile foarte sensibile şi mijlociu de rezistente, infecţiile virotice au fost în relaţie directă cu zborul speciei *Aphis fabae* (COJOCARU, 1987).

Judeţul Suceava este considerat ca o zonă favorabilă şi foarte favorabilă pentru cultura cartofului, în ceea ce priveşte condiţiile climatice şi ca o zonă favorabilă sub aspectul tipurilor de sol (BERINDEI, 1977).

Cadrul natural, economic, social şi tehnic al judeţului au permis organizarea „zonei închise" Suceava, din care în perioada anilor 1967-1989, s-au produs şi livrat sute de mii de tone de cartofi pentru sămânţă cu valoare biologică şi stare fitosanitară corespunzătoare (TRÎMBACIU, 1975).

Staţiunea de Cercetare Dezvoltare Agricolă Suceava îşi desfăşoară activitatea de producere a cartofului pentru sămânţă pe baze ştiinţifice, care permit aplicarea tuturor măsurilor agrotehnice şi fitosanitare cu privire la lichidarea surselor de infecţie, combaterea afidelor care transmit virusurile şi prevenirea posibilităţilor de infecţie. Aceasta se încadrează în unitatea geomorfologică Podişul Sucevei şi este situată la extremitatea estică a depresiunii Litenilor.

Vânturilor dominante dinspre nord-vest în lunile mai, iunie şi iulie şi frecvenţa vânturilor de 2 m/secundă, conduc la existenţa pericolului mobilizării pasive a afidelor. Astfel s-a realizat în anii 1963–1968, un zbor mai timpuriu şi intens al speciei *M.persicae,* ceea ce a determinat o răspândire mai activă a virusului răsucirii frunzelor, deci un procent de infecţie mai ridicat (COJOCARU şi colab., 1973).

MATERIALUL ŞI METODA DE CERCETARE

Această lucrare constituie un studiu cu privire la influenţa condiţiilor meteorologice asupra zborului afidelor în perioada 1997-1999 la cultura de cartof pentru sămânţă de la Staţiunea de Cercetare Dezvoltare Agricolă Suceava. Au fost studiate 6 specii de afide: *Myzus persicae, Acyrtosiphon pisum, Aphis frangulae, Aphis nasturtii, Aphis fabae şi Rhopalosiphum sp..*

Zborul afidelor a fost urmărit prin metoda vaselor galbene (capcane Moerike) cu apă şi adaos de detergent. Determinarea speciilor captate din câmpul de producere cartof sămânţă de la S.C.D.A. Suceava, a fost efectuată la I.C.D.C.S.Z Braşov, de către d-na dr. biol. Daniela Donescu.

Presiunea biologică exercitată de afide este exprimată în unităţi de transmitere (U.T.), aducând la un numitor comun speciile şi virulenţa acestora. Nu toate speciile de afide transmit la fel virusurile, de exemplu cea mai periculoasă este *M. persicae.* Virulenţa acesteia este egală cu 1. Celelalte specii de afide au o virulenţă mai mică, cuprinsă între 0,1 şi 0,286 U.T. (HARTEN, 1983, citat de BEDÖ, 1988).

Tabelul 1

Capacitatea diferitelor specii de afide de a transmite virusurile
(HARTEN, 1983, citat de BEDÖ, 1988)

Nr. crt.	Specia de afide	Unitatea de transmitere de virusuri
1.	*Myzus persicae*	1
2.	*Aphis nasturtii*	0,286
3.	*Aphis frangulae*	0,20
4.	*Aulacorthum solani*	0,20
5.	*Phorodon humuli*	0,15
6.	*Macrosiphum euphorbiae*	0,10
7.	*Aphis fabae*	0,10
8.	*Acyrtosiphon pisum*	0,05
9.	*Rhopalosiphum insertum*	0,05
10.	*Rhopalosiphum padi*	0,02
11.	*Metopolophium dirhodum*	0,01
12.	*Brachycaudus helichrysi*	0,01

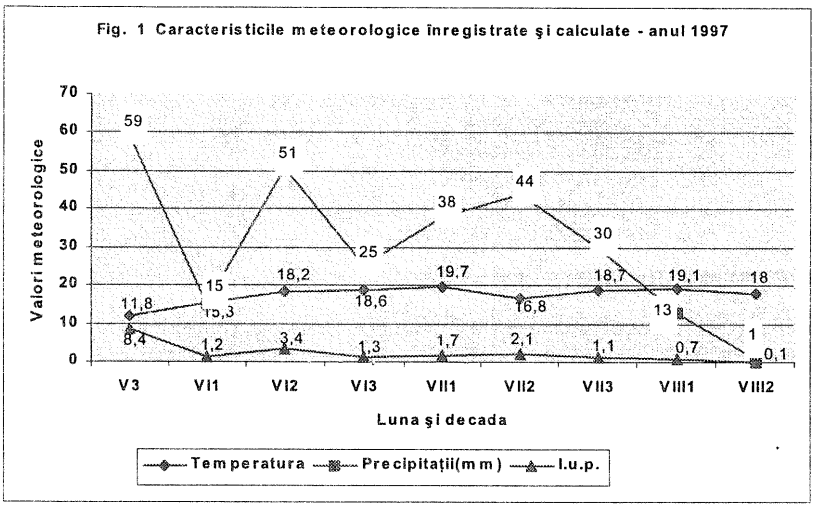
REZULTATE ŞI DISCUȚII

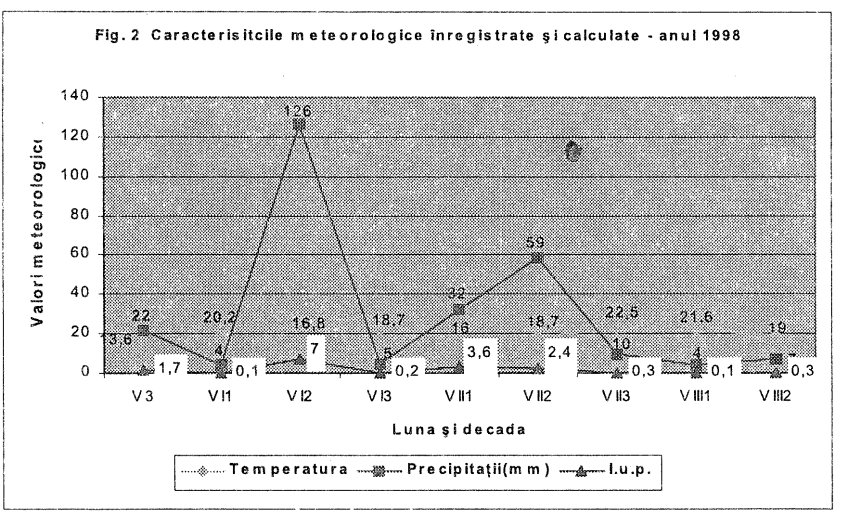
Asupra frecvenței zborului afidelor (total specii), un rol important îl reprezintă condițiile meteorologice, de care depind înmulțirea acestora cât şi facilitatea deplasării lor.

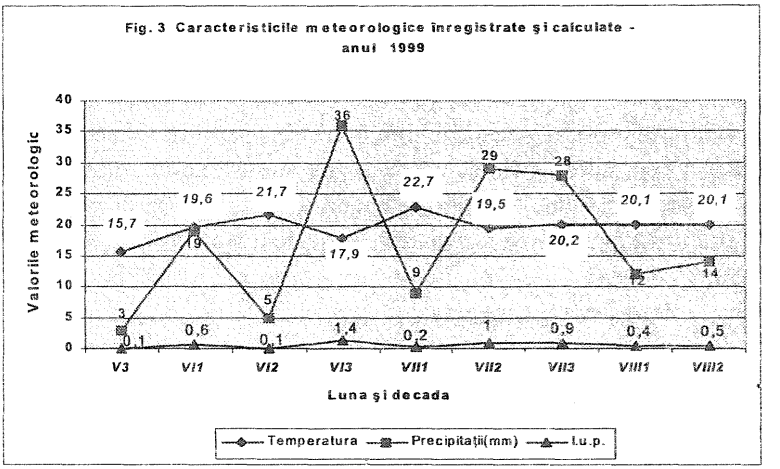
Tabelul 2. Relațiile dintre intensitatea zborului afidelor şi unii parametri meteorologici
Suceava 1997–1999

Anul	Luna	Decada	Nr. Total afide	Unități de Transmitere (U.T.)	t oC	Precipitații (mm)	i.u.p.
1997	V	3	18	1,8	11,8	59	8,4
	VI	1	48	4,8	15,3	15	1,1
		2	69	8,3	18,2	51	3,4
		3	135	23,4	18,6	25	1,3
	VII	1	311	42,1	19,6	38	1,7
		2	117	13,1	16,8	44	2,1
		3	289	46,9	18,7	30	1,1
	VIII	1	205	51,3	19,1	13	0,7
		2	121	17,5	18,0	1	0,1
1998	V	3	10	1,0	13,6	22	1,7
	VI	1	89	10,0	20,2	4	0,2
		2	68	8,5	16,8	126	7,0
		3	271	34,8	18,7	5	0,2
	VII	1	98	11,7	16,0	32	3,6
		2	115	12,3	18,7	59	2,4
		3	122	12,5	22,5	10	0,3
	VIII	1	38	3,9	21,6	4	0,1
1999	VI	2	114	13,9	21,7	5	0,6
		3	300	35,9	17,9	36	0,1
	VII	1	433	58,6	22,7	9	1,4
		2	221	27,2	19,5	29	0,2
		3	230	58,1	20,2	28	1,0
	VIII	1	45	13,2	20,1	12	0,9

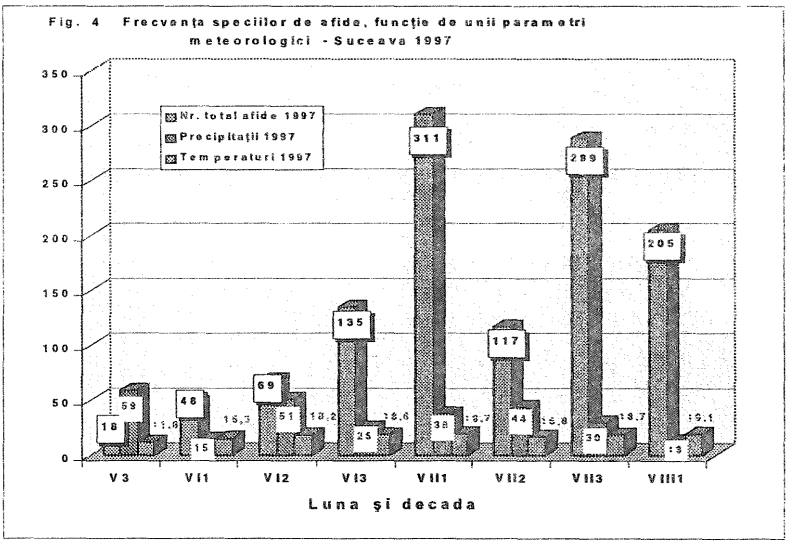
Determinările efectuate pe parcursul celor trei ani, evidențiază că zborul afidelor a avut o frecvență sporită în anii 1997–1999 (tab. 2), când temperaturile medii decadale din a doua jumătate a lunii iunie și prima jumătate a lunii iulie au fost mai mari de 18° C, când nivelul de umezire pluvială (i.u.p.) nu a depășit de două ori necesarul de precipitații (fig. 1, 2, 3).



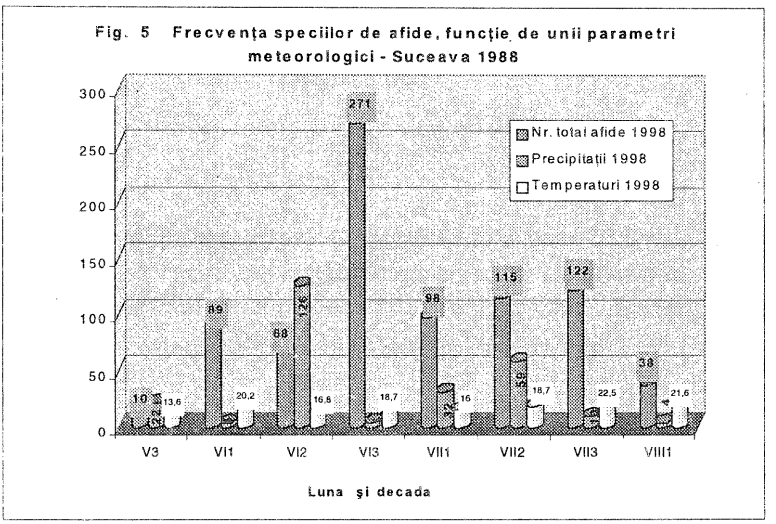


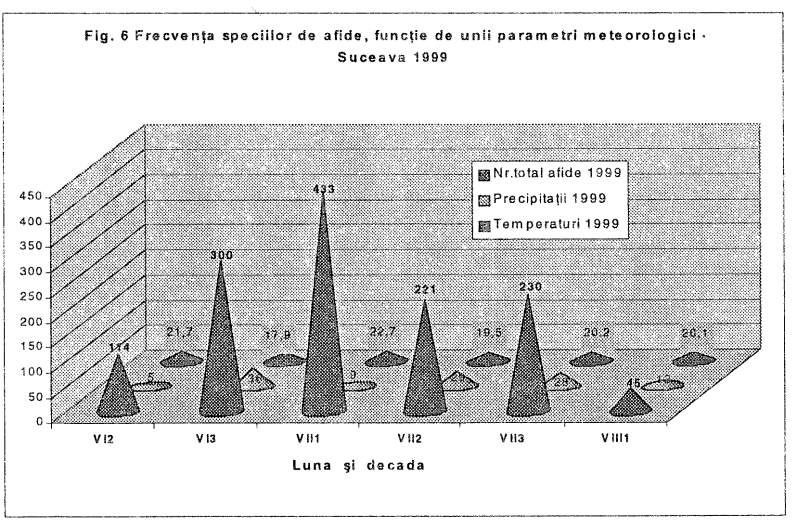


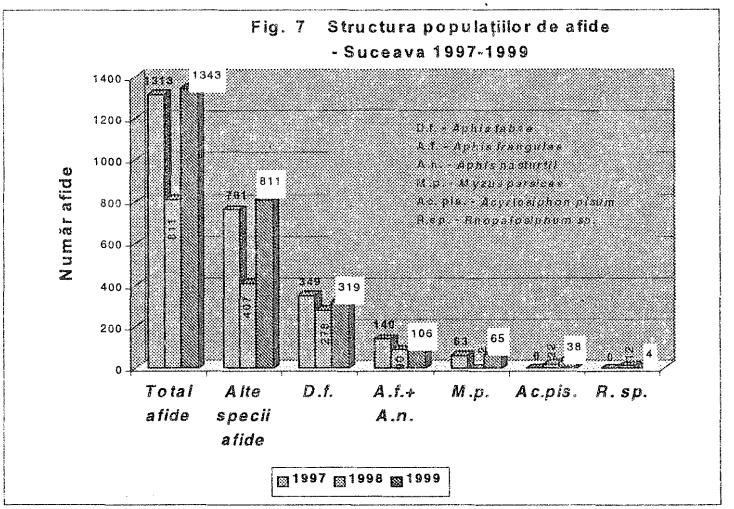
În anul 1998, când în intervalul menționat temperatura medie a fost mai mică de 18°C, iar indicele umezirii pluviale a fost de două ori mai mare, s-a înregistrat cea mai mică frecvență a zborului afidelor cu un total de 484 exemplare (fig. 4), comparativ cu 563 exemplare în 1997 (fig. 5) și 847 exemplare în 1999 (fig. 6).

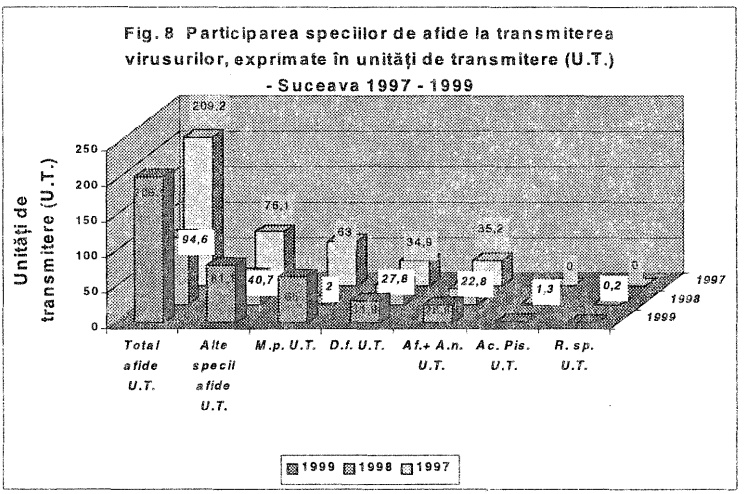


Menținerea la sfârșitul lunii iulie și începutul lunii august a unui regim termic ridicat (20–22°C) și a unui regim hidric scăzut (i.u.p. = 0,1–0,9) a defavorizat rata înmulțirii afidelor, fiind asociat cu un zbor mult mai redus în anii 1998 -160 exemplare (fig. 5) și 1999 - 275 exemplare (fig. 6). Anul 1997 se remarcă printr-un zbor mai intens în ultima decadă a lunii iunie și prima decadă a lunii iulie. Temperaturi mai mari de 18°C au fost în ultima decadă a lunii iulie și prima decadă a lunii august, iar numărul indivizilor captați a fost cuprins între 205–289. În ultima decadă a lunii iunie (1998), s-au capturat 271 exemplare, datorită faptului că temperaturile au fost ridicate (18,7°C), iar precipitațiile reduse (5 mm).









Dintre speciile determinate se remarcă *M. persicae*, care sub formă de unități de transmitere, a fost predominant în anii 1997 (63 UT) și 1999 (65 UT). Specia *A. fabae* a avut o prezență constantă în toți anii de studiu ca număr de indivizi captați (278–349), dar și ca unități de transmitere 27,8–34,9 UT (fig. 8).

Grupul de afide „alte specii" a fost evident pe primul loc cu 407 indivizi captați în anul 1988 și cu un maxim de 811 exemplare în anul 1999, (fig. 7).

CONCLUZII

- Cei trei ani luați în studiu au confirmat faptul că în zona de nord a Podișului Sucevei există un număr important de specii de afide vectori ai virusurilor cartofului pentru sămânță;

- În 1997 și 1999 se remarcă cea mai ridicată frecvență a numărului de indivizi transmițători de boli virotice, iar specia *Myzus persicae* a fost dependentă de condițiile climatice (1998);

- Frecvența speciilor *Aphis frangulae*, *Aphis nasturtii* și *Aphis fabae* a fost mai puțin influențată de condițiile climatice existente în zonă;

- Izolarea în spațiu a loturilor de producere a cartofului pentru sămânță, reprezintă una din măsurile de bază în tehnologia acestei plante de cultură.

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INFLUENCE OF CLIMATIC CONDITION ON APHID POPULATION EVOLUTION (VECTOR OF VIRUSES) ON S.C.D.A. SUCEAVA (1997-1999)

Abstract

The quality of potato crops are straightly influenced by seed potato quality. The majority of aphid species, vectors of seed potato viruses, present on the North zone of Suceava plateau, developed on different host-plant.

On frequency of aphid flight (total species), climatic conditions play an important role, on which depend the aphid reproduction and movement ability. Six different species were studied (*Myzus persicae*, *Aphis frangulae*, *Aphis fabae*, *Acyrthosiphon pisum* and *Rhopalosiphum sp*).

The experimental results obtained on three years emphasize that aphid flight increased between 1997-1999, when the average of decadely temperature on the second part of June and first part of July, exceeded 18 C and the level of rain moisture (i. u. p.) do not overtake twice the necessary of rainfalls.

Keywords: aphids, viruses, seed potato, climatic condition

Tables:

1. The capacity of different aphid species on virus transmission
2. The relationship between aphid flight and some meteorological parameters Suceava 1997-1999.

Figures:

1. Meteorological characteristics, registrated and calculated, 1997.
2. Meteorological characteristics, registrated and calculated, 1998.
3. Meteorological characteristics, registrated and calculated, 1999.
4. The frequency of aphid species, depending on some meteorological parameters, Suceava - 1997.
5. The frequency of aphid species, depending on some meteorological parameters, Suceava - 1998.
6. The frequency of aphid species, depending on some meteorological parameters, Suceava - 1999.
7. The structure of aphid population-Suceava 1997-1999.
8. Participation of aphid species on virus transmission, expressed on transmission units (U.T.) – Suceava 1997-1999.

INFLUENȚA CONDIȚIILOR DE CLIMĂ ȘI A CALITĂȚII MATRIALULUI DE PLANTAT ASUPRA PRODUCȚIEI DE CARTOF ÎN SUD-VESTUL ROMÂNIEI

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REZUMAT

În condițiile din sud-vestul României, tipice zonei de stepă , pe un sol nisipo-lutos, în perioada 1991-1995, în condiții de irigare, în localitatea Amărăștii de Jos, s-au efectuat cercetări privind influența condițiilor de climă și a epocii de întrerupere a vegetației asupra infecției cu virusuri și a producției de cartof în al II-lea an de cultivare (postcultură). Pentru obținerea unui material de plantat cu o infecție cu viroze cât mai redusă, trebuie să se facă întreruperea vegetației la 60-65 de zile de la răsărire. Cu toate acestea, condițiile de climă din timpul vegetației și în timpul păstrării conduc la îmbătrânirea fiziologică a tuberculilor și la reducerea dramatică a producției, în funcție de soi după cum urmează: 63,2 to/ha (în primul an) / 47,4 to/ha (în postcultură) la soiul Sante, 63,3/ 42,2 to/ha la Latona, 60,6/18,7 to/ha la Mariame, 56,2/31,1 to/ha la Oscar, 51,7/39,6 to/ ha la Minerva, 48,7/31,3 to/ha la Titus, 48,6/18,8 to/ha la Rustic, 45,9/36,7 la Fresco, 46,9/37,9 to/ha la Cibin, 46,5/27,8 to/ha la Bârsa, 47,9/22,8 to/ha la Bran, 44,3/27,4 to/ ha la Desiree, 41,4/15,8 to/ha la Ostara.

Cuvinte cheie: cartof, soi, calitate, virus, întrerupere vegetație

INTRODUCERE

Practica cultivării cartofului din întreaga lume dovedește că toate soiurile de cartof, prin cultivarea lor an de an își pierd progresiv potențialul inițial de producție, se depreciază calitativ, degenerează. Degenerarea este un proces ireversibil.

Degenerarea cartofului a fost observată cu mult timp în urmă, încă din secolul al XVIII – lea (1778), când "Agricultural Society of Manchester" a instituit un premiu pentru a stimula cercetarea cauzelor acestei scăderi progresive a capacității de producție a cartofului (CATELLY, 1974). În anul 1786, LOUIS AUGUSTINE PARMANTIER , considerat pe bună dreptate părintele răspândirii cartofului în Europa, a sesizat degenerarea soiurilor de cartof cultivate în Franța, explicând fenomenul ca un efect al îmbătrânirii prin înmulțirea vegetativă repetată. Ca mijloc de combatere a degenerării, PARMANTIER preconiza crearea continuă de soiuri noi din semințe și scoaterea din cultură a soiurilor vechi, degenerate.

Una din pârghiile cele mai eficiente de sporire a producției agricole o reprezintă cartoful pentru sămânța sau materialul de plantare, care exprimă potențialul biologic de producție al soiului creat și caracterizat printr-o anumită structură genetică.

La cartof, mai mult ca la oricare altă plantă de cultură, calitatea materialului de plantare este un factor esențial care determină mărimea și calitatea recoltei (CONSTANTINESCU ECATERINA și colab., 1965).

Înmulțirea cartofului pe cale vegetativă, prin tuberculi permite transmiterea de la un an la altul a unui număr însemnat de boli cauzate de virusuri, micoze, bacterioze, nematozi sau mycoplasme. De calitatea biologică a materialului de plantare depinde capacitatea de încolțire, răsărirea, creșterea plantelor și formarea tuberculilor, acumularea producției, mărimea și calitatea acesteia. Starea biologică a materialului de plantare, în general, este tot atât de importantă pentru practica agricolă ca însuși soiul de cartof (CATELLY, 1974).

Din aceste considerente cartoful pentru sămânță constituie o problemă de actualitate permanentă în toate țările producătoare de cartof de sămânță, chiar și în cele cu veche tradiție în producerea și înmulțirea acestuia.

Analizând, printr-un model matematic (GOREA și colab., 1986) contribuția unui mare număr de factori cauzali la realizarea producției de cartof, în condițiile unei tehnologii corecte, producția este determinată proporțional de următorii factori:

- 51% de valoarea materialului de palntare;
- 21% de potențialul biologic al soiului;
- 13% de utilizarea rațională a îngrășămintelor;
- 12% de măsurile de protecție a culturii;
- 3% de alți factori.

Calitatea materialului de plantare, exprimată prin potențialul de producție al soiului, determină în cea mai mare măsură nivelul producției, constituind factorul principal al producției, în timp ce măsurile de fertilizare și protecție fitosanitară sunt considerați factori de menținere a potențialului biologic. Iată de ce obiectivul principal al activității de producere a materialului de plantare la cartof în România îl reprezintă creșterea calității acesteia pentru menținerea la un nivel cât mai ridicat a potențialului de producție a soiurilor.

MATERIAL ȘI METODA DE CERCETARE

Pentru determinarea infecției cu virusuri cauzate de epoca de întrerupere a vegetației s-a folosit soiul Fresco. Cercetările au fost efectuate în perioada 1992-1995.

În anul de înmulțire, cu materialul de plantat din soiul Fresco, categoria biologică elită (E), a fost amplasată o experiență monofactorială, cu lungimea parcelei de 6 m , număr de rânduri 16, distanța între rânduri 0,75 m, distanța între tuberculi pe rând de 0,25m , număr de ciuburi pe rând 24, suprafața parcelei 72 m^2.

Elementele de tehnologie privind fertilizarea, combaterea buruienilor, a bolilor și dăunătorilor, precum și regimul de irigare au fost cele care se recomandă pentru cultura cartofului în zona de stepă.

Planta premergătoare, în toți cei trei ani de experimentare, a fost grâu, experiența aflându-se într-un asolament de 4 ani cu structura: 1.grâu; 2. cartof; 3. grâu; 4. mazăre.

Fertilizarea s-a făcut organic (25 t/ha gunoi de grajd) administrat sub brazdă şi chimic (N_{120} P_{120} K_{120}), la pregătirea terenului în vederea plantării, la care s-a adăugat N_{64} în timpul vegetaţiei la împreunarea rândurilor.

Culturile au fost menţinute curate de buruieni printr-o rebilonare şi erbicidare cu Dual 500 EC – 3l/ha plus Sencor 70 WP – 0,4 kg/ha. Gândacul din Colorado şi ceilalţi dăunători de sol au fost combătuţi prin administrarea de Vydate 10G- 15 kg/ha, înainate de planatare, care a menţinut culturile protejate timp de cca. 30 zile de la răsărire, după care s-au folosit piretroizi. Împotriva manei şi alternariozei s-au aplicat două tratamente cu Ridomil MZ 72 WP –2,5 kg/ha.

Necesarul de apă a fost asigurat prin 10- 15 udări prin aspersiune cu norme de udare de 300-350 m^3/ha în fncţie de perioada de vegetaţie, menţinând plafonul minim pe adâncimea de 0,4m la 60-70% din IUA.

Au fost făcute observaţii privind data răsăritului pentru stabilirea datei de întrerupere a vegetaţiei şi infecţia cu virusuri, fără eliminarea plantelor virozate.

Întreruperea vegetaţiei s-a făcut prin smulgere, lăsând vrejii pe bilon pentru evitarea înverzirii tuberculilor care nu întotdeauna pot fi acoperiţi cu pământ.

La 18-20 de zile de la întreruperea vegetaţiei, după suberificarea tuberculilor, s-a făcut recoltarea. La recoltare, au fost reţinute trei probe a câte 1800 tuberculi care au fost păstrate în pivniţă.

În postcultură, materialul de plantat provenit din anul I, a fost încolţit şi plantat în parcele experimentale aşezate în blocuri randomizate, în 4 repetiţii a câte 12 rânduri, lungimea parcelei 6 m, distanţa între rânduri de 0,75 m, distanţa între cuiburi/rând de 0,20 m.

Elementele de tehnologie legate de fertilizare, erbicidare, combaterea bolilor şi dăunătorilor, irigare, au fost aceleaşi ca în anul I (anul de înmulţire).

În timpul vegetaţiei au fost făcute aceleaşi observaţii ca în anul I, iar recoltarea s-a făcut la maturitatea fiziologică a soiului.

De asemenea, în perioada 1993-1995, în aceleaşi condiţii de sol, mediu, şi tehnologie, s-a testat capacitatea de producţie la mai multe soiuri de cartof din România şi Olanda.

REZULTATE ŞI DISCUŢII

Infecţia cu virusuri în anul de înmulţire (tabelul 1). Materialul de plantat adus din zona închisă Braşov, a fost sănătos din punct de vedere al infecţiei cu virusuri; infecţia fiind diferită de la un an la altul, având valori de 0,94% în anul 1992, 1,5% în anul 1993 şi 1,74% în anul 1994. La viroze grave (Y+VRF), infecţia a fost în anul 1992 de 0,45%, în anul 1993 de 0,77%, iar în anul 1994 a fost de 0,86%. În medie pentru cei 3 ani de experimentare, infecţia cu virusuri a fost de 1,39% la total viroze, din care 0,77% la viroze grave (Y+VRF).

Tabelul 1. Infecția cu virusuri în anul de înmulțire la soiul Fresco (1992-1994)

Anul	Nr.mediu de plante analizate	Viroze total		Din care					
		Număr	%	Y		VRF		Mozaic ușor	
				Număr	%	Număr	%	Număr	%
1992	1853	17,42	0,94	4,67	0,25	3,75	0,20	9,08	0,49
1993	1820	27,35	1,50	7,62	0,42	6,35	0,35	13,38	0,74
1994	1876	32,55	1,74	8,54	0,46	7,59	0,40	16,42	0,88
Media	1850	25,77	1,39	6,94	0,38	5,9	0,32	12,96	0,70

Infecția cu virusuri în postcultură

În anul 1993, la total viroze, pornind de la o infecție primară de 0,94%, după un an de înmulțire în sudul Olteniei, infecția cu virusuri a fost diferită în funcție de factorii cercetați și a fost cuprinsă între 1,22% și 3,35%.

La viroze grave (Y+VRF), pornind de la o infecție primară de 0,49%, după un an de înmulțire, infecția cu virusuri a fost cuprinsă între 0,77% și 2,11%.

În anul 1994, pornind de la o infecție primară de 1,5%, infecția totală a fost cuprinsă între 2,25% și 8,75%.

La viroze grave (Y+VRF), față de o infecție primară de 0,77%, după un an de înmulțire, infecția a fost cuprinsă între 1,42% și 5,52%.

În anul 1995, la total viroze, față de o infecție primară de 0,86%, după un an de înmulțire, infecția a fost cuprinsă între 1,55% și 5,76%.

Tabelul 2. Infecția cu virusuri în postcultură la soiul Fresco în funcție de condițiile climatice și de epoca de întrerupere a vegetației (1993-1995)

Factorii	Infecția cu virusuri - %						
	Total		Din care				
						Y+VRF	
	%	Test Duncan	Y	VRF	Mozaic ușor	%	Test Duncan
Condițiile climatice							
1993	2,03	C	0,7	0,58	0,75	1,28	B
1994	4,17	B	1,44	1,20	1,54	2,63	A
1995	4,87	A	1,68	1,40	1,80	3,07	A
DS 5 %	0,58		0,22	0,26	0,10	0,48	
Epoca de întrerupere a vegetației							
55 zile	2,46	C	0,85	0,71	0,91	1,55	C
65 zile	3,11	B	1,07	0,89	1,15	1,96	B
Maturitate	5,51	A	1,90	1,58	2,03	3,48	A
DS 5%	0,48		0,16	0,14	0,18	0,30	

După un an de înmulțire în sudul Olteniei, la soiul Fresco, infecția totală cu virusuri a fost în anul 1993 de 2,03%, în anul 1994 de 4,17%, iar în anul 1995 a fost de 4,87%. În anul de înmulțire 1992 condițiile climatice au favorizat mai puțin infecția virotică, clasând anul 1993 ca an cu infecția secundară cea mai mică, acest fenomen datorându-se în mare parte și infecției inițiale. Anul cu cea mai mare infecție virotică a fost 1995, datorită atât condițiilor climatice diferite cât și infecției primare.

La viroze grave, (Y+VRF) infecția a fost în anul 1993 de 1,28%, în anul 1994 a fost de 2,63% iar în anul 1995 infecția a fost de 3,07%. Condițiile climatice ale anului de înmulțire 1992 au favorizat mai puțin răspândirea virusurilor, astfel că în anul 1993, față de anii 1994 și 1995, infecția a fost mai redusă, fiind asigurată statistic.

Epoca de întrerupere a vegetației în anul de înmulțire a influențat infecția virotică din anul de cultură a cartofului timpuriu, la total viroze, crescând de la 2,46% la 55 de zile și 3,11% la 65 de zile, până la 5,51% la maturitate, diferențele de infecție fiind asigurate statistic. La viroze grave, infecția a crescut de la 1,55% la 55 de zile la 1,96% la 65 de zile și a ajuns la 3,48% la maturitate, de asemenea diferențele fiind asigurate statistic.

Influența epocii de întrerupere a vegetației asupra infecției cu virusuri în funcție de condițiile climatice (tabelul 3).

În anul 1993, la total viroze, infecția la materialul de plantat provenit din întreruperea vegetației la maturitate a crescut la 2,76% față de materialul de plantat provenit din întreruperea vegetației la 55 și 65 de zile la care infecția a fost de 1,15 – 1,81%.

La viroze grave, materialul de plantat provenit din întreruperea vegetației la maturitate, infecția a crescut la 1,74% față de 0,95 – 1,14% la materialul provenit din întreruperea vegetației la 55 de zile și respectiv la 65 de zile, nu au fost diferențe de infecție virotică asigurate statistic.

În anul 1994, la total viroze, față de materialul provenit de la întreruperea vegetației la 55 de zile, la care infecția a fost de 0,94%, materialul provenit de la întreruperea vegetației la 65 de zile a avut o infecție virotică mai mare (3,48%), iar cel provenit de la întreruperea vegetației la maturitate infecția cu virusuri a crescut la 6,3%, creșterea fiind asigurată statistic atât de materialul obținut la 55 de zile cât și față de cel obținut la 65 de zile.

La viroze grave, față de materialul obținut la 55 de zile, la care infecția a fost de 1,73%, prin întârziereaa întreruperii vegetației, infecția a crescut la 2,2% la 65 de zile și la 3,98% la maturitate.

Tabelul 3. Infleuența epocii de întrerupere a vegetației asupra infecției cu virusuri la soiul Fresco, în funcție de condițiile climatice (1993-1995)

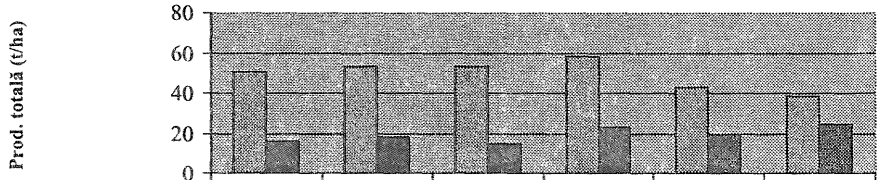
Anul	Epoca de întrerupere a vegetației	Infecția cu virusuri						
		Total		Din care				
		%	Test Duncan	Y	VRF	Mozaic ușor	Y+VRF	Test Duncan
1993	55 de zile	1,15	E	0,52	0,43	0,56	0,95	E
	65 de zile	1,81	E	0,62	0,52	0,67	1,14	E
	maturitate	2,76	D	0,95	0,79	1,02	1,74	D
1994	55 de zile	2,74	D	0,94	0,79	1,01	1,73	D
	65 de zile	3,48	CD	1,20	1,00	1,28	2,20	CD
	maturitate	6,30	B	2,17	1,81	2,32	3,98	B
1995	55 de zile	3,12	D	1,07	0,9	1,15	1,97	D
	65 de zile	4,04	C	1,39	1,16	1,49	2,55	C
	maturitate	7,46	A	2,57	2,14	2,75	4,71	A
DS 5 %		0,84		0,28	0,24	0,31	0,53	

În anul 1995, la total viroze, față de materialul obținut la 55 de zile, la care infecția virotică a fost de 3,12%, prin întârzierea întreruperii vegetației la 65 de zile, infecția a crescut la 4,04%, iar la maturitatea fiziologică infecția a ajuns la 7,46%.

La viroze grave, față de materialul plantat obținut la 55 de zile, la care infecția a fost de 1,97%, prin întârzierea întreruperii vegetației, infecția a ajuns la 2,55% la 65 de zile și la 4,71% la maturitate.

S-au testat de asemenea mai multe soiuri de cartof și s-a constatat că ele au reacționat foarte diferit în postcultură față de anul I (figura 1).

Figura1. Producția de cartof în anul I și în postcultură la soiurile timpur semitimpurii (1994- 1995)



	Ostara	Duchese	Florette	Safrane	Aida	Atlas
Ptot. Anul I	50,6	53,3	53	58,3	43,1	38,3
Ptot. Postcultura	16	18,3	14,6	23,5	19,8	24,6

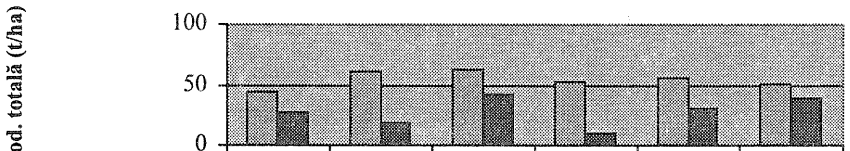
Soiul

La soiul Ostara în anul I s-a obținut o producție totală de 50,6 t/ha, iar în postcultură s-a obținut o producție de 16 t/ha. La soiul Duchese producția obținută în postcultură a fost mai mică decât cea obținută în anul I și anume 18,3 t/ha față de 53,3 t/ha. La soiul Florette s-a obținut o producție de 53 t/ha în anul I și 14,6 t/ha în anul al II-lea. La soiul Safrane în anul I s-a obținut o producție de 58,3 t/ha, iar în postcultură s-a obținut o producție de 23,5 t/ha. La soiul Aida s-a obținut o producție de 43,1 t/ha în anul I, iar în postcultură s-a realizat o producție de 19,8 t/ha. La soiul Atlas s-a obținut o producție totală de tuberculi în anul I de 38,3 t/ha, aceasta fiind mai mică decât producția obținută la soiurile prezentate mai sus, dar ceea ce este foarte important este faptul că producția de tuberculi obținută în postcultură a fost mai mare decât cea obținută la celelalte soiuri și anume 24,6 t/ha.

În figura 2 este prezentată producția totală de tuberculi care s-a realizat în condițiile de la Amărăștii de Jos în anul I și în postcultură. La soiul Desiree s-a obținut în anul I o producție de 44,3 t/ha iar în postcultură 27,4 t/ha, la soiul Mariane în anul I s-a obținut o producție de 60,6 t/ha iar în postcultură s-a realizat o producție de 18,7 t/ha, la soiul Latona în anul I s-a obținut o producție totală de tuberculi de 63,3 t/ha iar în postcultură s-a obținut o producție de 42,2 t/ha , aceasta fiind cea mai mare producție totală de tuberculi care s-a realizat la soiurile analizate. La soiul Symfonia s-a realizat o producție totală de 52,9 t/ha în anul I , iar în postcultură s-a obținut cea mai mică producție comparativ cu soiurile analizate și anume 10,4 t/ha. La soiul Oscar în anul I s-a obținut o producție

totală de tuberculi de 56,2 t/ha, iar în postcultură s-a obținut o producție totală de 31,1 t/ha. La soiul Minerva s-a obținut în anul I o producție totală de 51,2 t/ha, iar în postcultură producția totală obținută a fost de 39,6 t/ha.

Figura2. Productia în anul I şi în postcultură la soiurile semitardive (1994- 1995)

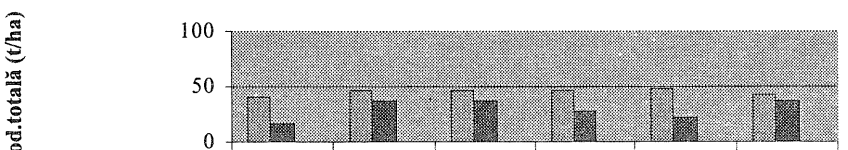


	Desiree	Marianc	Latona	Symfonia	Oscar	Minerva
Ptot. Anul I	44,3	60,6	63,3	52,9	56,2	51,2
Ptot Postcultura	27,4	18,7	42,2	10,4	31,1	39,6

Soiul

În figura 3 sunt prezentate, de asemenea, rezultatele privind producția obținută în funcție de soi în anul I şi în postcultură. Se poate constata că la soiul Ostara producția totală obținută a fost în anul I de 41,4 t//ha, iar în postcultură s-a obținut o producție de tuberculi de 15.8 t/ha. La soiul Fresco în anul I s-a obținut o producție totală de tuberculi de 45,9 t/ha, iar în postcultură s-a realizat o producție totală de tuberculi de 36,7 t/ha; la soiul Cibin s-a obținut în anul I o producție de 46,9 t/ha, iar în postcultură s-a obținut o producție de 37,9 t/ha. La soiul Bârsa în anul I s-a obținut o producție de 46,5 t/ha iar în postcultură s-a obținut o producție de 27,8 t/ha. La soiul Bran producția obținută în anul I a fost de 47,9 t/ha iar în postcultură producția realizată a fost de 22,8 t/ha. La soiul Mureşan producția totală de tuberculi a fost de 42,8 t/ha în anul I, iar în postcultură s-a obținut o producție totală de 36,9 t/ha.

Fig.3. Productia în anul I şi în postcultură la soiurile timpurii, semitimpurii si semitardive (1993- 1994)

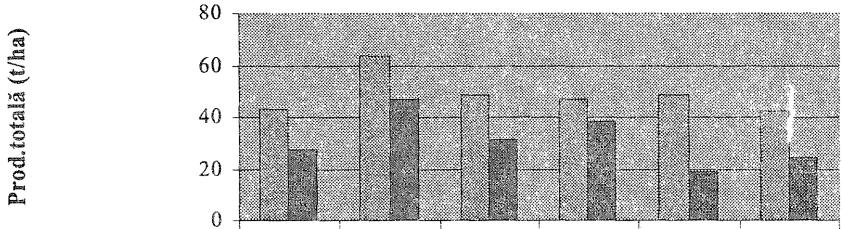


	Ostara	Fresco	Cibin	Bârsa	Bran	Mureşan
Ptot. Anul I	41,4	45,9	46,9	46,5	47,9	42,8
Ptot. Postcultura	15,8	36,7	37,9	27,8	22,8	36,9

Soiul

În figura 4 sunt prezentate rezultatele privind producția de tuberculi care s-a obținiut în anul I și în postcultură la soiurile Desiree, Sante, Titus, Roclas, Rustic și Teo. La soiul Desiree în anul I s-a obținut o producție totală de tuberculi de 43,3 t/ha iar în postcultură s-a obținut o producție de tuberculi de 27,1 t/ha. La soiul Sante în anul I s-a obținut o producție totală de tuberculi de 63,2 t/ha iar în postcultură s-a obținut o producție de tuberculi de 47,4 t/ha. La soiul Titus în anul I s-a obținut o producție totală de tuberculi de 48,7 t/ha iar în postcultură s-a obținut o producție de tuberculi de 31,3 t/ha. La soiul Roclas în anul I s-a obținut o producție totală de tuberculi de 47,3 t/ha iar în postcultură s-a obținut o producție de tuberculi de 38,6 t/ha. La soiul Rustic în anul I s-a obținut o producție totală de tuberculi de 48,6 t/ha iar în postcultură s-a obținut o producție de tuberculi de 18,8 t/ha. La soiul Teo în anul I s-a obținut o producție totală de tuberculi de 42,6 t/ha iar în postcultură s-a obținut o producție de tuberculi de 24,6 t/ha.

Figura 4. Productia în anul I și în postcultură la soiurile semitardive si tardive (1993- 1994)



	Desiree	Sante	Titus	Roclas	Rustic	Teo
Ptot.anul I	43,3	63,2	48,7	47,3	48,6	42,6
Ptot. Postcultura	27,1	47,4	31,3	38,6	18,8	24,6

Soiul

CONCLUZII

După un an de înmulțire în sudul Olteniei, la soiul Fresco, infecția totală cu virusuri a fost în anul 1993 de 2,03%, în anul 1994 de 4,17%, iar în anul 1995 a fost de 4,87%. În anul de înmulțire 1992 condițiile climatice au favorizat mai puțin infecția virotică, clasând anul 1993 ca an cu infecția secundară cea mai mică, acest fenomen datorându-se în mare parte și infecției inițiale foarte mici. Anul cu cea mai mare infecție virotică a fost 1995, datorită atât condițiilor climatice diferite cât și a infecției primare.

Epoca de întrerupere a vegetației în anul de înmulțire a influențat infecția virotică În postcultură, la total viroze, crescând de la 2,46% la 55 de zile și 3,11% la 65 de zile, până la 5,51% la maturitate, diferențele de infecție fiind asigurate statistic. La viroze

grave, infecția a crescut de la 1,55% la 55 de zile la 1,96% la 65 de zile și a ajuns la 3,48% la maturitate, de asemenea diferențele fiind asigurate statistic.

Producția care s-a obținut în postcultură a fost mai mică decât cea care s-a obținut în anul I la toate soiurile testate, înregistrându-se diferențe foarte mari între soiuri în ceea ce privește producția obținută în postcultură.

La soiul Sante s-a obținut cea mai mare producție atât în primul an (63,2 to/ha cât și în postcultură (47,4 t/ha), urmat de soiul Latona cu 42,2 t/ha, soiul Minerva cu 39,6 t/ha, soiul Roclas cu 38,6 t/ha, soiul Mureșan cu 36,9 t/ha și soiul Fresco cu 36,7 t/ha.

La soiul Symfonia s-a obținut cea mai mică producție de tuberculi în postcultură și anume 10,4 t/ha precum și la soiul Florette la care s-a obținut o producție de tuberculi de 14,6 t/ha.

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INFLUENCE OF CLIMATIC CONDITIONS AND SEED POTATO QUALITY ON POTATO YIELD IN THE SOUTH-WEST REGION OF ROMANIA

Abstract

Researches were carried out under the conditions of the S-W of Romania, specific o the steppe area, on a sandy-loamy soil, between 1991-1995, and under irrigation conditions. The purposes of the researches was to establish the influence of climatic conditions and of the moment of haulm killing on the the virus infection rate and on the potato yield in the second crop year (postculture). In order to obtain a planting material with a virus infection as low as possible, haulm killing must be operated at 60-65 days after emergence. Despite these, the weather conditions during the crop season and the storage period lead to phyisiological senescence of tubers and to the dramatic decrease of yield, as follows: 63,2 to/ha (in the first year) / 47,4 to/ha (in postculture) in Sante variety, 63,3/42,2 to/ha in Latona, 60,6/18,7 to/ha in Mariame, 56,2/31,1 to/ha in Oscar, 51,7/39,6 to/ha in Minerva, 48,7/31,3 to/ha in Titus, 48,6/18,8 to/ha in Rustic, 45,9/36,7 in Fresco, 46,9/37,9 to/ha in Cibin, 46,5/27,8 to/ha in Bârsa, 47,9/22,8 to/ha in Bran, 44,3/27,4 to/ha in Desiree, 41,4/15,8 to/ha in Ostara.

Keywords: potato, variety, quality, virus, haulm killing

Tables:

1. Viruses infection during the multiplication year, in Fresco variety (1992-1994)
2. Viruses infection în post-culture in dependence of climatic conditions and the haul killimg moment in Fresco variety (1992-1995)
3. Influence of haulm killing moment on the rate of viruses infection in dependence of climatic conditions, in Fresco variety.

Figures:

1. Potato yield of early and middle early varieties in 1st year and in post-culture (1994-1995).
2. Potato yield of middle late varieties in 1st year and in post-culture (1994-1995).
3. Potato yield of early and middle early varieties in 1st year and in post-culture (1993-1994).
4. Potato yield of middle late and late varieties in 1st year and in post-culture (1993-1994).

USING A WORMCOMPOST FOR INCREASING POTATO YIELD IN ORGANIC FARMS

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SUMMARY

During last years wormcompost have got a high importance especially in organic farms. Use of such fertilizer allows to bring up a organic crop product with high yield, least expenses and excluding of necessity of destruction of weeds.

A field trials for studying the influence of using wormcompost on potato growing as ecologically adaptive technology of soil amelioration for increase the yield and prevention the degradation processes in agrosystems was carried out during 3 years (2001–2003). A different variants with application of various doses of wormcompost, comparing with use of mineral fertilizers (MF-variant) were used in the experiment. There was used a wormcompost from various vegetable-manure substratum with the established optimum share of cow manure (40 %). A wormcompost of intermediate stage of bioconversion, as the most adaptive for applying into soil was used. The frequency of variants of trial was triple. Dutch potato cultivar Sante was used in the trials as variety which have a high respond to soil fertilizing. A phenological observations and measures of tuber growth were carried out by standard methods.

Keywords: wormkompost, fertilizers, potato, yield.

INTRODUCTION

The low efficiency of application of traditional organic fertilisers is predetermined by incompatibility of manure and soil biota with and degradation of last one, caused by used agrotechnology and aggravated natural and climatic factors. Particularly it degrade because the ground during the winter period freeze so that their standard biomass is restored only by the end of June. So, the plants in the most important period of growth are deprived the alive substance of the ground playing certain and, probably, a main role in a metabolism of their nutrition and deformation of a proton barrier in the root zone, arising at adverse conditions of an environment (stress).

Obtained by wormcomposting bioorganic fertilisers have a number of distinctive biophysical properties being consequence of presence in them of specific humus substances and regulators of plant growth, formed with participation of consuments

(earthworms and different kinds of mezo- and microfauna accompanying them). Thus the wormcomposts differ appreciably from products of microbiocenoze termofermentation during which the stimulation of too fast propagation of micro-organisms and decomposition of composts can not result to obtain a high humus product, similar to natural organic substance of ground. Without consument any compost or soil ecosystem remains open-ended, deprived a necessary component regulating energy of microbiocenoze reducents-decompositors and resulting to natural diversity of humus, mineral and fermental complexes used by autotrofes-producers (plants and chemosintesing bacteria) during their feed and a reconstruction of organic substances.

For applying wormcompost in soil (and for field crop rotations) the optimal is the final stage of 2-nd stage of composting which is determined on microorganisms-indicators [4]. It allows to increase a biological soil activity and simultaneously to reduce their toxicosis appreciably caused by accumulation of some toxic substances for plants, formed by specific micro-organisms at 1 and 3 stages of bioconversion. In this connection it is offered to distinguish terms: "wormcompost" and "wormhumus" (or biohumus) - the products of accordingly, intermediate 2-nd and final 3-rd stages [2].

In the beginning of 90-th years, according to researches carried out (spent) in field experiences in Russia and on Ukraine [1; 3] plants on responsiveness on "wormhumus" were divided on the following groups: 1/rich carbohydrates (a potato, sugar beet, cabbage, carrots, a tomato) - the increase of a crop up to 35% is possible; 2/grain (barley, corn, oat, rice, wheat) - an increase up to 25%; 3/leguminous (peas, a string bean) - a gain up to 15%; 4/olive cultures - react poorly. Recently these data were specified by new researches. At the same time, in Northwest of the Non black earth zone of the Russian Federation of field experiences with studying efficiency of products of wormcomposting till now it was not carried out.

The purpose was to carrying out a field trials on application of wormcompost with the for use it as ecologically adaptive technological influence on soil and plants for increase of efficiency agricultural crops and prevention a degradation processes in the agrosystems. In this connection the investigation on studying influence of use wormcompost on growth, development and yield of agricultural crops, including potato is actual.

MATERIAL AND METHODS

Long-term stationary experience on studying of influence of wormcompost on growth and development of potato plants was carried out 2001–2003 in Pushkin, Saint-Petersburg region. Variants of experience were pawned on a background with entering mineral fertiliser (MF) nitrofoska (1:1:1) in a doze of 400 kg / ha:

1. $N_{60}P_{60}K_{60}$; **2.** wormcompost - 4 t/ha; **3.** wormcompost – 8 t/ha.

The wormcompost was obtained from plant-manure substrates with an optimum share of cow-manure - 40% [2]. The placement of variants was regular in plots with the size: 8 ő 5,6 m = 45 m2. Frequency of variants in experiences was triple. The planting of a potato - Dutch cultivar Sante (categories "elite") was carried out in the end of May,

after preliminary sprouting. The seed tuber size was 20-40 g. The scheme of planting – 70ŏ35 sm. The wormcompost was applied locally under tubers. Phenological observations were carried out by methods of N. Vavilov Institute, including measures of tuber increase. Harvesting was carried out in the first decade of September. Meteorological conditions for the period of researches differed (quantity and distribution of rain and the sums of active temperatures) – was favourable for development of a potato in 2001 and 2002 but in 2003 – they were adverse: (the summer of 2003 year more cold and rainy in comparison with 2002 and 2001, that promoted a high development of late blight.

RESULTS AND DISCUSSION

The phenological observations over growth and development of plants of a potato in 2001–2003 shown a different terms of passage of phenological phases of start and end of flowerings were established: In the variant with applying worm compost 4t/ha and 8t/ha the period since planting to flowerings was: in variants with use wormcompost they began correspondingly on 5 and 7 day earlier in comparison with the variant where were used MF-variant.

In variants with applying of they began earlier for 3 days (with a doze 4 t/ha) and for 5 days (with a doze 8 t/ha) in comparison with the variants with mineral fertilisers, at identical terms of occurrence of shoots (table 1).

Table 1 Influence of use of different kinds of fertilisers on length of phenological phases

Variants of trial	Number of days from planting		
	Appearing of flower buds	Start of flowering	End of Flowering
1. Mineral fertilisers ($N_{60}P_{60}K_{60}$)	48	52	69
2. Cow manure 60t/ha	45	49	65
3. Wormcompost 4t/ha	42	48	65
4. Wormcompost 8t/ha	39	46	62

A different terms of plant developing was established between variants of trial. The mean number and length of stems was also different in the variants (table 2). The average length of stems, as well as their number was more in variants with use wormcompost 8 t/ha.

Accumulation of tubers weight was accounted on 60-th day of vegetation. The number and tubers weight exceeded parameters of MF- variant already at applying a doze of compost 4 ñ/ha, and the most essential distinctions were established at doze 8 t/ ha. For the period of harvesting this tendency was same.

In result of experiment trials was determined, that use of wormcompost with dose 8t /ha have not so significant difference on yield comparing use mineral fertilisers but have advantage as fine ecological product (table 3).

Table 2. Developement of potato plants in flowering phase (number and length of stems) in dependence of dose of used fertilizers

Variants of trial	Length of stems (sm)			Number of stems		
	Year			Year		
	2001	2002 r.	2003 r.	2001	2002 r.	2003 r
1. Mineral fertilisers ($N_{60}P_{60}K_{60}$)	39,1	37,2	42,7	2,7	2,7	3,1
2. Cow manure 60t/ha	42,9	43,7	44,8	3,3	3,0	3,7
3. Wormcompost 4t/ha	43,9	42,7	44,1	3,9	3,1	3,1
4. Wormcompost 8t/ha	48,8	46,2	51,1	4,1	3,5	4,3

Table 3. Influence of wormcompost dose to potato tuber yield In comparison with use other fertilisers (2001–2003 years)

Variants of trial	Average			Yield t/ha
	Tuber weight g/plant	Tuber number per plant	weight (g) of one tuber	
1. Mineral fertilisers ($N_{60}P_{60}K_{60}$)	985	8,1	101	344
2. Cow manure 60t/ha	846	8,8	89	296
3. wormcompost 4t/ha	779	9,3	82	273
4. wormcompost 8t/ha	937	10,1	85	330

Conclusion: Use of wormcompost is the most effective method of increase of potato yield in organic farms. The most optimal doze of applied wormcompost – 8t/ha. Even at higher yield at use of manure as organic fertilizer, application of wormcompost is economically more favorable.

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FOLOSIREA COMPOSTULUI BIOLOGIC PENTRU CREŞTEREA PRODUCŢIEI DE CARTOF ÎN CADRUL AGRICULTURII ORGANICE

Rezumat

În ultimii ani, compostul biologic (cu râme) a căpătat o importanţă deosebită, mai ales în agricultura organică. Folosirea unui asemenea îngrăşământ permite obţinerea unei producţii ridicate, cu cheltuieli minime şi fără a fi nevoie să se aplice tratamente pentru distrugerea buruienilor.

S-a întreprins un studiu de câmp pe durata a 3 ani (2001–2003) pentru studierea influenţei compostului asupra cultivării cartofului ca şi tehnică ecologică de îmbunătăţire a solului pentru creşterea productivităţii şi prevenirea proceselor de degradare în agrosisteme. În experiment s-au folosit diferite variante de aplicare a diferitelor doze de compost, în comparaţie cu folosirea de îngrăşăminte minerale (varianta MF).

S-a folosit compost din amestecuri diferite vegetale-gunoi de cu un procentaj optim de bălegar de vacă (40%). A fost utilizat compost în stadiul intermediar de bioconversie, fiind cel mai adecvat pentru aplicarea pe sol. Frecvenţa variantelor de experimentare a fost triplă. Soiul olandez de cartof Sante a fost folosit în acest studiu, deoarece este un soi cu reacţie ridicată la fertilizarea solului. Observaţiile fenologice şi determinările creşterii tuberculilor s-au efectuat prin metode standard.

Cuvinte cheie: compost, îngrăşăminte, cartof, productivitate.

Tabele:

1. Influenţa folosirii diferitelor feluri de îngrăşăminte asupra lungimii fazelor fenologice;
2. Dezvoltarea plantelor de cartof în faza înfloririi (numărul şi înălţimea tulpinilor);

Influenţa dozei de compost asupra producţiei de tuberculi în comparaţie cu folosirea altor fertilizatori (anii 2001–2003).

POTATO TUBER YIELD AND QUALITY IN RESPONSE TO NITROGEN, PHOSPHORUS AND POTASSIUM FERTILISATION IN NW SPAIN

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SUMMARY

A three-year field experiment was conducted in Galicia, NW Spain, to evaluate the response of potato (*Solanum tuberosum* L.) to N, P and K fertilisation. The experiment was carried out on an acid sandy-loam soil. Two potato varieties (Kennebec and Agria) were sown spaced 0.75 x 0.32 m. The following parameters were determined on harvested tubers: fresh tuber yield, marketable (40-75 mm) tuber yield, average tuber weight, dry matter, specific gravity; starch, reducing sugars, total nitrogen, ascorbic and citric acid contents; incidence of common scab, silver scurf and Rhizoctonia disease; enzymatic browning; frying quality; aptitude for washing.

Four nitrogen levels (0, 130, 180, and 230 kg N/ha, as ammonium sulphate and nitrate), four potassium levels (0, 150, 300, and 450 kg K_2O/ha, as potassium chloride), and three phosphorus levels (0, 100, and 200 kg P2O5/ha, as calcium superphosphate) were applied in the field in a factorial design with three replications.

Tuber yield was on average 7% higher for cv. Agria than Kennebec. Most quality parameters were significantly affected by the cultivar.

There were significant ($P<0.05$) main effects of increasing rates of applied potassium on tuber yield, marketable tuber yield, average tuber weight, specific gravity, dry matter concentration, enzymatic browning, frying quality and aptitude for washing. Higher K rates yielded higher crop production and tuber size, but lower dry matter content. The enzymatic browning was lower at higher K rates. The crisp quality was higher the higher the K rate. The aptitude for washing was higher at higher K rates. The incidence of common scab, silver scurf and Rhizoctonia were lower at higher K rates.

N fertilisation affected significantly but inconsistently the reducing sugars content. P fertilisation affected significantly but inconsistently the reducing sugars content and frying quality. There were significant year x N x P interactions on reducing sugars content and year x P interactions on French fries colour.

The year affected significantly total and marketable tuber yield, tuber weight, specific gravity, contents of starch, reducing sugars, ascorbic and citric acids, incidence of common scab, frying quality and aptitude for washing.

None of starch, total nitrogen, ascorbic and citric acids contents in tubers were significantly affected by fertilisation.

Keywords: potato yield, quality, fertilization.

INTRODUCTION

Potato production in the region of Galicia (NW Spain) is one of the most important agricultural activities. A Limia is one of the areas in this region where potato is a staple crop and upon which farmers' income depends. Currently potato cropping occupies nearly 30% of the total agricultural land of A Limia, with a yearly production of 110 million kilograms, of which 40% are of cultivar Agria and 30% of cultivar Kennebec. Production of Agria is mainly directed to the crisping industry and Kennebec to fresh consumption. In any of these cases, quality parameters are of great concern for the producers.

Several parameters can be used to characterise the tuber quality; some of them refer to tuber size or appearance, whilst others are related to chemical composition or organoleptic characteristics. These quality parameters depend upon potato cultivar, environmental conditions and cultural practices.

Tuber size is of great importance for marketing. Moreover consumers usually prefer potatoes with a uniform appearance and which are easily washable.

Among compositional parameters, reducing sugars (glucose and fructose) are of interest for producers and processors because of its relation to colour development during frying. Other compounds that might be related to the extent of non-enzymatic browning of potato chips are ascorbic acid and phenolic compounds (Rodríguez-Saona *et al.*, 1997).

Texture of cooked potatoes, which is related to starch content, determines its suitability for different uses and to meet specific preferences of consumers. For fries, colour and appearance are fundamental characteristics.

Various investigations showed an influence of fertilisation practices on tuber quality (Swiniarsky and Ladenberger, 1970; Stricker, 1974; Chapman *et al.*, 1992; Westermann *et al.*, 1994; Maier et al., 1994; Kolbe *et al.*, 1995; Panique *et al.*, 1997; Freeman *et al.*, 1998; Allison *et al.*, 2001; Abdel Gadir *et al.*, 2003; Sparrow and Chapman, 2003).

There is dearth of information on the effect of fertilisation on tuber quality parameters in Galicia, particularly in relation to the widely used cultivars Agria and Kennebec.

The main objective of this paper is to study the effect of nitrogen, phosphorus and potassium (NPK) fertilisation on the tuber yield and quality of two cultivars (Agria and Kennebec) grown in A Limia (Galicia, NW Spain) over three seasons.

MATERIALS AND METHODS

Field experiments were conducted over three consecutive years (1998, 1999 and 2000) in Xinzo de Limia (42º 04' N lat.; 04º 01'W long.; 630 m altitude). The soil used in

the experiments is a gleyic Umbrisol (FAO/UNESCO, 1998) developed from alluvial sediments, with an acid (pH ~ 5.5), sandy-loam surface horizon and high levels of available phosphorus and potassium (Prado *et al.*, 2000). The climate is characterised by two distinct seasons, a wet and cold period (October to April) and a dry and warm one (May to September). The long-term average (30 years) annual temperature and rainfall are 11.2şC and 888 mm, respectively. The potential soil water deficit developed from May onwards reaches the total amount of 260 mm at the end of September.

The experimental layout was a factorial design with three replications and consisted of two potato varieties (Kennebec and Agria), three nitrogen levels (130, 180, and 230 kg N/ha), three potassium levels (150, 300, and 450 kg K_2O/ha), and two phosphorus levels (100, and 200 kg P2O5/ha); three control plots (without fertilisation) were sown with each variety. The intermediate fertilisation levels are those usually applied in the region. Nitrogen was applied at equal rates as ammonium sulphate at planting and ammonium nitrate at mid-season, potassium and phosphorus were applied as potassium chloride and calcium superphosphate at planting. Each individual plot was 6 x 6 m^2 in size. In each year planting, at 0.75 m between lines and 0.32 m within the line, took place around May and the crop was harvested in September. Throughout the experiments irrigation was applied to maintain the soil moisture at field capacity at all times. Crop protection chemicals were applied according to best commercial practice.

Fresh tuber yield (tons per hectare) was determined, soon after harvest, from tubers harvested from all plants of the six central rows of a given individual plot. Tubers were graded into three size categories: <40 mm, 40 to 75 mm, and >75 mm, the central category constituting the marketable production. Average tuber yield was calculated weighing a representative tuber sample and dividing by the number of tubers. The specific gravity was calculated from the underwater weight and the normal weight of a sample of around 5 kilograms of tubers.

Five to ten tubers randomly selected from each individual plot were hand-peeled and homogenised in a blender before analysis. The dry matter content was determined by oven drying a 5-10 grams homogenised sample at 105şC to constant weight. Samples were kept at –18şC until analysis of ascorbic and citric acids, which were determined by HPLC according to Vázquez Oderiz *et al.* (1994). Total nitrogen concentrations were determined using a LECO 2000 autoanalyzer and referred to fresh matter. Reducing sugars were determined by visible spectrometry with dinitrosalicylic acid (Miller, 1959) and expressed as percent of fresh weight; the determination of reducing sugars was made after two or three month storage. The starch concentrations (as percent of fresh matter) were estimated from the tuber specific gravity (von Schéele *et al.*, 1937).

To evaluate enzymatic browning, potatoes were hand-peeled and homogenised in a blender. After one hour the browning was assessed by comparison with a colour chart (Rousselle *et al.*, 1996). The scale ranges from 1 to 9, a higher number indicating less browning.

The texture of cooked potatoes was described based on sensory perception by a trained sensory panel (Meilgard *et al.*, 1991). Potatoes were steam-cooked for 13 minutes. By evaluating four sensory characteristics (disintegration, firmness, mealiness and structure) potatoes were classified into four main types of cooking behaviour (A, B, C, D; Rousselle *et al.*, 1996). To assess darkening of cooked potatoes, cooked tubers were homogenised in a blender and colour determined after one hour, using a scale from 1 to 9.

The suitability for frying was assessed in both crisps and French fries. Potato crisps were prepared by peeling and slicing (1.3 mm thick) tubers. The three central slices were selected from each tuber, washed with water, dried with filter paper and fried in sunflower oil for 3 minutes at 178şC. The crisp colour was evaluated by comparison with IBL charts; values range from 1 to 9; 1-4 values indicate unacceptable, very dark colour, 5 or 6 acceptable colour, and 7-9 very good golden crisps. Besides colour evaluation, the percent of reject fries (greenish, spotted, very dark) was estimated visually.

To prepare chips (French fries), potatoes were peeled and cut, using a hand-operated chipping machine, into strips having a cross section of 1 cm x 1 cm. Strips were washed and blanched in hot water for 3 minutes, cooled, dried and prefried at 140şC in sunflower oil for 3 minutes. After storage at 4şC for 24 hours, colour was evaluated by comparison with a colour chart. The strips were then fried at 180şC in sunflower oil for 3 minutes and the colour evaluated again. A higher number indicates a lighter colour, values below 5 being unacceptable.

The aptitude of tubers for washing was evaluated using a scale going from 1 (no washing) to 9 (perfect washing). This is an important factor of quality for potatoes directed to fresh consumption.

The incidence of common scab (*Streptomyces scabies*), silver scurf (*Helminthosporium solani*) and Rhizoctonia (*Rhizoctonia solani*) were estimated as percent of tuber surface affected.

Analysis of variance was performed using the statistical programme SPSS 12.0 for Windows.

RESULTS AND DISCUSSION

Tuber yield and size

The fresh tuber yield was significantly influenced by the year, the variety and the potassium fertilisation. Significant interactions were observed between these parameters. Yield was significantly higher in 2000 (Table 1); this highest production is related to lower values of the maximum temperatures during tuberisation (Krauss and Marschner, 1984) in this year (Figure 1). This influence of climatic factors is significantly higher for variety Agria (fresh tuber yield in 2000 differed significantly, $P < 0.05$, from 1998 and 1999) than for variety Kennebec (the differences between years were not significant).

Table 1

Yield and tuber characteristics

	1998		1999		2000	
	Agria	*Kennebec*	*Agria*	*Kennebec*	*Agria*	*Kennebec*
Fresh tuber yield, t/ha	46 ± 9^{a}	44 ± 9^{a}	44 ± 11^{a}	44 ± 8^{a}	53 ± 11^{b}	47 ± 9^{a}
Marketable tuber yield, t/ha	44 ± 10^{a}	43 ± 9^{a}	39 ± 11^{a}	39 ± 7^{a}	47 ± 8^{b}	41 ± 7^{a}
Average tuber weight, g	nd	nd	153 ± 47^{a}	183 ± 34^{a}	175 ± 29^{b}	193 ± 38^{b}
Specific gravity, g/cm^3	1.077 ± 0.008^{a}	1.077 ± 0.006^{a}	1.082 ± 0.007^{c}	1.084 ± 0.005^{c}	1.081 ± 0.009^{b}	1.081 ± 0.006^{b}
Dry matter, %	22.5 ± 2.7	22.3 ± 4.7	21.7 ± 1.4	21.9 ± 1.0	22.9 ± 2.8	22.1 ± 2.6

nd: not determined; different letters indicate significant differences between years

The fresh tuber yield was higher for the variety Agria in every year studied, but the difference between varieties is significant ($P < 0.05$) only in the most favourable year (2000).

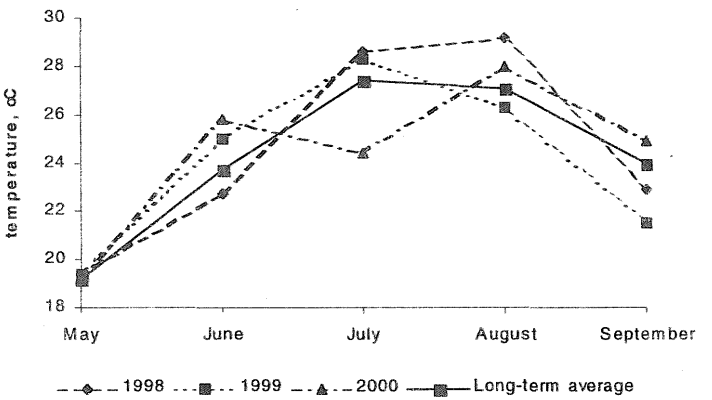

Figure 1. Mean monthly maximum temperature in the years of trials and long-term average

For variety Kennebec, the yield increased with higher rates of applied potassium, including the highest one, in 1998 and 1999. In 2000, the increase of potassium rate from 300 to 450 kg K_2O/ha did not produce a significant increase of yield (Figure 2). On the contrary, for variety Agria, 2000 was the only year in which yield responded positively to potassium fertilisation up to the highest application rate. It appears that for this variety

a synergy existed between climatic factors and fertilisation. Also Chapman *et al.* (1992), Maier *et al.* (1994) and Allison *et al.* (2001), among others, reported increased tuber yields at higher potassium application rates.

Nitrogen and phosphorus fertilisation, at the rates applied, did not affect fresh tuber yield.

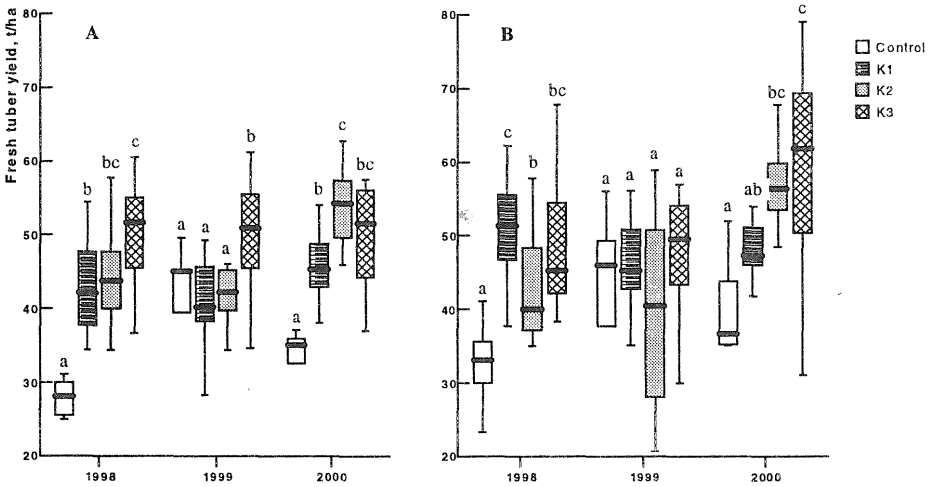

Figure 2. Fresh tuber yield for both potato varieties studied in every year of trial as a function of potassium fertilisation. A: Kennebec; B: Agria. Control: unfertilised; K1: 150 kg K_2O/ha; K2: 300 kg K_2O/ha; K3: 450 kg K_2O/ha. In one year, different letters indicate significant differences.

The marketable tuber (40 to 75 mm) yield varied in a way similar to that of total fresh tuber yield. The most remarkable difference is that in 2000 (the most productive year) the highest potassium rate (450 kg K_2O/ha) produced a decrease of marketable yield, not only in variety Kennebec but also in Agria. In the latter variety, the decrease of marketable production, while the total fresh tuber yield increased, resulted from a considerable increase of yield of tubers >75 cm.

The marketable tuber (40-75 cm) yield as a percentage of total yield was significantly lower in variety Kennebec that in Agria, as a result of a higher proportion of large tubers (>75 cm) in variety Kennebec. The lower percentage of large tubers in variety Agria makes it more suitable for crisp production, because the large tubers produce large slices, which tend to break on packaging.

Year, variety and potassium fertilisation had significant effects on average tuber weight, which was significantly higher in variety Kennebec and in 2000 (the most productive year). It increased with the rate of applied potassium, being significantly higher at the highest K rate (450 kg K_2O/ha) than in the control plots.

Chemical composition

The dry matter concentration (Table 1) was significantly influenced by potassium fertilisation, decreasing as potassium rate increased in the whole range studied (0 to 450 kg K_2O/ha). Similar results were reported by Kolbe *et al.* (1995) in both pot and field experiments. Allison *et al.* (2001) reported reduction of dry matter concentration at high potassium application rates. No influence was observed of nitrogen or phosphorus fertilisation on dry matter content.

Percentage of dry matter in potatoes for crisp production should be 20-25% (Kita, 2002). Lower dry matter contents result in decreased yields, increased oil consumption and crisps with higher oil content and less crunchy. Most tubers in our experiments, including those produced at the highest potassium application rates, met this requirement.

The tuber specific gravity was significantly influenced by the year and the potassium fertilisation, and interactions were observed between these parameters. The specific gravity increased in the order 1998 <2000 <1999 (Table 1) and decreased at higher potassium rates.

For both varieties, the average specific gravity was only above 1.080 g cm^{-3}, the recommended threshold value for crisps (Borruey *et al.*, 2000), in 1999 and 2000 (Table 1). This value is usually not reached at high potassium rates (300 or 450 kg K_2O/ha).

Since the starch content was estimated from the specific gravity, it showed the same trend of variation, being higher in control plots.

Table 2

Chemical composition of tubers

	1998		1999		2000	
	Agria	*Kennebec*	*Agria*	*Kennebec*	*Agria*	*Kennebec*
Starch, % FW	13.5 ± 1.7^{a}	13.6 ± 1.3^{a}	14.7 ± 1.5^{c}	15.0 ± 1.1^{c}	14.4 ± 1.5^{b}	14.2 ± 1.1^{b}
Reducing sugars, % FW	0.15 ± 0.06^{b}	0.16 ± 0.07^{b}	0.14 ± 0.04^{b}	0.20 ± 0.05^{c}	0.09 ± 0.04^{a}	0.12 ± 0.05^{a}
Total nitrogen, % FW	0.35 ± 0.10	0.36 ± 0.10	nd	nd	0.35 ± 0.08	0.34 ± 0.07
Ascorbic acid, mg kg^{-1} FW	nd	nd	113 ± 32^{b}	124 ± 58^{b}	87 ± 21^{a}	23 ± 5^{a}
Citric acid, mg kg^{-1} FW	nd	nd	6206 ± 1239^{b}	5566 ± 1121^{b}	3058 ± 930^{a}	2335 ± 1067^{a}

nd: not determined; different letters indicate significant differences between years

The total nitrogen content in tubers was not significantly influenced by year, variety or fertilisation. This result contrasts with findings by other authors, according to which N levels in tubers may vary depending on fertilisation practices (Roe et al., 1990; Klein et al., 1980 and 1982; Millard, 1986). This lack of influence of N fertilisation along with the fact that the total N contents lay in the upper limit of the reported normal levels (0.24 – 0.36%, according to Burton, 1966) suggest excess N fertilisation in the present field experiments.

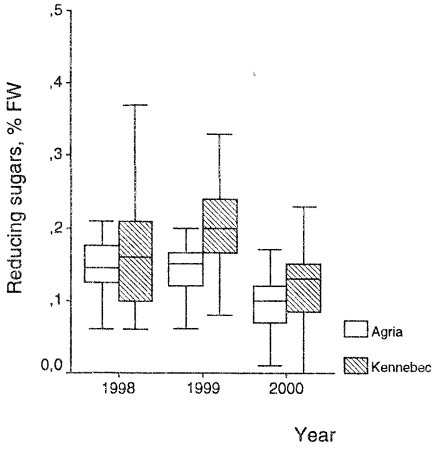

Figure 3. Concentrations of reducing sugars for both varieties in the three years of trials

The content of reducing sugars (glucose and fructose) in tubers was significantly influenced by the year, the variety, and the nitrogen and phosphorus fertilisation. Significant interactions between these parameters were identified. The content of reducing sugars (Table 2, Figure 3) was higher in variety Kennebec in all three years, the difference being statistically significant ($P < 0.05$) in 1999 and 2000. In the year 2000 tubers of both varieties had the lowest content of reducing sugars; this lower content could be attributed to drier climatic conditions in 2000 (Figure 4). Hamouz *et al.* (2000) reported lower reducing sugar contents in potatoes from drier and warmer regions.

The contents of reducing sugars were very often (Table 2, Figure 3) below 0.15% FW, threshold value recommended for crisps, and almost always below 0.25% FW, recommended for chips (Borruey *et al.*, 2000).

The significantly lower content of reducing sugars in variety Agria in 1999 and 2000 is consistent with the lighter colour of Agria chips and crisps. Potatoes suitable for frying should have low levels of reducing sugars to avoid excessive browning of fries through the Maillard reaction (Roe *et al.*, 1990).

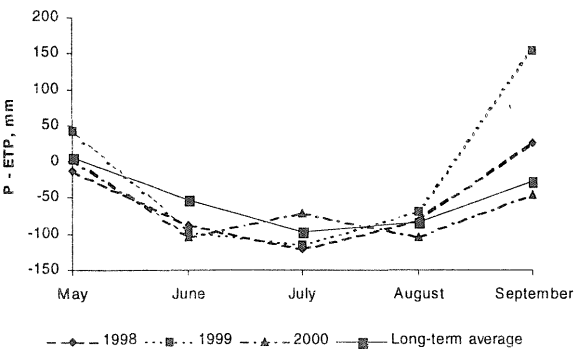

Figure 4. Rainfall minus evapotranspiration potential in the years of trials and long-term average

Nitrogen or phosphorus fertilisation affected significantly the content of reducing sugars, yet significant interactions were identified between these parameters and with year. Kolbe *et al.* (1995) reported that contents of reducing sugars decreased with nitrogen fertilisation and increased with phosphorus fertilisation; the latter was true in the present study in 1999 and 2000.

The concentrations of ascorbic and citric acids in tubers were determined only in years 1999 and 2000 and were significantly influenced by the year and the variety. Both concentrations were significantly higher in 1999 than in 2000. The variety did not affect these concentrations in 1999, whilst in 2000 both parameters were higher in variety Agria. Fertilisation did not affect concentrations of ascorbic and citric acids. In contrast with these results, Kolbe *et al.* (1995) reported that potassium fertilisation increased the contents of ascorbic and citric acids in pot experiments.

Ascorbic acid has been reported to contribute to crisps browning in tubers with low contents (<0.06% of FW) of reducing sugars (Rodríguez-Saona *et al.*, 1997). In the present study most tubers had reducing sugars contents above this value.

Culinary quality

The enzymatic browning was significantly influenced by the variety ($P < 0.05$) and the potassium fertilisation ($P < 0.10$). Mean value was 6 for variety Agria and 4 for variety Kennebec. The less browning of variety Agria was consistent with its higher content of ascorbic and citric acids. These compounds, as reducing agents, should be involved in the prevention of the browning process and can be used as browning inhibitors for fresh-cut potatoes (Sapers and Miller, 1995; Almeida and Nogueira, 1995). Tubers with high levels of ascorbic acid showed low enzymatic browning (Figure 5).

Browning decreased when increasing potassium rate. Similar decrease of the enzymatic browning was reported by other authors for different potato varieties (Mondy *et al.*, 1967; Rinno *et al.*, 1972; Baerug and Enge, 1974). Similarly other authors show the lack of influence of nitrogen fertilisation on enzymatic browning (Rinno *et al.*, 1972).

The darkening after steam cooking was significantly influenced by the variety, being lower in Agria than in Kennebec. It was not significantly influenced by fertilisation.

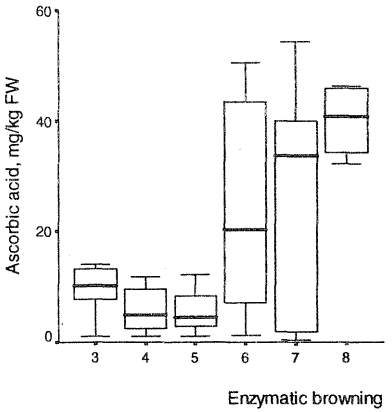

Figure 5. Ascorbic acid contents for different scores of enzymatic browning

The texture of steam-cooked tubers was not significantly influenced by the variety. Yet it was influenced by the nitrogen and phosphorus fertilisation, and interactions between these two parameters have also been identified.

The softest texture (mealy) corresponded to tubers from control plots, coinciding with the highest content of starch. As for the nitrogen rate, the firmest potatoes correspond to the intermediate rate. The phosphorus fertilisation significantly influenced texture only at the highest nitrogen rate; in this case, the texture is mealier at the lowest phosphorus rate. For the most part tubers belong to the B class of potatoes, which are quite firm and appropriate for several uses.

The crisp colour was significantly influenced by the year, the variety and the rate of applied potassium. The crisps of variety Agria presented lighter colour than those of variety Kennebec (on average 6.1 and 5.5, respectively). As for the year, in 1998 crisps had significantly darker colour than in years 1999 and 2000. Increasing potassium rates gave place to better crisp colour. Similar influence of K fertilisation was reported by Zehler *et al.* (1981).

The percentage of reject crisps was significantly influenced by the year, the variety and the rate of applied potassium; no interactions existed between these parameters at a 95% significance level. The percentage of reject crisps was lower in 1999, when production was also lower. This percentage was significantly higher in variety Kennebec (23% on average) than Agria (16% on average) and lowest for the highest potassium rate.

The score of prefried and fried chips (French fries) was significantly influenced by the variety, and the potassium and phosphorus fertilisation; there existed interactions between these variables as well as with the year and the rate of applied nitrogen. The score of prefried and fried chips was higher for variety Agria (on average 6.6 and 6.3, respectively) than Kennebec (on average 5.7 and 5.8, respectively). Fertilisation produced a deterioration of prefries colour with regard to the control. The highest rate of applied P led to lighter French fries.

The aptitude for washing was significantly influenced by the variety, the year and the potassium fertilisation. The variety Agria washed better than Kennebec (scores 3.4 and 2.3, respectively). The low aptitude for washing is related to the presence of disease lesions. The year 1999 was the most favourable for washing. Higher potassium rates improved washing aptitude with regard to control plots.

Incidence of diseases

The incidence of common scab was on average 7% and was significantly influenced by the year and the potassium fertilisation; significant interaction was observed between these two variables. The incidence of this disease was imperceptible in the year 1999. In 1998 the incidence of common scab was minimum in control plots. On the contrary, in 2000 the highest potassium rate (450 kg K_2O/ha) is that which results in the minimum incidence of common scab.

The incidence of silver scurf (that was studied only in year 2000) amounted to 35% on average and was significantly influenced by the variety and the potassium fertilisation, no interactions existing between these two parameters. The incidence of silver scurf was

significantly higher in Kennebec than in Agria. The maximum incidence took place in control plots and the minimum at 300 kg K_2O/ha.

The incidence of Rhizoctonia, which was studied only in 2000, amounted on average to 8% and was significantly influenced by potassium fertilisation, being lower at higher potassium rates.

CONCLUSIONS

Fertilisation, especially potassium application rates, affected significantly the yield and quality of potato tubers in the conditions of the present study. Higher potassium rates resulted in increased tuber yield and size as well as lighter crisp colour, less enzymatic browning and slightly better washing aptitude. On the other hand, increased potassium fertilisation led to lower dry matter concentration and specific gravity, which are related to poorer crisp yield and texture.

Nitrogen and phosphorus fertilisation affected significantly the concentration of reducing sugars and the texture of steam-cooked potatoes. In both cases significant interactions were identified between both variables. Moreover phosphorus fertilisation exerted a main effect on colour of prefried and fried chips.

The scant influence of nitrogen and phosphorus fertilisation on tuber yield and quality indicates that the applied rates are above the optimum levels. As for potassium, in spite of the high rates applied, significant responses were observed, at least in some years or variety; this fact confirms to some extent the general belief that potato shows large responses to K fertilisers. Nevertheless, high K application rates resulted, in some cases, in decrease of fresh tuber yield and/or marketable tuber yield; in other cases, the increases in fresh tuber yield and crisp colour at high potassium rates were counterbalanced by a decrease in dry matter content. So it seems that the high K rates usually applied in the region are not justified. Similarly, Allison *et al.* (2001) advocate the application to potato crops in Great Britain of K rates lower than those currently usual.

Besides fertilisation, climatic factors play a principal role in determining potato tuber yield and quality.

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PRODUCȚIA ȘI CALITATEA TUBERCULILOR DE CARTOFI CA RĂSPUNS LA FERTILIZAREA CU AZOT, FOSFOR ȘI POTASIU ÎN N-V SPANIEI

Rezumat

S-a întreprins un experiment în câmp pe durata a 3 ani în Galicia, N-V Spaniei, pentru evaluarea reacției cartofului (*Solanum tuberosum* L.) la fertilizarea cu NPK. Experimentele s-au desfășurat pe un sol acid ușor argilos. Au fost plantați tuberculi din două soiuri (Kennebec și Agria) la distanța de 0.75 x 0.32 m. Au fost determinați următorii parametri ai tuberculilor recoltați: producția de tuberculi proaspeți, producția de tuberculi pentru comercializare (40-75 mm), masa medie a tuberculilor, conținutul de substanță uscată, greutatea specifică; amidon, zaharuri reducătoare, azot, acid citric și ascorbic; incidența râiei comune, a râiei argintii și a rizoctoniozei; brunificarea enzimatică; calitatea la preparare; rezistența la spălare.

Au fost aplicate în câmp, pe baza unei scheme factoriale cu trei repetiții, patru nivele de azot (0, 130, 180, și 230 kg N/ha, sub formă de sulfat și nitrat de amoniu), patru nivele de potasiu (0, 150, 300, și 450 kg K_2O/ha, sub formă de clorură de potasiu), și trei nivele de fosfor (0, 100, și 200 kg P2O5/ha, sub formă de superfosfat de calciu).

Producția de tuberculi a fost în medie cu 7% mai mare la soiul Agria față de Kennebec. Majoritatea parametrilor de calitate au fost afectați în mod decisiv de soi.

Un coeficient mai mare al aplicării de potasiu a avut efecte semnificative ($P<0.05$) asupra producției de tuberculi, a producției de cartof pentru vânzare, asupra greutății medii a tuberculilor, a substanței uscate, a brunificării enzimatice, asupra calității la preparare și a rezistenței la spălare. Cantități mai mari de potasiu au dus la o producție mai mare și la dimensiuni mărite ale tuberculilor, dar și la scăderea conținutului de materie uscată. Brunificarea enzimatică a fost mai scăzută când s-a aplicat mai mult potasiu. Calitatea culinară a crescut odată cu cantitatea de K. Rezistența la spălare a fost mai ridicată în cazul aplicării unei cantități mai mari de K. Incidența râiei comune, a râiei argintii și a rizoctoniozei a fost mai scăzută la cantități mai mari de K.

Fertilizarea cu N a influențat nesemnificativ conținutul de zaharuri reducătoare. Fertilizarea cu P a influențat nesemnificativ conținutul de zaharuri reducătoare și calitatea la preparare. Interacțiunile an x N x P au fost semnificative asupra conținutului de zaharuri reducătoare iar interacțiunile an x P au avut efect semnificativ asupra culorii pommes-frites-ului.

În funcție de an, au diferit semnificativ producția totală de tuberculi și cea de cartof pentru comercializare, masa tuberculilor, greutatea specifică, conținutul de amidon, de zaharuri reducătoare, de acid ascorbic și citric, incidența râiei comune, calitatea la preparare și rezistența la spălare.

Nici unul din conținuturile de amidon, azot, acid ascorbic și citric din tuberculi nu au fost afectate decisiv de fertilizare.

Cuvinte cheie: producție, calitate, fertilizare

Tabele:

1. Caracteristicile producției și ale tuberculilor
2. Compoziția chimică a tuberculilor

Figuri:

1. Temperatura maximă medie lunară în anii de experiență și media pe termen lung
2. Producția de tuberculi proaspeți din ambele soiuri studiate în fiecare an de experiență în funcție de fertilizarea cu potasiu. A: Kennebec; B: Agria. Martor: nefertilizat; K1: 150 kg K_2O/ha; K2: 300 kg K_2O/ha; K3: 450 kg K_2O/ha. În cadrul unui an, literele diferite indică diferențe semnificative.
3. Concentrațiile de zaharuri reducătoare pentru ambele soiuri în cei trei ani de experiență
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PRODUCTIVITY AND QUALITY RESPONSE PATTERNS OF POTATOES (SOLANUM TUBEROSUM, L.) TO WATER AND NITROGEN IN NORTH PORTUGAL

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SUMMARY

Field experiments using line-source experiments and potatoes crops (*Solanum tuberosum*, L.) of cultivar Desirée, were conducted during four different seasons and at two different locations in the region of Trás-os-Montes, Northern Portugal (1988-89 in Bragança at 680 m and 1997-98 in Montalegre at 1005 m altitude). The crops were subjected to four nitrogen (N) levels (N0, N1, N2 and N3) and five irrigation (I) treatments (I4-I0). Full irrigation increased mean yields of fresh tubers at Bragança from 11.8 to 24.7 t ha-1 in 1988 and from 13.6 to 49.8 t ha-1 in 1989, and from 19.3 to 44.5 t ha-1 (1997) and from 15.6 to 56.0 t ha-1 (1998) in Montalegre. In all four trials, total fresh tuber yield from droughted crops tended to decline with N fertiliser up to 80 kg ha-1. Above this threshold value, the effect of N application on fresh tuber yields was not consistent and approached significance only at the extreme N (N3) and water treatment (I4) in 1989, 1997 and 1998. Crops in the fully irrigated regime (I4) displayed a greater percentage of "marketable size" (50-100 mm) tubers (61%) than "seed size" (30-50 mm) tubers (36%) followed next (3%) by the smallest size (<30 mm). As water was reduced from fully irrigated to the rain-fed regime the average distribution of tuber size % changed to a reverse pattern to only 24% (50-100 mm), 64% (30-50 mm) and 10% (<30 mm). Nitrogen fertiliser application had no significant effect on tuber size grading in any of the four trials. There was a strong interaction between irrigation and the site on % tuber size distribution. It appears that temperature induced by altitude of the location is an important factor influencing the % of "marketable size" and "seed size" tubers in the final fresh tuber yield of irrigated crops. Warmer conditions appear to favour the presence of a greater percentage of "marketable size" (50-100 mm) tubers and reduce "seed size" (30-50 mm) tubers in the final yield. These results indicate that at both locations irrigation offers a better choice for raising potato yields and for controlling tuber size grading.

Keywords: *Solanum tuberosum;* productivity; tuber size; irrigation and nitrogen; northern Portugal

INTRODUCTION

Potatoes are an important staple crop in Portugal and are cropped all over the north of the country either in small family properties or in medium to large commercial enterprises. The climate of this region reflects its topography, varying from near sea level up to 1300 m altitude. The productivity of this crop is particularly favoured in high altitude sites from about 700 m upwards where the annual rainfall ranges from d"600 mm (classified as the cold plateau land) to e"1400 m (known as the cold mountain land) and mean annual temperature varies from e"12.5şC to d"8şC respectively (Gonçalves, 1985).

Two of the locations in the north of Portugal where potatoes are cropped and that may be considered representative of this climatic variation are the regions of Bragança (lat 41§ 49' N; long 6§ 46' W; 680 m) and Montalegre (41ş 49' N, 7ş 47' W, 1005 m). Their common feature is that potato crops grown during the summer season (May-September) are mainly directed to seed production and they suffer from erratic rainfall and a gradual rise in temperature, which invariably results in the development of soil water deficit of varying degree and warm environmental conditions during the growing season.

The facts above lead to the need to apply irrigation to supplement rainfall and to sustain potato productivity and farmers´ economic returns. Nitrogen fertiliser (N) is applied also frequently to potato crops with the intention of overcoming the low organic matter content of the soils of both locations. This type of activity in potato cropping is well established and practiced among local farmers and elsewhere in the world, as total production of potato crops can be influenced by water use (Levy *et al.*, 1990; Rab and Willat, 1987) and nitrogen fertilisation (Shimshi and Susnoschi, 1985; Harris, 1992). However, the amount of water applied as irrigation and the rate of N application vary widely, with important implications for the final fresh tuber yields and the tuber size distribution. When potato utilisation is mainly directed to the canning and crisping industry, total production of fresh tuber yield does not represent the major productivity factor, as tuber size grading as percentage of total production becomes the key parameter for industrial and commercial output. It appears that this parameter can be influenced by water and nitrogen application. In fact, reports on this matter indicate that smaller sized tubers formed a greater proportion of the total yield of crops exposed to drought stress (Waterer, 1997). On the other hand, other researchers found earlier that yield of large size tubers decreased by lower nitrogen rate (Porter, 1993).

The main objective of this paper is to report the results of total fresh tuber yield and tuber size grading obtained from field trials carried out with potato crops differentially irrigated, and nitrogen fertilised, in two different locations of the north of Portugal. The specific objectives are twofold: the first is to ascertain the importance and significance of the effect of water and nitrogen application on total fresh tuber productivity and the second is to identify if with these applications, there is any consistent pattern of tuber size grading distribution in the two locations where the trials were carried out.

MATERIAL AND METHODS

Site, climate and soils

Field experiments were conducted during four different seasons and at two different locations in the region of Trás-os-Montes, Northern Portugal (1988-89 in Bragança at 680 m and 1997-98 in Montalegre at 1005 m altitude).

The daily weather variables were recorded at the sites by meteorological stations located at about 200 m from the field experimental plots. The mean rainfall amounts for the period between planting and harvesting (May-September inclusive) varied from 248 (1988), 125 (1989), 215 (1997) to 325 (1998) mm, representing 158%, 80%, 82% and 124% respectively of the long-term average rainfall for this five-month period. Accordingly, mean air temperature varied from 16.7şC, 18.8şC, 14.6şC to 14.0şC.

The soil of all four sites could be described as silt-loams as they showed high proportions of silt and fine sand (55-61%), followed by clay (22-18%) and sand (22-21%) in 1988-89 and high proportions of silt and fine sand (50-60%), followed by sand (38-28%), and clay (12%) in 1997-98. The soil water holding capacity between field capacity (29-39 vol%) and permanent wilting point (10-19 vol%) varied from 150 (1988), 200 (1989), 140 (1997) to 160 (1998) mm m-1. In all sites the soil pH varied between 5.3 and 5.7 to depths of 1.1 m. Organic matter content varied from 3% (1988-89) and 4-5% (1997-98) at the surface to 0.5% at 1.0 m. Total nitrogen content (NC) varied from 0.20% at the surface to 0.050% at 1.0 m.

Crop, experimental design and treatments

In all four trials, pre-sprouted tubers (cv. Desirée, class AA1) were planted by hand, on the 1 June (1988), 11 May (1989), 21 May (1997) and 4 June (1998) at the same density of 45 000 plants ha-1 (0.7 m between rows by 0.3 m within row). Basal fertiliser application of 330 kg of P2O5 (18%P) and 270 kg of K2O (60%K) ha-1was applied to all field trials. Nitrogen (N) was applied at the time of planting as ammonium sulphate at four different rates: 0(N0), 80(N1), 160(N2) and 240(N3) kg ha-1 and constituting the main fertiliser treatments. Nitrogen level N0, represents the control treatment and N1 (80 kg ha-1), the minimum average rate widely used by the local farmers. Emergence (50%) occurred 34 (1988), 26 (1989), 30 (1997) and 26 (1998) days after planting (DAP).

Line-source design (Hanks *et al.*, 1976) was used in all four trials to impose a gradient of water application to the crops from rain-fed (I0) to fully irrigated (I4) with three partially irrigated treatments (I1, I2 and I3). Each experiment consisted of 20 treatment combinations [4 nitrogen (N0-N3) x 5 water (I0-I4) treatments] each replicated four times, with two 24.4 x 36 m blocks on either side of a central path. After 50% emergency, crops were irrigated uniformly until around 40 to 50 DAP and thereafter, they were differentially irrigated by weekly applications until two weeks prior to their harvest at maturity, reached at 120 (1988), 140 (1989), 140 (1997) and 140 (1998)

DAP. Total water applied as precipitation (P) plus irrigation (I) varied from 387 (1988), 724 (1989), 445 (1997) to 532 (1998) mm in the wettest treatments (I4), and from 148, 295, 218 to 256 mm respectively, in the rain-fed treatments (I0).

Tuber yield and tuber size grading

Fresh tuber yield was obtained from the final harvesting which in Bragança took place between 120 and 122 DAP in 1988 and from 142 to 143 DAP in 1989. In Montalegre the corresponding final harvesting dates were 140-141 DAP (1997) and 138-140 DAP (1998). In both locations and all four experiments, the fresh weight of the tubers (FWtub) of each treatment combination at the final harvest was determined from at least 50 plants, which were removed from the soil and from the centre of each of the sub-plots, disregarding the border plants, totalising 4000 per trial. Harvested tubers were immediately weighed at the site to avoid any loss of water by evaporation. All tubers recovered from the 50 plants harvested from each sub-plot were graded for tuber size and external defects. Percentage of tubers by weight was then recorded in four individual class intervals: <30 mm; 30-50 mm; 50-100 mm and >100 mm. These class intervals were chosen according to the guidelines for potato commercialisation outlined by the Ministry of Agriculture.

Statistical analysis

Since there were differences in planting dates, site and season, all data were subjected to analysis of variance per year separately to test for main effects and interactions among the irrigation treatments, N fertiliser treatments, site and season. Whenever the data failed the analysis of variance assumptions, the percentage data were analysed after proper transformation. To allow for any systematic variation across the experimental area, such as a fertility gradient, covariance analysis, with distance of each sub-plot from the line-source as the co-variate, was used to test for treatment differences in fresh tuber yields (Morgan and Carr, 1988). The comparison of the means of the percentage of tuber size grade observed per given treatment and site was carried out using a standard paired comparison test using least significant procedure at á=0.05 for each comparison.

RESULTS AND DISCUSSION

Climate

The climate during the four growing seasons (May-September) reflected primarily the locations of the experiments, with warmer and drier conditions in Bragança (680 m) than in Montalegre (1005 m). However, within each location there were differences between years with 1988 being cooler and wetter than 1989 at Bragança. Similarly in Montalegre, 1998 was rather cooler year and wetter than 1997. The mean monthly temperatures and rainfall are shown in Figure 1. At both sites rainfall varied between 80 and 160% (1989-1988) of the long-term average at Bragança and between 80 and 120% (1997-1998) at Montalegre.

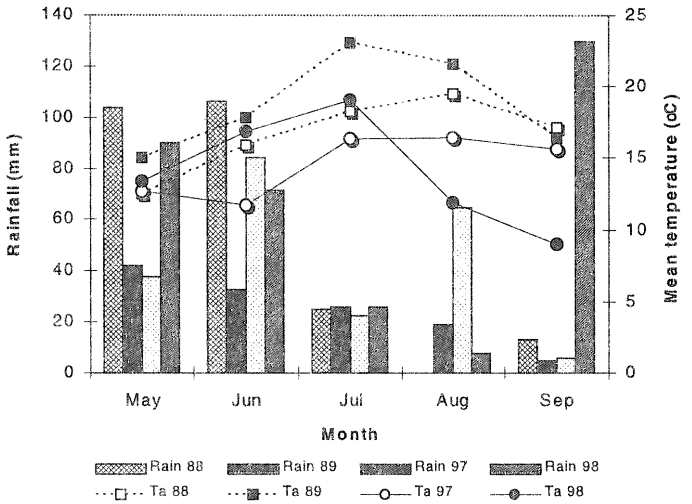

Figure 1. Monthly rainfall totals (mm) and mean monthly air temperatures (şC) during the four growing seasons (May-September) in Bragança (1988-89) and Montalegre (1997-98).

Mean maximum daily air temperatures at Bragança varied from 17.1 (May) to 28.3şC (August) in 1988, and from 22.5 (May) to 32.1şC (July) in 1989. The corresponding values for Montalegre are respectively 17.3şC (June) and 25.3şC (September) in 1997 and 15.8şC (September) and 29.3şC (July) in 1998.

Effect of irrigation treatment on fresh tuber yield

Water applied as irrigation increased mean yields of fresh tubers (Table 1) at Bragança from 11.9 to 24.7 t ha-1 in 1988 and from 13.6 to 49.3 t ha-1 in 1989. Similarly, at Montalegre (Table 1), yields of fresh tuber increased with water application from 19.3 to 44.5 t ha-1 (1997) and from 15.6 to 56.0 t ha-1 (1998).

Overall, the application of water to potato crops in all four experiments resulted in a significant increase in mean fresh tuber yields, of the order of about 110% (1988), 260% (1989), 130% (1997) and 150% (1998), which in some cases represented over threefold the mean value obtained under rain-fed regime.

The statistical analysis (Table 2) indicates that total yields of fresh tuber were raised consistently and significantly ($P<0.01$) by irrigation application, regardless of that altitudinal difference. The range of yield increase obtained in this study is in accordance with most of the reports available in the literature. In a similar environment in Israel irrigation raised the yield of potatoes from 22.6 to 57.3 t ha-1 (Levy *et al.*, 1990) and from 23 to 43 t ha-1 (Susnoschi, 1982); in Australia yields of potatoes crops were raised by irrigation up to 50 t ha-1 (Sale, 1973) and 55 t ha-1 (Rab and Willat, 1987).

Table 1. Final fresh tuber yield (t ha-1) obtained during four seasons at Bragança (1988-89) and Montalegre (1997-98) in response to differential irrigation from rain-fed to full irrigation (I0-I4) and nitrogen application rates, N0 (0 kg ha-1) to N4 (240 kg ha-1). Values refer to harvests made 120 DAP in 1988 and 140 DAP in 1989, 1997 and 1998

Bragança						*Montalegre*					
1988	I4	I3	I2	I1	I0	*1997*	I4	I3	I2	I1	I0
N0	28.9	24.9	19.2	16.7	14.0	N0	44.2	46.2	41.2	27.0	21.8
N1	23.3	22.5	18.0	14.1	11.0	N1	45.8	44.6	36.8	23.5	19.1
N2	22.2	20.4	14.8	11.8	10.0	N2	41.8	45.8	40.4	25.9	18.6
N3	24.4	24.4	18.8	14.0	12.4	N3	46.2	49.1	40.6	26.4	17.7
Mean	**24.7**	**23.1**	**17.7**	**14.2**	**11.9**	**Mean**	**44.5**	**46.4**	**39.8**	**25.7**	**19.3**
SE	**2.9**	**2.0**	**2.0**	**2.0**	**1.7**	**SE**	**2.0**	**1.9**	**2.0**	**1.5**	**1.8**
Bragança						*Montalegre*					
1989	I4	I3	I2	I1	I0	*1998*	I4	I3	I2	I1	I0
N0	48.4	42.2	34.0	27.3	17.3	N0	49.8	41.9	34.7	25.7	23.2
N1	49.3	49.2	35.6	25.1	12.6	N1	52.8	42.4	35.7	25.6	21.3
N2	50.1	50.1	33.9	24.3	12.3	N2	53.3	43.5	29.2	23.4	20.4
N3	49.4	46.5	33.5	24.4	12.2	N3	58.6	50.0	38.4	26.5	20.8
Mean	**49.3**	**47.0**	**34.3**	**25.3**	**13.6**	**Mean**	**53.6**	**44.5**	**34.5**	**25.3**	**21.4**
SE	**0.7**	**3.5**	**0.9**	**1.4**	**2.5**	**SE**	**3.7**	**3.8**	**3.9**	**1.3**	**1.2**

Table 2. Results from the analysis of variance performed on total fresh tuber yield (t ha-1) and tuber size distribution, as percentage (%) of total weight, obtained during four seasons at Bragança (1988-89) and Montalegre (1997-98) in response to differential irrigation from rain-fed to full irrigation (I0-I4) and nitrogen application rates, N0 (0 kg ha-1) to N4 (240 kg ha-1). Values refer to harvests made 120 DAP in 1988 and 140 DAP in 1989, 1997 and 1998

Analysis of variance	**Tuber yield (t ha-1)**	**<30 mm**	**30-50 mm**	**50-100 mm**
Year	88 89 97 98	88 89 97 98	88 89 97 98	88 89 97 98
Source of variation				
Irrigation (I) n =12	** ** ** **	** ** ** **	** ** ** **	** ** ** **
Nitrogen (N) n =16	ns ns ns ns	ns ns ns ns	ns ns ns ns	ns ns ns ns
Sites (S) n =4	*	**	**	**
NxS	ns	ns	ns	ns
IxN	*	ns	ns	ns
IxS	*	*	**	**
IxNxS	ns	ns	ns	ns

*, **, ns Significant at the 0.05, 0.01 probability levels and non significant, respectively

Effect of nitrogen treatment on fresh tuber yield

By comparison, in all four experiments, the effects of nitrogen (Table 2) on final fresh tuber yield were relatively small and not significant ($P<0.05$). In all four seasons, under rain-fed conditions (I0) nitrogen application had a negative effect on the final fresh tuber yield which declined ($P<0.01$) with the nitrogen application up to 80 kg ha-1 (N1). This tendency contrasts with results referred by Harris (1978) in which yields on unirrigated crops increased with nitrogen rate. However, an important finding that may explain the mechanism underlining the observed effect of N fertiliser application is that of Dyson and Watson (1971) which indicates that the early rate of growth of potato tubers was reduced by nitrogen application. Based on this fact, it may well be the case that in all four experiments, tuber growth of fertilised crops was delayed early in the season as compared to the control crops (N0). Furthermore, in the unirrigated treatments, the dryness of the soil may have also, on one hand, restricted the absorption of N fertiliser. On the other hand, soil water deficit may have raised the soil temperature, through cumulative drought, so that tuber bulking was also constrained later in the season (Mohabir and John, 1988).

There were also no significant interactions between nitrogen application and both the sites and the irrigation regimes. Within a given location and season, the response of final fresh tuber yield to nitrogen rate was not consistent under any irrigation regime. Nevertheless, and with exception of 1988, the difference between fresh tuber yield of control plots (N0) and the fully fertilised treatment (N3) approached significance ($P<0.05$) in crops that were fully irrigated.

Smaller yields obtained in the irrigated treatments (I1- I4) in 1988, as compared to the other three seasons (1989, 1997 and 1998), were probably the result of a shorter growing season than the remaining, due to later planting in this year. On average, yield responses of nitrogen fertilised crops were *ca.*30% higher in Montalegre than in Bragança.

Effect of irrigation treatment on tuber size distribution

Very few tubers of size >100 mm were found in any of the four trials. Therefore, only three of the four different categories (<30 mm; 30-50 mm; 50-100 mm and >100 mm) under which tuber size was classified showed a clear response to irrigation regimes. This response was significant (Table 2) and compensatory in its nature, as the percentage of "seed size" (30-50 mm) tubers used for seed production and the "marketable size" (50-100 mm) tubers used in fresh consumption varied in a complementary manner.

On the average, in all four seasons, the yield obtained from crops grown under the fully irrigated regime (I4) displayed a greater ($P<0.01$) percentage of "marketable size" (50-100 mm) tubers (61%) than "seed size" (30-50 mm) tubers (36%) followed next (3%) by the smallest size (<30 mm) considered as rejects (Figure 2.a). As water applied was reduced from fully irrigated conditions through partially irrigated regime (Figure 2.b) and down to the rain-fed regime the average distribution of tuber size % changed to a reverse pattern (Figure 2.c) with only 24% of "marketable size" (50-100 mm), 64% of "seed size" (30-50 mm) and 10% of reject tubers (<30 mm).

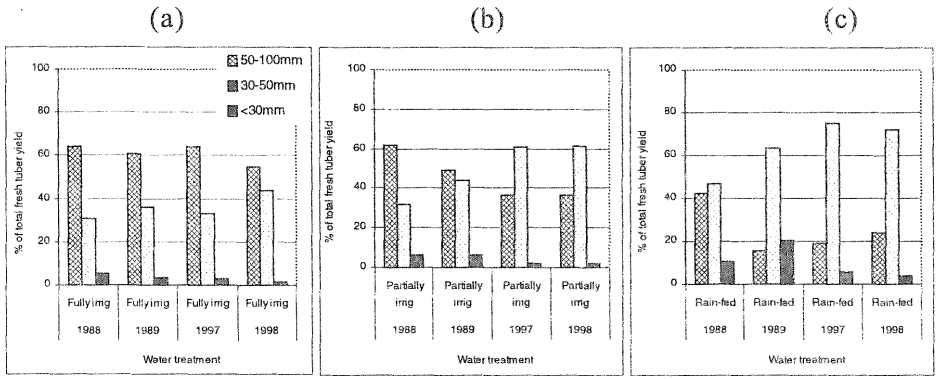

Figure 2. Response patterns of tuber size grade (50-100 mm; 30-50 mm; <30 mm) distribution under (a) fully irrigated, I4, (b) partially irrigated, I2, to (c) rain-fed, I0, treatments in Bragança (1988 and 1989) and Montalegre (1997 and 1998).

These results indicate that distribution of the percentage of tuber size grades in the total yield obtained in all four experiments was significantly ($P<0.01$) affected by irrigation (Table 2). Wetter conditions appear to favour the increase of large size tubers (50-100 mm) and the reverse is true for the medium size tubers (30-50 mm). This effect of irrigation on distribution of tuber size percentage is evident if the results are analysed for each of the sites. A graphical example of this compensatory behaviour of tuber size distribution in relation to irrigation regime for each of the locations is shown in Figure 3. This performance of tuber size distribution on the final yield is in accordance with some recent reports. Fabeiro *et al.* (2001) refer to the positive effect of irrigation applied throughout the season on the increase of large tubers. Other results obtained elsewhere (Porter *et al.*, 1999) also indicate a significant ($P<0.05$) and positive effect of irrigation on the increase of the percentage of large tubers particularly of medium sized (29-57 mm) and large sized grades (57-102 mm). The same results indicate that there was no significant effect of irrigation on tubers smaller than 29 mm and greater than 102 mm.

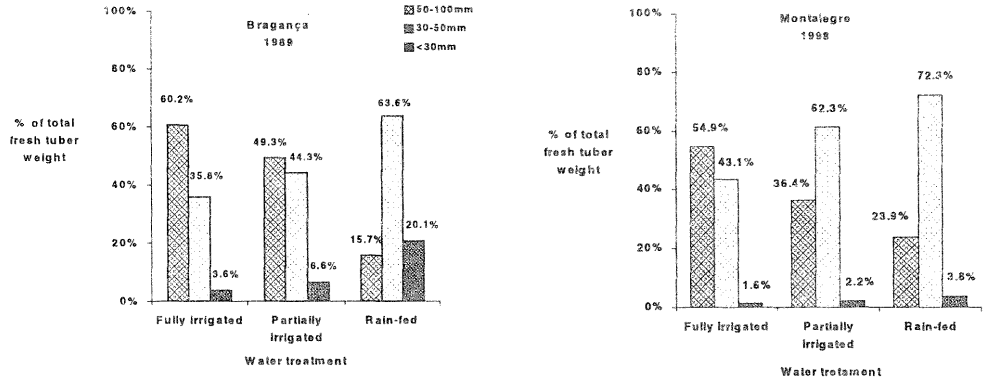

Figure 3. Examples of the effect of irrigation regimes, from fully irrigated (I0), partially irrigated (I2), to rain-fed (I4) conditions, on tuber size grade (50-100 mm; 30-50 mm; <30 mm) distribution obtained at Bragança in 1989 and at Montalegre in 1998.

Effect of nitrogen treatment on tuber size distribution

Response of tuber size distribution in relation to N application was not consistent and no significant effect ($P<0.05$) was observed in any of the four trials (Figure 4.a,b,c,d). Considering all four seasons at one time, the mean tuber size distribution maintained unchanged by nitrogen application rates from 0 (N0) to 240 kg ha-1 (N3) varying from 42-40% (50-100 mm); 52-53% (30-50 mm) to 6-7% (<30 mm). Interestingly, if N fertiliser treatments are considered one at time, the site factor appears to affect more than the other factors on the overall percentage of tuber size distribution in the final fresh tuber yield. As a result, the mean (1988-89) pattern of tuber size distribution obtained at Bragança, irrespectively of nitrogen treatment, was 49% (50-100 mm), 42% (30-50 mm) and 9% (<30 mm). By contrast, the corresponding values (1997-98) obtained at Montalegre were 34%, 63% and 3%.

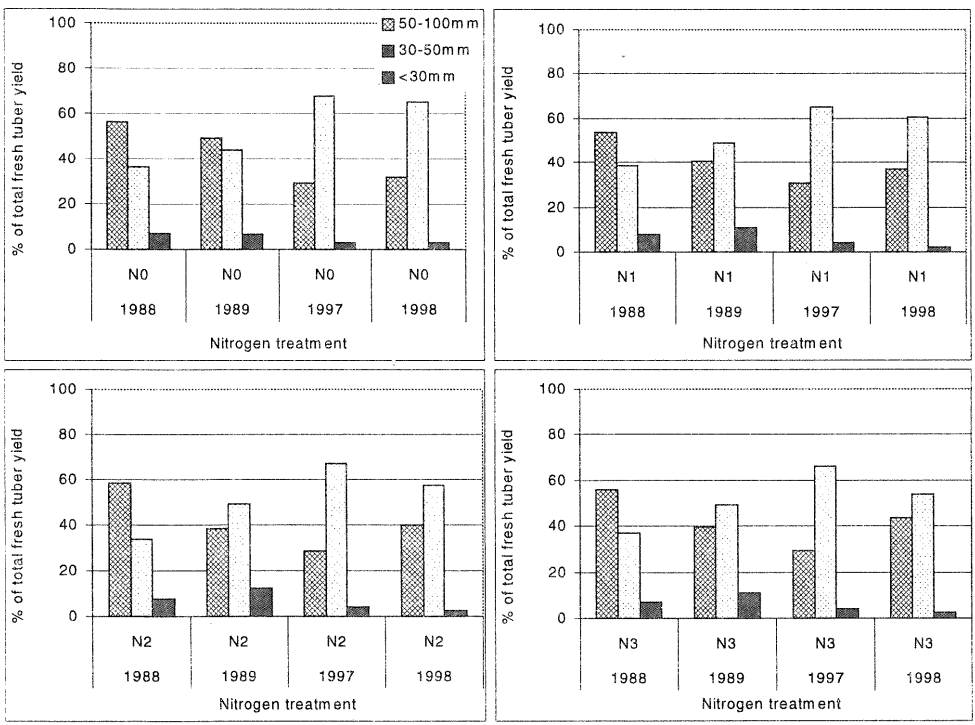

Figure 4. Response patterns of tuber size grade (50-100 mm; 30-50 mm; <30 mm) distribution under four nitrogen treatments: 0 kg ha-1 (N0), 80 kg ha-1 (N1), 160 kg ha-1 (N2) and 240 kg ha-1 (N3) in Bragança (1988 and 1989) and Montalegre (1997 and 1998).

These results obtained at both sites in northern Portugal are contrary to some recent reports which indicate that yield of large size tubers were decreased by lower nitrogen rate (Porter, 1993) and that N application increased both total and large tuber size marketable yields in eight cultivars (Arsenault *et al.*, 2001). These conflicting findings may be a result of differences in environmental and husbandry conditions of the experiments, which include soil type, N source and perhaps due to the cultivar specific responses.

The fact that, under each N treatment, averaged across all irrigation regimes, Bragança had more % of large tubers (50-100 mm) than Montalegre, where the reverse was true with far larger % of medium sized tubers (30-50 mm), is in accordance with the results from the analysis of variance (Table 2), which indicates that there was a significant interaction between irrigation regimes and sites.

Indeed, the study of the relationship between mean monthly minimum temperatures observed during the four seasons and tuber size distribution as % of the final fresh tuber yield showed a close relationship between the two variables. Warmer conditions appear to favour the presence of a greater percentage of large size tubers (50-100 mm) in the final yield ($y = 5.137x - 0.899$, $n=4$, $r2=74.6\%$). By contrast the relationship between the increase in mean monthly minimum temperature (x) and the percentage of medium size (30-50 mm) tubers (y) yielded a negative function ($y = -5.785x + 145.99$, $n=4$, $r2=64.2\%$). This relationship for the smaller size tubers was $y = 0.957x - 2.8958$, $r2=85.1\%$. No references have been found in the published literature that enables the assessment of these results. However, these relationships can have great implications in the strategy leading to the production of potato seed tubers nationwide.

CONCLUSIONS

The results obtained from the two locations and four growing seasons indicate that irrigation is the primary factor influencing the potato productivity irrespectively of the site or season.

Surprisingly, nitrogen application did not favour the increase in potato productivity; instead it seems to depress crop yields under rain-fed conditions.

Tuber size distribution as percentage of the final fresh tuber yield, when considered as a quality parameter, is greatly affected by irrigation regime and not by nitrogen application. Wetter conditions appear to favour the increase of "marketable" tubers (50-100 mm) and the reverse is true for the "seed" tubers (30-50 mm).

The close relationship between mean monthly minimum temperature and tuber size distribution, as percentage of total fresh tuber yield, may strengthen the idea that the highlands of northern Portugal are indeed suitable for seed potato production, as it is the general belief, but under moderately irrigated conditions.

ACKNOWLEDGEMENTS

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ELEMENTELE DE PRODUCTIVITATE ŞI CALITATE ALE CARTOFULUI (SOLANUM TUBEROSUM, L.) CA RĂSPUNS LA IRIGARE ŞI FERTILIZARE CU AZOT ÎN NORDUL PORTUGALIEI

Rezumat

S-au efectuat cercetări în câmp folosind metoda amplasării în be ızi la cartof (*Solanum tuberosum*, L.) soiul Desirée, pe perioada a 4 sezoane diferite şi în 2 localităţi din regiunea Trás-os-Montes din nordul Portugaliei (1988-89 în Bragança la 680 m altitudine şi între 1997-98 în Montalegre la 1005 m altitudine). Culturile au fost supuse la 4 nivele de fertilizare cu azot (N) (N0, N1, N2 şi N3) şi la 5 tratamente de irigare (I) (I4-I0). Irigarea completă a dus la creşterea producţiei medii de tuberculi proaspeţi în câmpul de la Bragança de la 11.8 la 24.7 to/ha în 1988; de la 13.6 la 49.8 to/ha în 1989; de la 19.3 la 44.5 to/ha (1997) şi de la 15.6 la 56.0 to/ha (1998) în câmpul de la Montalegre. În toate cele 4 experienţe, producţia totală de tuberculi proaspeţi din culturile cu deficit de apă şi cu fertilzare cu N au avut tendinţa de a scădea până la 80 kg/ha. Deasupra acestui prag valoric, efectul aplicării de N asupra producţiilor de tuberculi proaspeţi nu a fost semnificativ decât la doza extremă a tratamentului cu N (N3) şi a irigării (I4) în 1989, 1997 şi 1998. Culturile din varianta cu irigare completă (I4) au prezentat un procentaj mai mare de tuberculi de mărime "pentru piaţă" (50-100 mm) (61%) decât tuberculi "de sămânţă" (30-50 mm) (36%) urmaţi de dimensiunea ce mai mică (<30 mm) (3%). Regimurile de irigare au fost cuprinse între irigare completă şi regim de precipitaţii; distribuţia procentuală medie a mărimii tuberculilor a variat indirect între doar 24% (50-100 mm), 64% (30-50 mm) and 10% (<30 mm). Aplicarea de îngrăşământ azotat nu a avut nici un efect semnificativ asupra mărimii tuberculilor în nici unul dintre cele 4 experimente. A existat o legătură strânsă între irigare şi localitate asupra

procentajului distribuției mărimii tuberculului. Se pare că temperatura indusă de altitudinea localității este un factor important care influențează procentul de tuberculi "pentru piață" și "pentru sămânță" din producția finală la culturile irigate. Condițiile de climă mai blânde par a favoriza prezența unui procentaj mai mare de tuberculi "pentru piață" (50-100 mm) și a reduce numărul de tuberculi "pentru sămânță" (30-50 mm) din producția finală. Aceste rezultate indică faptul că în ambele localități irigarea este o soluție eficientă pentru creșterea producției de cartof și pentru a controla calibrarea tuberculilor.

Cuvinte cheie: *Solanum tuberosum*, productivitate, mărimea tuberculilor, irigare, azot, N Portugaliei.

Tabele:

1. Producția finală de tuberculi proaspeți (to/ha) obținuți pe o perioadă de 4 sezoane la Bragança (1988-89) și Montalegre (1997-98) ca răspuns la diferite nivele de irigare (de la precipitații la irigare completă) (I0-I4) și de aplicare de N, de la N0 (0 kg/ha) la N4 (240 kg/ha). Valorile se referă la recoltările făcute la 120 zile după plantare (DAP) în 1988 și 140 DAP în 1989, 1997 și 1998.

2. Rezultatele analizei variantei aplicate la producția totală de tuberculi proaspeți (to/ha) și la distribuția mărimii tuberculilor, ca procentaj din masa totală, reultate obținute pe parcursul a 4 sezoane la Bragança (1988-89) și Montalegre (1997-98) ca răspuns la diferite nivele de irigare (de la precipitații la irigare completă) (I0-I4) și de aplicare de N, de la N0 (0 kg/ha) la N4 (240 kg/ha). Valorile se referă la recoltările făcute la 120 zile după plantare (DAP) în 1988 și 140 DAP în 1989, 1997 și 1998.

Figuri:

1. Totalul precipitațiilor lunare (mm) și temperatura medie lunară a aerului (șC) în timpul celor 4 sezoane de cultivare (mai-septembrie) la Bragança (1988-89) și Montalegre (1997-98).

2. Modele de distribuție a mărimii tuberculilor (50-100 mm; 30-50 mm; <30 mm) ca răspuns la următoarele tratamentele (a) irigare completă, I4, (b) irigare parțială, I2, (c) precipitații, I0, în câmpul de la Bragança (1988 și 1989) și Montalegre (1997 și 1998).

3. Exemple ale efectelor regimurilor de irigare, de la irigare completă (I0), irigare parțială (I2), precipitații (I4), asupra distribuției mărimii tuberculilor (50-100 mm; 30-50 mm; <30 mm) obținută în câmpul de la Bragança în 1989 și în cel de la Montalegre în 1998.

4. Modele de distribuție a mărimii tuberculilor (50-100 mm; 30-50 mm; <30 mm) ca răsuns la 4 nivele de tratament cu azot: 0 kg/ha (N0), 80 kg/ha (N1), 160 kg/ha (N2) și 240 kg/ha (N3) în câmpul de la Bragança (1988 și 1989) și Montalegre (1997 și 1998).

EFFECTS OF PRESPROUTING AND PLANTING DATE ON GROWTH AND YIELD OF POTATO CROP IN A MEDITERRANEAN TYPE ENVIRONMENT

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SUMMARY

A two-year field study was conducted to determine the effects of pre-sprouting and planting date on earliness, growth and yield of early potato crop in Hatay which is located in the East Mediterranean region of Turkey during 2001 and 2002 growing seasons. The seed tubers of medium early cultivar Marfona were pre-sprouted in trays in a temperature and light controlled storage starting from one month prior to prescribed planting date. Pre-sprouted and non-sprouted seed tubers were planted at six different date with 15 days interval starting from 1 January. Pre-sprouting resulted in earlier emergence and enhanced early growth of potato crop, and consequently produced higher tuber yields at final harvest. The delaying of planting especially later than early February resulted in dramatic yield reductions due to increasing air temperature. It was concluded that potato should be planted whenever soil conditions suitable for planting in January. The yield reductions due to delaying of planting could be acceptable in some extent until mid February, but potato should not be planted after that date in semi-arid Mediterranean environments.

Keywords: early potato, planting date, pre-sprouting, growth duration, Mediterranean

INTRODUCTION

In the Mediterranean type environments potato crop is grown during winter and spring months as early crop. However low temperatures after planting and early growth stages, and high temperatures during the tuber bulking stage were the main constraints of crop growth and yield. Therefore, enhancing earlier emergence and early growth of potato crop is very important to achieve higher tuber yield under these types of environments. However, very early emergence in February is also not preferred due to frost damage risk. Therefore, planting date optimization is very important in early potato production in Mediterranean type environments.

The seed tubers used in early potato production comes from autumn harvest of temperate regions. Therefore, mostly physiologically younger seed tubers are used in early potato production. However, there is a general agreement that rather young seed produces high yields in long growing season, while older seed is suitable to obtain high yields early in the season or in short cycle seasons (Wurr, 1979). Pre-sprouting of seed tubers can be a solution to make seeds suitable for early planting. Hence, rapid emergence, fast initial growth and a homogeneous development of the crop can be ensured with pre-sprouting. Pre-sprouting also favours the growth of a larger number of sprouts/stems per seed potato, which leads to a more efficient use of the seed (Baarveld et al., 2001).

This study was aimed to determine the effects of planting date with or without pre-sprouting treatment on earliness, growth and yield of early potato crop in a Mediterranean type environment in Turkey.

MATERIALS AND METHODS

This study was conducted at the Experimental Farm of Agricultural Faculty, Mustafa Kemal University in Hatay, Turkey (36° 39' N, 36° 40' E) during winter and spring seasons of 2001 and 2002. The soil of the experimental fields has low organic matter content and was slightly alkaline in both years. Hatay province has typical Mediterranean climate conditions with hot-dry summers and mild-rainy winters. Some important climatic data of Hatay province during experimental periods are given in Table 1.

Table 1. Some climatic data during experimental period in 2001 and 2002

Months	2001				2002			
	Temperature (°C)			Rainfall	Temperature (°C)			Rainfall
	Min.	Max.	Mean	(mm)	Min.	Max.	Mean	(mm)
January	4,7	13,6	8,9	35,0	1,0	11,8	5,8	99,7
February	4,0	15,4	9,5	129,7	3,9	18,5	10,8	72,2
March	8,6	22,7	15,3	66,1	6,8	20,7	13,2	77,8
April	11,4	25,2	17,9	24,2	10,7	22,1	16,1	50,8
May	13,3	28,4	20,9	175,6	13,9	28,3	20,8	13,5
June	19,2	37,2	26,6	--	19,2	33,4	26,2	2,8

The pre-sprouted and normal seed tubers were planted at six different date with 13-15 days interval starting from 1 January. Tubers were pre-sprouted at 18-20 °C in a temperature and light controlled storage starting one month before of each planting date. The potato tubers were kept in the dark until they have formed sprouts of a few millimeters, and then lights turned on. Rests of tubers used in pre-sprouting

treatments for later plantings were kept in cool storage at 3-4°C until their pre-sprouting time. The other half of seed tubers were kept in natural room conditions used by regional farmers. Twelve treatment combinations comprising two seed types (pre-sprouted and normal) and six planting dates (1 january, 15 January, 1 February, 15 February, 1 March, 15 March) were laid out in two factor randomized complete block design with three replications. Each plot comprised of four rows, 10 m long and 0.70 m apart. The medium-early potato cultivar 'Marfona' was planted with 25 cm intra-row spacing using an assist-feed planter on each planting date. Plots were fertilized with 90 kg N, P, K per ha before planting, and an additional nitrogen dose of 60 kg per ha was side-dressed at the beginning of tuber bulking for each planting date.

The plots were harvested when plants turned to yellowish. Plant height (cm), number of main stems per plant, haulm dry weight per plant (after drying 48 hours at 70°C), number of tubers per plant, mean tuber weight (g) and harvest index (%) were determined on ten randomly selected plants in each subplot, prior to harvest. Total tuber yield per hectare was calculated using tuber weight of two centre rows.

Analysis of variance (ANOVA) was used to evaluate effects of treatments on yield and yield components, and to determine significance of main effects and interactions for the variables measured. Least Significant Differences (LSD) test was used for comparing and ranking treatments.

RESULTS AND DISCUSSION

Emergence and Total Growing Duration

The seed types, planting dates and seed type x planting date interaction significantly affected to both days to emergence and total growing duration in both years (Table 2). The emergence duration of potato crop ranged between 16 and 64 days in 2001 and between 16 and 58 days in 2002. Emergence duration significantly shortened with delaying of planting date and pre-sprouting resulted in earlier emergence at all planting dates in both years. Optimum temperature for sprout growth and emergence in potato is around 20°C and emergence is very slow at temperatures below 12°C (Dean, 1994). Mean temperatures were below 12°C in January and February in both years (Table 1). Therefore, emergence duration was too long at plantings in these months. The mean temperatures increased to around 15°C after March although it was still lower than 20°C. Hence, emergence duration shortened around 20 days in March plantings. The earlier emergence with pre-sprouting was also reported by Günel (1982) and Kara (1999).

Table 2. The effects of pre-sprouting and planting date on emergence and total growing duration of early potato.

Seed types	Planting dates	Days to emergence		Total growth duration (days)	
		2001	2002	2001	2002
Pre-sprouted	1 January	59	52	87	92
	15 January	48	38	83	91
	1 February	36	28	82	85
	15 February	28	22	82	77
	1 March	21	20	76	75
	15 March	16	16	71	68
Normal	1 January	64	58	82	86
	15 January	54	44	80	85
	1 February	41	34	77	79
	15 February	35	27	75	76
	1 March	26	24	75	70
	15 March	20	19	67	65
	$LSD_{(0.05)}$	1.4	1.3	1.2	1.4
Seed types (A)		**	**	**	**
Planting dates (B)		**	**	**	**
A x B		*	*	**	**

* : p d" 0.05, ** : p d" 0.01

Total growth duration ranged from 67 to 87 days in 2001, and from 65 to 92 days in 2002 (Table 2). Pre-sprouting caused longer growth duration due to earlier emergence. While time between the first and the last planting was 74 days, time between the first and last emergence were 30 days in 2001 and 37 days in 2002, and time between the shortest and longest growing duration were 20 days in 2001 and 27 days in 2002. Although low temperatures caused delaying of emergence, the temperatures increased over the optimum for potato crop growth after late April. Optimum temperatures for growth and net photosynthesis for potato is around 16-21°C (Marinus and Bodlaender, 1975; Struik et al., 1989a; Gawronska et al., 1992; van Dam et al., 1996). The mean temperatures were around 20°C in May, temperatures generally reached 27-28°C during daytime in May. These high temperatures forced the crops to mature earlier.

Stem and Haulm Growth

The number of main stem per plant and plant height were significantly affected by seed types and planting dates in both years while the effects of seed type x planting date interaction were significant only on number of main stem per plant in 2002 (Table 3). The number of main stem per plant consistently increased with pre-sprouting in both years. The highest number of main stem per plant was obtained at 15 February and 1 March plantings in 2001, and 15 February in 2002.

The effects of pre-sprouting and planting date on plant height were inconsistent between years (Table 3). Pre sprouted seeds gave shorter plants in 2001 and taller plants in 2002. The highest plant height was obtained at 15 January planting and plant height significantly decreased with delaying of planting. In contrary, plant height increased with delaying of planting in 2002.

Table 3. The effects of pre-sprouting and planting date on number of main stem per plant, plant height and haulm dry weight of early potato.

	Number of main stem per plant		Plant height (cm)		Haulm dry weight (g plant^{-1})	
	2001	2002	2001	2002	2001	2002
Pre-sprouted	3.0	4.4	34.6	30.7	28.1	22.5
Normal	2.6	4.7	37.0	29.5	27.8	22.0
1 January	2.6	4.2	36.0	25.9	30.7	23.1
15 January	2.6	4.5	39.2	26.1	30.7	20.4
1 February	2.6	4.5	37.0	28.6	24.4	18.9
15 February	3.0	5.2	36.3	31.2	25.0	21.3
1 March	3.1	4.7	33.8	32.9	28.7	22.0
15 March	2.9	4.0	32.6	35.8	28.1	27.8
LSD (Planting date) (0.05)	0.3	0.2	2.1	1.3	1.7	1.7
Seed types (A)	**	**	**	**	ns	ns
P. dates (B)	**	**	**	**	**	**
A x B	ns	**	ns	ns	ns	ns

* : p d" 0.05, ** : p d" 0.01, ns: non significant

The haulm dry weight was significantly affected by planting dates while the effects of seed types and seed type x planting date interaction were not significant on plant height in both years. The highest haulm dry weight was obtained from 1 January and 15 January plantings, and significantly reduced after these dates in 2001 (Table 3). However, haulm dry weight per plant showed a relative increase in last two plantings. The highest haulm dry weight per plant was obtained from 15 March planting while the lowest value was obtained 1 February in 2002.

Tuber Growth and Harvest Index

Pre sprouting significantly increased number of tuber per plant in 2001 whereas effect of seed types on number of tuber was not significant in 2002 (Table 4). The number of tuber per plant was significantly affected by planting dates in both years. The highest number of tuber per plant was obtained from 15 January planting in 2001 while the first four planting dates gave similarly higher tuber number per plant in 2002. The lowest number of tuber per plant was obtained from the last planting in both years.

Decreasing number of stem per plant probably caused to decrease in tuber number per plant in last planting date. Furthermore, increasing temperature after mid April caused production of fewer tubers per plant in late-planted plots. Many authors reported that tuber number per plant significantly decreased when temperature increased above 6-20°C (Marinus and Bodlaender, 1975; Struik et al., 1989b; van Dam et al., 1996).

Table 4. The effects of pre-sprouting and planting date on number of tuber per plant, mean tuber weight and harvest index of early potato.

	Number of tuber per plant		Mean tuber weight (g)		Harvest index (%)	
	2001	2002	2001	2002	2001	2002
Pre-sprouted	7.1	8.5	85.3	53.4	79.9	78.5
Normal	6.4	8.4	83.3	48.5	77.7	76.2
1 January	7.4	8.9	98.4	65.1	81.9	82.5
15 January	7.8	9.1	97.4	61.3	82.5	83.8
1 February	7.0	9.0	93.1	54.2	83.9	82.9
15 February	6.7	9.0	84.5	44.7	81.1	78.0
1 March	6.5	7.9	74.4	41.0	76.5	72.9
15 March	5.2	7.0	58.1	39.1	67.0	63.9
$LSD_{(Planting\ date)\ (0.05)}$	0.3	0.4	2.8	2.5	0.8	1.5
Seed types (A)	**	ns	*	**	**	**
P. dates (B)	**	**	**	**	**	**
A x B	ns	ns	ns	ns	*	**

* : p d" 0.05, ** : p d" 0.01, ns: non significant

Both the seed types and planting dates significantly affected mean tuber weight while the effect of seed type x planting date interaction was not significant in both years (Table 4). Pre-sprouted seeds gave significantly higher mean tuber weight at harvest in both years. Mean tuber weight reduced with delaying of planting in both years. As discussed earlier, total growing period of potato crop increased with earlier planting (Table 2). Therefore, dry matter accumulations to tubers continued for longer periods, and consequently mean tuber weight increased. Furthermore, significant part of tuber bulking stage occurred under cooler conditions comparing to late plantings. Temperature significantly affects partitioning of photosynthate between shoots and tubers, and in general, air temperatures above 20°C favor shoot growth and temperatures below 20°C favor tuber growth (Ewing, 1981; Benoit et al., 1983). Cao and Tibbitts (1994) subjected potato plants to different temperature regimes during there successive growth periods, and concluded that tuber development of potatoes is optimized with a phasic pattern of high temperature during early growth and low temperature during later growth. In the

current study, opposite temperature patterns were occurred at early and late growth stages. Consequently, mean tuber weights as well as number of tuber per plant reduced due to delaying of planting.

The seed types, planting dates and seed type x planting date interaction significantly affected to harvest index in both years (Table 4). Pre-sprouted seeds gave higher harvest index values in both years. Mean harvest index values at different planting dates were ranged from 67% (15 March) to 83.9% (1 February) in 2001, and from 63.9% (15 March) to 83.8% (15 January) in 2002. Delaying of planting date later than 1 February resulted in significant decrease in harvest index, this decrease was more pronounced at last two plantings.

Table 5. The effects of pre-sprouting and planting date on grading and total tuber yield of early potato.

	Tuber yield (t ha^{-1})					
	>45 mm	28-45 mm	Total	>45 mm	28-45 mm	Total
	2001			2002		
Pre-sprouted	28.80	5.65	35.39	13.26	11.13	26.28
Normal	24.97	5.07	31.10	11.84	9.79	23.44
1 January	36.24	4.89	41.48	19.42	11.71	32.81
15 January	37.40	5.40	43.22	18.31	11.84	31.74
1 February	32.10	4.47	37.24	15.17	10.90	27.82
15 February	25.45	5.42	32.04	10.23	10.91	22.90
1 March	20.84	5.88	28.18	7.29	9.15	18.39
15 March	9.27	6.11	17.30	4.87	8.24	15.52
LSD (Planting date) (0.05)	1.78	0.70	1.87	0.85	1.10	1.74
Seed types (A)	**	**	**	**	ns	ns
P. dates (B)	**	**	**	**	**	**
A x B	ns	ns	ns	ns	ns	ns

* : p d" 0.05, ** : p d" 0.01, ns: non significant

Tuber Yield

Both seed type and planting date significantly affected to >45 mm, 28-45 mm and total tuber yield whereas no significant effect of seed type x planting date interaction on total and graded yield were found in 2001 (Table 5). In 2002, seed types significantly affected to >45 mm tuber yield, but neither 28-45 mm tuber yield nor total yield were affected by seed types, while effect of planting date on total and graded yields were found as significant (Table 5). Pre-sprouting had positive effects on all yield values in both years, and total yields increased 12% and 11% with pre-sprouting in 2001 and 2002, respectively. The highest total and larger (>45 mm) tuber yields were obtained from first two planting dates in both years. Further delaying of planting date resulted in significant

decrease in total and larger tuber yields, and yield reduction was more severe in March plantings. 28-45 mm tuber yield increased with delaying of planting date in 2001 while it decreased planting after 1 March in 2002.

Temperature is a major factor regulating biomass accumulation and tuber development in potatoes (Ewing, 1981; Wolf et al., 1990). Optimum temperature for tuber growth in potato is around 16 to 20°C, and higher air temperature reduces net photosynthetic rate (Hammes and de Jager, 1990), partitioning of assimilates to the tubers and markedly reduces tuber yield (Marinus and Bodlaender, 1975; Benoit et al., 1983; Struik et al., 1989b; Gawronska et al., 1992). Phasic temperature change pattern also significantly affects growth and tuberization of potatoes, and high temperature during early growth (22°C) and low temperature (17°C) during later growth is more beneficial for tuber development (Cao and Tibbitts, 1994). In the Mediterranean type environments, potato is grown during winter and spring months. Temperature is low during early growth stages and gradually increases later in growing season. Therefore, potato crops grow under opposite of proposed temperature regime with even higher temperatures, and in consequence yield potential is generally low comparing to temperate zones. In our study, late-planted potato crops subjected to higher temperatures at all growth stages. Hence, tuber growth and yield was dramatically reduced with late planting.

CONCLUSION

When considering emergence duration, it could be thought that very early planting (January) of potato seems not logical due to very long emergence duration. However, the periods between January and mid March are the rainiest season of the year and so; soils are mostly not suitable for planting at the most suitable time for planting in respect to temperature. Furthermore, even a few days earlier emergence in late February or early March could result in significant increase in tuber yield at harvest. Therefore, it is recommended that potato should be planted whenever soil conditions are suitable for planting in January. The yield reductions due to delaying of planting could be acceptable in some extent until mid February, but planting after mid February is not recommended for semi-arid Mediterranean environments.

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EFECTELE PREÎNCOLŢIRII ŞI ALE DATEI DE PLANTARE ASUPRA CREŞTERII ŞI PRODUCTIVITĂŢII CULTURII DE CARTOF ÎN CONDIŢII DE MEDIU DE TIP MEDITERANEAN

Rezumat

S-au întreprins cercetări în de câmp pe o perioadă de 2 ani pentru determinarea efectelor preîncolţirii şi ale datei de plantare asupra timpurietăţii, creşterii şi productivităţii culturii cartofului timpuriu în timpul sezonului de creştere, în Hatay, localitate din estul regiunii mediteraneene din Turcia. Tuberculii pentru sămânţă din soiul semitimpuriu Marfona au fost preîncolţiţi în lăzi în condiţii de temperatură şi lumină controlate, cu o lună înainte de data prevăzută pentru plantare. Tuberculii de sămânţă preîncolţiţi şi neîncolţiţi au fost plantaţi la 6 date diferite, la intervale de 15 zile, începând cu 1 ianuarie.

Preîncolțirea a avut ca efect o germinare mai rapidă şi o creştere mai viguroasă a culturii cartofului, şi, drept urmare, producții mai mari de tuberculi la recoltare. Întârzierea plantării, în special după începutul lunii februarie, a avut ca efect reducerea dramatică a producției din cauza temperaturilor mari ale aerului. S-a ajuns la concluzia că tuberculii ar trebui plantați atunci când condițiile de sol sunt corespunzătoare, în luna ianuarie. Reducerea producției datorată întârzierii plantării ar putea fi acceptată într-o anumită măsură până la jumătatea lunii februarie, însă nu trebuie să se mai facă plantări după această dată, în condițiile de mediu semi-arid din zona mediteraneană.

Cuvinte cheie: cartof timpuriu, epocă de plantare, preîncolțire, sezon de vegetație, zona mediteraneană

Tabele:

1. Câteva date climatice din perioada experimentală din 2001 şi 2002.
2. Efectelor preîncolțirii şi ale datei de plantare asupra germinării şi asupra duratei totale de vegetație a culturii de cartof timpuriu.
3. Efectelor preîncolțirii şi ale datei de plantare asupra numărului de tulpini principale per plantă, asupra înălțimii plantei şi asupra masei uscate a cartofului timpuriu.
4. Efectelor preîncolțirii şi ale datei de plantare asupra numărului de tuberculi per plantă, asupra masei medii a tuberculilor şi asupra indexului de recoltă a cartofului timpuriu.
5. Efectele preîncolțirii şi ale datei de plantare asupra calibrării şi asupra producției totale de cartof timpuriu.

WEED CONTROL IN POTATOES IN THE CZECH REPUBLIC

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SUMMARY

Field trials conducted during 2000-2002 studied the effect of selected herbicides on weed control efficiency and yield and potato quality parameters. The trials were established on medium-textured brown soil of Valečov Research Station. Five weed species occurred on trial plots. Total weed fresh weight was measured in $g.m^{-2}$ and from this weight of following species was determined: winter *Brassica napus*, *Galium aparine*, *Chenopodium album*, *Polygonum convolvulus* and *Viola arvensis*. Following active ingredients were tested using application with clomazone: metribuzin, linuron and terbuthylazine with terbutryn. Winter *Brassica napus* was dominant weed species. This weed represented 31% in 2000, 51% in 2001 and 79% in 2002 of fresh weight of all weeds pre-harvest removed from untreated control. The total weed weight of untreated control was 788,8 $g.m^{-2}$ in 2000, 1135,4 $g.m^{-2}$ in 2001 and 1631,1 $g.m^{-2}$ in 2002. Weed control efficiency of herbicides tested was very high in 2000 and 2001 (98,8 to 99,6%), in 2002 it was lower in relation to high weed infestation. It was 84,5% (87,9% efficiency against winter *Brassica napus*) for metribuzin, 95,8% for linuron (94,9%) and 90,8% (88,4%) for terbuthylazine with terbutryn. Tuber yield was significantly lower on untreated variants, no significant differences were found among individual active ingredients. Yield reduction (between the herbicide-treated variant with the highest yield and the control untreated variant) was 44% in 2000, 41% in 2001 and 48% in 2002. Post-harvest measured tuber dry matter content was not affected by herbicide treatments.

Keywords: weed management; weeds; herbicides; tuber yield

INTRODUCTION

Weeds are highly significant injurious agents. Dependent on range of weed species and intensity of occurrence, they have adverse impacts, especially on tuber yield. Lower and intermediate weed infestation reduces yield at least about 20-30%; however, high weed infestation decreases yield up to 85%. Weeds compete with potato plants as regard as all conditions of potato growth and development. Plants of many weeds are able to better take up soil moisture and this enables more rapid growth and prevalence of weeds over potatoes. It is also associated with competition for nutrient uptake - weeds have better capacities, shade young potato plants and deprive them of sun radiation. It leads to

growth inhibition of potato plants and weed dominance in the field. Weeds increase risk of plant and tuber disease infection, complicate harvest and increase mechanical damage on tubers during harvest. Higher intensity of weed infestation increases potential of seeds or weed rhizomes in soil, and also risk of weed infestation in further crops.

Historically, weed management practices are natural part of all growing technologies. During last forty years substantial changes have been done in ways of potato weed control. Till that time, weeds were only removed by hand weeding, later mechanical cultivation. In 1960s applications of chemicals – herbicides started. In general, herbicide applications replaced 1-2 hoeings and harrowing after potato emergence (Vokál et al., 1985). In 1990s agricultural enterprises specialized in intensive potato production started to fully use the technology of potato growing in de-stoned ridges and weed management based only on herbicide applications (Čepl, 2001).

Foreign literature sources are quite rich; however, they mostly deal with weed control practices for author's site or locality, i.e. various climatic conditions and various weed species are included. In our conditions volunteer rape, *Chenopodium album, Galium aparine, Agropyron repens, Polygonum convolvulus, Viola arvensis, Veronica persica, Lamium purpureum, Cirsium arvense, Sonchus arvensis* belong to weeds with the greatest competitiveness for potatoes (Čepl, 2002). Intensity of weed infestation depends on weather conditions and also cultural practices within the whole crop rotation. Although generally it is said that potatoes are weed-killing crop, from published results of long-term trials by Zimny et al. (1999) it could be concluded that higher portion of potatoes increases weed infestation. The whole dry weight of weeds was also increased by manuring compared to variant without manuring; however the total number of weed per unit area was decreased. Ploughless systems are developed for potatoes with direct tuber planting in mulch, consisted of frost-killing intercrop, since risk of water erosion and nitrogen leaching is decreased. Ploughless system has impact on increased intensity of weed germination (Bohren et al., 2001). Irrigation and nitrogen fertilization (Rolbiecki et al., 2000) have direct impact on increased occurrence of weeds. Weeds increase risk of potato tuber infection with diseases, not only late blight infection, several weed species can be hosts of other diseases. From *Alisma plantago-aquatica* Potato virus Y was isolated (Kazinczi et al., 2001), *Solanum dulcamare* is host of *Ralstonia solanacearum* (Natural, 2001).

With development of growing systems with decreased inputs of pesticides or alternative systems with production of ecological raw staff and foods, effects of technologies on weed occurrence are compared. Results are highly dependent on weather conditions. Gallandt et al. (1998) found in three-year trial the lowest weed occurrence in conventional system in two years, between decreased inputs of herbicides (by 50% combined with mechanical cultivation) and only mechanical cultivation no difference was recorded. In one year the highest weed reduction was

recorded for the system of full mechanical cultivation. Diviš (2002) and (Čepl, 2003) focus on these problems; they confirm strong effect of cultural practices, however, problem of applying only mechanical cultivations consists in work organization (particularly in agricultural enterprises specialized in intensive potato production) and/or in time consumption at least for three mechanical practices and dependence on soil moisture. Weed management was concentrated only on herbicide treatments due to change in the technology.

It is remarkable that assortment of conventional herbicides against dicotyledonous weeds for potatoes is constant over more than thirty years and it is focused on application of metribuzin, linuron and terbuthylazine with terbutryn. Enlargement of efficacy spectrum on *Galium aparine* was achieved due to combined applications with clomazone. Totally 12 active ingredients are intended for control of dicotyledonous weeds in potatoes, included in the Czech list of plant protection preparations. In 1998, Bayer synthesized a new active ingredient – flufenacet (Ramsak, 2001; Arcangeli, 2000) selective on maize, cereals, soybean, rice, tomatoes and potatoes with broad spectrum of efficacy incl. against *Galium aparine.*

Besides basic control measures, i.e. mechanical cultivation, herbicide treatments and their combinations, several alternatives are experimentally tested utilizing effect of cover crops seeded into potatoes (vetch, oats, barley, clover) and following hilling. In this way weeds were reduced by 27% compared to variant of herbicides (Rajalahti et al., 1999). Effects of 25 medicinal plants incorporated into soil with potatoes were tested. The lowest weed infestation was found following incorporation of leaves of *Malvae folium* (Krebs et al., 2001).

MATERIALS AND METHODS

Exact field trials were established by the experimentation principles in 2000-2002 at the research station with the above sea level of 460 m, medium-heavy soil, loam to silt loam topsoilm in condition of technology de-stoning.

Pre-emergent applications were done by sprayer Agrotop, which corresponds to principles of good experimental practice (GEP).

Variants of pre-emergent herbicide treatments are shown in table 1.

For the whole trial area, unique cultural practices and treatments were used. Weed weight was measured per one square meter of each replication by hand pulling before harvest. Results of weight and tuber quality were determined after plant physiological maturity.

Total weed biomass was studied in $g.m^{-2}$ and weight of following weed species was determined: winter *Brassica napus*, international code of Bayer BRSNW, *Galium aparine* – GALAP, *Chenopodium album* – CHEAL, *Polygonum convolvulus* - POLCO, *Viola arvensis* – VIOLAR.

Table 1. Variants of pre-emergent herbicide treatments

Variant	active ingredient	preparation	dose of preparation
year 2000			
1	untreated control		
2	metribuzin	Sencor 70 WP	0,5 kg.ha-1
3	linuron	Afalon 45 SC	1,5 l.ha-1
year 2001			
1	untreated control		
2	metribuzin	Sencor 70 WP	0,5 kg.ha-1
3	linuron	Afalon 45 SC	1,0 l.ha-1
year 2002			
1	untreated control		
2	metribuzin	Sencor 70 WP	0,5 kg.ha-1
3	linuron	Afalon 45 SC	1,75 l.ha-1
4	terbuthylazine + terbutryn	Topogard 500 SC	2,0 l.ha-1

note: all mentioned preparations were applied together with a.i. clomazone in dose of Command 4 EC 0,1 l/ha

RESULTS AND DISCUSSION

Natural weed occurrence on the site is a result of potential weed reserve in soil and definite progress of weather conditions. Weight of weed fresh matter per 1 m^2 are shown in table 2.

Intensity of weed infestation was highest in the year 2002. Weight of weed fresh matter was 1631,1 $g.m^{-2}$ i.e. 16,31 $t.ha^{-1}$ in untreated variant, weight of weeds was 1135,4 $g.m^{-2}$ i.e. 11,35 $t.ha^{-1}$ (69,6% of the year 2002) in the year 2001 and 788,8 $g.m^{-2}$ i.e. 7,89 $t.ha^{-1}$ (48,4% of the year 2002) in the year 2000. In survey of meteorological data it is possible to find explanation of various intensity of weed infestation, because the highest mean temperature and also the highest rainfalls were recorded for the year 2002.

Range of weed species concentrated on 5 weed species; volunteer rape was the dominant weed of all weeds observed, in combination with *Chenopodium album* (31% and 56% of total weed weight) in 2000, with *Galium aparine* (51 and 28% of total weed weight) in 2001 and with *Chenopodium album* (79 and 16% of total weed weight) in 2002. Winter rape was the direct preceding crop of potatoes in 2000 and 2001; in the year 2002 potatoes were grown after two years following winter rape.

Table 2. Weight of weed fresh matter per 1m^2 and tuber yield

var.	Weed species					total weeds		tuber yield t.ha-1		
	BRSNW	GALAP	CHEAL	POLCO	VIOAR					
	weight of fresh matter in g per 1 m2	weight of fresh matter in g per 1 m2	weight of fresh matter in g per 1 m2	weight of fresh matter in g per 1 m2	weight of fresh matter in g per 1 m2	weight of fresh matter in g per 1 m2	dry matter in g	t.ha-1	F test	significant dif.
year 2000										
1	243,6	8,3	439,3	94,9	2,6	788,8	328,6	30,87	F= 47,17**	5% - 8,6
2	0,0	0,2	0,0	3,1	0,1	3,4	6,7	54,84		1% - 12,4
3	0,1	1,1	0,0	2,9	0,9	5,0	6,4	53,99		
year 2001										
1	575,7	318,4	57,2	147,3	36,8	1135,4	245,5	33,89	F= 15,32**	5% - 16,0
2	0,0	1,2	0,0	0,0	0,0	1,2	0,2	57,64		1% - 25,8
3	0,0	11,8	0,0	1,9	0,0	13,7	2,2	52,08		
year 2002										
1	1281,9	8,0	266,7	0,0	74,5	1631,1	359,7	31,36	F= 12,60**	5% - 19,1
2	155,6	2,4	86,3	0,0	8,0	252,4	50,5	58,05		1% - 27,4
3	65,7	0,3	0,0	0,0	2,7	68,7	9,6	59,14		
4	149,3	0,0	0,0	0,0	1,2	150,5	23,2	59,84		

Efficacy of metribuzine and linuron was significantly high in the years 2000 and 2001 and ranged between 98,8 and 99,6% in total weed-killing effect in both years. In the year 2001 an effect of clomazone was recorded, this active ingredient was applied in combinations with all preparations. Clomazone has specific efficacy against *Galium aparine*. Presence of *Galium aparine* was 318,4 g.m^{-2} on untreated control in the year 2001. Metribuzin has no effect on *Galium aparine*, i.e. the efficacy of 99,6% is a result of clomazone application. In the year 2002 the highest weed pressure or volunteer rape pressure was recorded, since its distribution in range of weed species was 78,6% in untreated control. In the conditions of such high intensity lower level of herbicide efficacy was found, namely against another weed species e.g. *Chenopodium album*, against which 100% of efficacy was recorded for metribuzin in the year 2000 with the presence of 439,3 g.m^{-2}, however, the efficacy was only 67,6% with the presence of 266,7 g.m^{-2} in the year 2002. Total efficacy against all weeds studied ranged between 84,5% (metribuzin) and 95,8% (linuron). The efficacy against volunteer rape was decisive, metribuzin displayed 87,8% of efficacy, linuron 94,8% and terbuthylazine + terbutryn 88,4%. These results do not fully correspond to the results of S o u k u p et al. (1998), who found the highest residual efficacy of metribuzin (100%) and terbuthylazine and terbutryn (86,5%) against volunteer rape in potatoes averaged over two years (1995-1996). From our results it is concluded that weather progress in given year has a strong effect on efficacy of applied compounds.

Weed infestation had statistically significant effect on reduction in tuber yield in all studied years. In the year 2000 the tuber yield was about 44% significantly lower (F=47,17**) in untreated control compared to the variant of metribuzin application (the highest yield was 54,8 t.ha^{-1}), in the year 2001 it was about 41% higher (F=15,32*) compared to the variant of metribuzin application (57,6 t.ha^{-1}) and in 2002 it was about 48% (F=12,60**) higher compared to the variant of terbuthylazine and terbutryn application (59,84 t.ha^{-1}). No statistically significant effect was found among variants of application. No statistically significant differences were recorded for dry matter content.

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COMBATEREA BURUIENILOR LA CARTOF ÎN REPUBLICA CEHĂ

Rezumat

Testele efectuate în câmp în perioada 2000-2002 au studiat efectul erbicidelor selectate asupra eficienței combaterii buruienilor și asupra parametrilor de producție și calitate ai cartofului. Experimentele au fost întreprinse pe un sol brun cu textură medie aparținând Stațiunii de Cercetare Valečov. S-a observat incidența a 5 specii de buruieni în loturile experimentale. Masa buruienilor verzi a fost măsurată în g/m^2 și s-a determinat masa următoarelor specii de buruieni: *Brassica napus* de iarnă, *Galium aparine*, *Chenopodium album*, *Polygonum convolvulus* și *Viola arvensis*. Au fost testați următorii ingredienți activi, folosind aplicarea cu clomazonă: metribuzin, linuron and terbutilazină cu terbutrin. *Brassica napus* a fost specia dominantă. Această buruiană a reprezentat 31% în 2000, 51% în 2001 și 79% în 2002 din totalul cantității de buruieni verzi din cultura martor netratată.. Masa totală a buruienilor la martorul netratat a fost de 788,8 g/m^2 în 2000, 1135,4 g/m^2 în 2001 și 1631,1 g/m^2 în 2002. Eficiența în combaterea buruienilor a erbicidelor testate a fost foarte mare în 2000 și 2001 (98,8 - 99,6%), în 2002 a fost mai scăzută din cauza gradului ridicat de infestare. Eficaciatea a fost de 84,5% (87,9% împotriva *Brassica napus* de iarnă) în cazul metribuzinei, 95,8% pentru linuron (94,9%) și 90,8% (88,4%) pentru terbutilazină cu terbutrin. Producția de tuberculi a fost semnificativ mai scăzută la variantele netratate; nu s-au observat diferențe semnificative în rândul ingredienților activi individuali. Reducerea producției (între varianta tratată cu erbicide având cea mai mare producție și martorul din varianta netratată) a fost de 44% în 2000, 41% în 2001 și 48% în 2002. Conținutul în substanță uscată măsurat după recoltare nu a fost afectat de tratamentul cu erbicide.

Cuvinte cheie: combaterea buruienilor; buruieni; erbicide; producție de tuberculi

Tabele:

1. Variante de tratamente cu erbicide preemergente;
2. Cantitatea de buruieni verzi/m^2 și producția de tuberculi.

MANA CARTOFULUI ŞI CONTROLUL ACESTEIA ÎN CONDIŢIILE SPECIFICE ZONEI BRAŞOV

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REZUMAT

Mana cartofului, produsă de ciuperca *Phytophthora infestans,* este cea mai distrugătoare boală a cartofului, producând pierderi de producţie foarte importante

Sunt necesare fungicide care să asigure o bună protecţie atât cantitativă cât şi calitativă a culturii de cartof. Din păcate, nici un fungicid disponibil la ora actuală nu asigură un control absolut al manei.

Condiţiile climatice in timpul atacul de mană sunt foarte importante.

În perioada 2001-2002 la ICDCSZ-Braşov a fost iniţiat un program de testare a unor fungicide din grupe chimice diferite.

S-a folosit soiul Sante, soi cu rezistenţă mijlocie la mană, având în vedere că 45% din suprafaţa cultivată cu cartof în România, la ora actuală este ocupată de acest soi.

Cuvinte cheie: *Phytophthora infestans*, fungicide, control, condiţii climatice

INTRODUCERE

Condiţii favorabile manei:

- Noaptea temperaturi nu mai scăzute de 7°C
- Temperaturile între 15 şi 21°C sunt cele mai favorabile pentru dezvoltarea leziunilor şi sporulare, în timp ce la temperaturi mai mari de 29°C patogenul nu se mai dezvoltă
- Perioada cu umiditate pe frunze (roua sau ploaie) peste 6 ore este favorabilă producerii de noi infecţii
- Perioadele cu umiditate pe frunze mai mult de 8 ore sunt foarte critice

În cazul infecţiilor severe ale culturii, tuberculii de sămânţă sunt purtătorii unei mari cantităţi de inocul în noul sezon agricol. (Louise R., Cooke, 1999)

2001 Precipitaţii (mm/m^2), Braşov

Perioada	Iunie	Iulie	August
Decada I	1,3 (2)*	30.0 (8)*	15,0 (2)*
Decada II	38.7 (5)	50,1 (3)	4,9 (1)
Decada III	40.0 (6)	1.5 (3)	48,3 (6)
Total lunar	80.0	81,6	68,2
Media multianuală	91,9	87,4	67,3
Diferenţa	-11,9	-5,8	+0,9

* = număr zile cu precipitaţii

2002 Precipitaţii (mm/m²), Braşov

Perioada	Iunie	Iulie	August
Decada I	24,4 (6)*	22,3 (4)	73,6 (6)
Decada II	18,3 (4)	32,0 (5)	38,6 (6)
Decada III	28,7 (3)	73,7 (9)	22,4 (2)
Total lunar	71,4	128,0	134,6
Media multianuală	91,9	87,4	67,3
Diferenţa	-20,5	+ 40,6	+76,3

* = număr zile cu precipitaţii

Începerea tratamentelor împotriva manei este influenţată de:

- **Presiunea de infecţie**
- **Sensibilitarea soiului cultivat**
- **Cresterea plantelor**
- **Condiţiile climatice existente**

MATERIAL ŞI METODĂ

Experienţele s-au făcut folosind soiul **Sante**, soi cu rezistenţă mijlocie la mană.

S-au plantat 5 rânduri a câte 20 plante în patru repetiţii randomizat.

În 2001 plantarea s-a făcut în 12 aprilie, iar în 2002 în 22 aprilie, pe un agrofond normal pentru cartoful de consum. Toate lucrările de întreţinere şi cele de control a gândacului din Colorado (3 tratamente în fiecare an) s-au efectuat normal.

Apariţie mană: 2001 – 3 iulie; 2002 – 24 iulie

Fungicidele luate în studiu în 2001 au fost: **Oxiclorura de cupru, Melody Duo, Ranman, Ridomil Gold şi Mancozeb.**

Fungicidele luate în studiu în 2002 au fost: **Folpet, Oxiclorură de cupru, Clorotalonil, Ranman şi Acrobat**.

S-au efectuat **tratamente**: 2001 - 21 iunie, 29 iunie, 5 iulie, 13 iulie, 20 iulie şi 27 iulie 2002 – 18 iunie, 1 iulie,15 iulie, 1 august.

S-a notat intensitatea atacului pe foliaj, folosind scare de notare pentru ***Phytophthora infestans (Mont.) de Bary*** (British Mycological Society; Anonymus 1947)

Intensitatea manei pe foliaj s-a apreciat cu note de la 1=lipsă atac, la 9=foliaj distrus.

Notări efectuate pe 20 plante/variantă:

I –11 iulie ; II – 18 iulie şi III – 1 august 2001

I – 30 iulie, II - 5 august şi III - 12 august 2002

La recoltare (septembrie) s-a notat şi s-a cântărit numărul tuberculilor mănaţi.

Trebuie menţionat că rezistenţa tuberculilor la mană, respectiv frecvenţa tuberculilor mănaţi, nu este în concordanţă cu rezistenţa foliajului. Frecvenţa tuberculilor atacaţi este în legătură directă cu lungimea perioadei în care ciuperca sporulează. Deci, un soi cu rezistenţă ridicată la foliaj este posibil să aibă mai mulţi tuberculi mănaţi decât un soi sensibil al cărui foliaj este distrus foarte rapid.

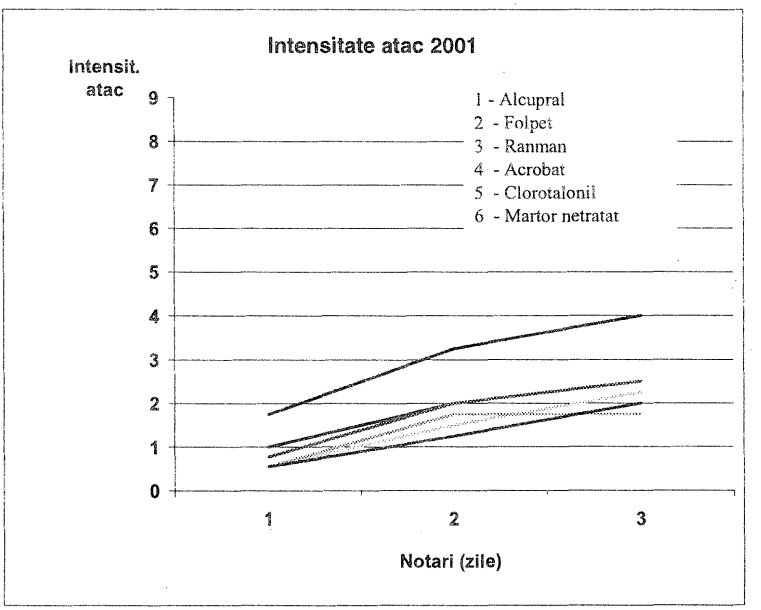
Productia de tuberculi depinde de repetabilitatea şi frecvenţa tratamentelor, deoarece soiurile –majoritatea- sunt mediu sensibile şi sensibile la mană.

REZULTATE ŞI DISCUŢII

În anul **2001** (figura 1) fungicidele s-au comportat aproximativ în aceeaşi manieră, intensitatea atacului fiind situată între 18-26% la toate variantele tratate. Martorul netratat a avut un procent mai mare de atac, de 40%.

La varianta pe care s-a aplicat fungicidul **Melody Duo (iprovalicarb)** atacul de mană a înregistrat cea mai mică creştere (20%), iar **Ridomil Gold Mz (metalaxyl)** din a doua jumătate a lunii august a întrerupt practic atacul de *Phytophthora infestans*, acesta situându-se la intensitatea de 18%, cea mai scăzută din întreaga experienţă.

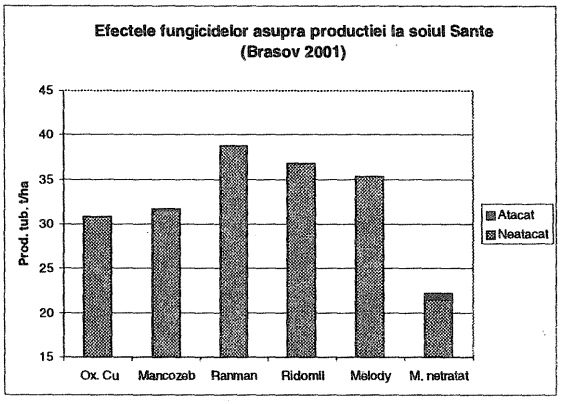
Mancozeb (mancozeb 80%) şi **Oxiclorura de cupru (copper oxide)** de la jumătatea intervalului (18 iulie) s-au comportat similar, iar **Ranman** a atins o intensitate de 22%.



Intensitatea atacului de mană pe foliaj -2001

Martorul netratat a înregistrat un maxim de atac de 40%.

În 2001 tuberculi mănaţi (tabelul 1) au fost găsiţi doar la două variante (Mancozeb şi Martor netratat). Nivelul foarte scăzut al atacului la tuberculi nu a determinat diferenţe între variante.



Efectul fungicidelor asupra producţiei de cartof -2001

În anul **2002** (figura 2) în primul interval de notare, mana a progresat lent, dar constant la toate variantele.

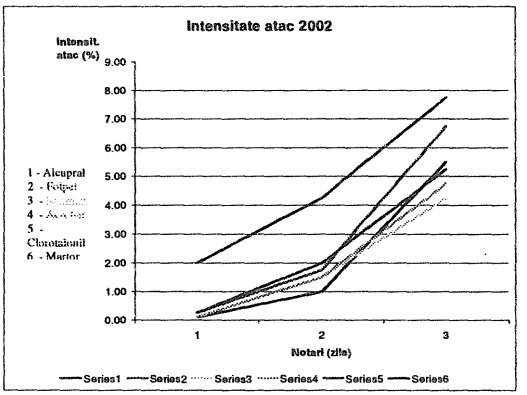
Departajarea a început practic în 5 august, când s-a produs o diferenţiere între produse. **Alcupralul (copper oxide)** nu a stopat o creştere rapidă a atacului, confirmând faptul că produsul este eficient la începutul perioadei de vegetaţie, în continuare fiind necesare alte substanţe active.

Folpetul (folpet), nepătrunzând în ţesuturile plantei nu protejează noile creşteri. Atacul înregistrat a fost relativ sever. Pentru a fi eficient sunt necesare intervale mai scurte între tratamente (7 zile) (A.R. Egan, A. Murray & S. 1996).

Clorotalonilul (chlorothalonil) s-a situat în jurul a 50-52% intesitate atac, ceea ce nu reprezintă potenţialul substanţei active (Schwinn, F.J., 1983).

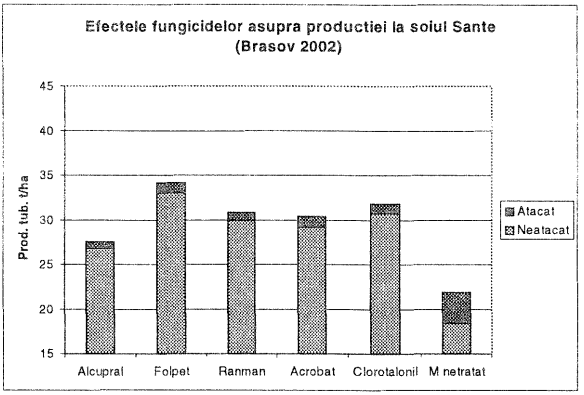
Bine şi foarte bine s-au comportat fungicidele **Acrobat (dimethomorph)**şi **Ranman (cyazofamid)**, având un nivel al intensităţii cuprins între 42-47%.

Martorul netratat a înregistrat o evoluţie ascendentă pe tot parcursul, ajungând la nivelul de 77-78%.



Intensitatea atacului de mană pe foliaj - 2002

Şi în anul 2002 (tabelul 2) diferenţele între variante privind tuberculii atacaţi nu au fost semnificative. Fenomenul se poate explica şi prin apariţia mai târzie a atacului de mană (24 iulie) şi prin rezistenţa soiului Sante la atacul manei pe tuberculi.



CONCLUZII

Este util să alegem produsele în funcţie de modul lor de acţiune, de presiunea de infecţie, de condiţiile de spălare şi de evoluţia culturii, în aşa fel încât să valorificăm atuurile fiecărei substanţe active, menţinând în acelaşi timp un cost rezonabil al tratamentelor.

Pentru a alege de manieră optimă produsele, sunt de reţinut câteva idei –cheie:

➢ Produsele de contact (ex: ditiocarbamaţii) sunt utile făcând raportul eficacitate/ preţ în perioadele cu presiune de infecţie slabă spre moderată.

➢ Produsele de contact (gen Brestan, Fluazinam) sunt de reţinut pentru protecţia tuberculilor.

➢ Interesul pentru produse translaminare (Acrobat, Tattoo C) este de subliniat în perioade cu spălări importante (ploi, irigaţii, furtuni).

➢ Produsele penetrante (pe bază de cymoxanil) permit stoparea contaminărilor recente (1-2 zile maxim).

➢ Produsele sistemice prezintă un interes în timpul fazei active de creştere a foliajului şi pentru stoparea contaminărilor mai vechi (maxim 3-4 zile).

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POTATO LATE BLIGHT AND ITS CONTROL IN SPECIFIC CONDITIONS OF BRASOV AREA

Abstract

The paper presents data regarding the control of late blight (*Phytophthora infestans*) using different fungicides in Braşov area.

Late blight caused by Phytophthora infestans is the most destructive disease of potato crops, causing important yield losses.

Effective fungicides are required to ensure quantity and quality of yield. Unfortunately, none of the fungicides available today gives absolute control of *Phytophthora.*

During 2002-2003 a test programme has been conducted in ICDCSZ Brasov plots for controlling *Phytophthora.*

We used Sante cultivar, which is cultivated by many farmers in Romania, aproximatively 45% of country surface and several fungicides, with different ingredients.

The 2001 year was not very suitable for observations regarding the influnce of *Phytophthora infestans* on foliage and yield damages.

The 2002 year was better for foliage observations concerning the influence of different fungicides.

The results are presented in a poster.

Keywords: *Phytophthora infestans,* fungicides, control, climatic conditions

Tables:

1. Fungicides effects on Sante yield production Braşov 2001
2. Fungicides effects on Sante yield production Braşov 2002

Figures:

1. Attack intensity of potato late blight 2001
2. Atack intensity of potato late blight 2002

NEW TRENDS IN POTATO GROWING USING DE-STONING TECHNOLOGY IN THE CZECH REPUBLIC

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SUMMARY

The technology of potato growing in the Czech Republic has been subjected to essential changes since the beginning of 1990s. New technological trends influence almost all the elements; most significant changes appear in soil preparation prior to crop establishment and in crop establishment. It is an essential shift from so-called conventional or classical technology towards technology of potato growing in stone-free ridges.

Destoning technology meant an important change for Czech potato growers. During last ten years it has been distributed into every agricultural enterprise specialized in intensive potato growing. In spite of high purchase costs, it brings an economic effect.

The results of trials performed at the Valecov Research Station of the Potato Research Institute Havlickuv Brod give evidence on advantages of soil cultivation using destoning technology. Presence of clods sized more than 20 mm in topsoil was markedly reduced compared to classical technology of soil preparation and clods more than 50 mm were not present in soil after separation. Post-planting and pre-harvest soil compaction was measured with digital penetrometer in spring and/or autumn. From results we can conclude reduction in soil compaction using destoning technology compared to classical technology. Increasing values of soil compaction were observed in classical technology from the depth of 120 mm, however using destoning technology soil compaction increased up to 240 mm. A large positive influence of the technology was found on porosity and soil volume weight; on the contrary, a negative influence was recorded for maximum capillary water capacity, immediate soil moisture and relative soil moisture. In other words we can say that soil remained loose for the whole growing period, however loose soil appeared to dry out compared to classical soil preparation. Tuber yield was not negatively influenced by this fact; it was increased by 12% averaged over four experimental years and three potato varieties. Lower mechanical damage was estimated for harvested tubers (i.e. mechanical damage up to the depth more than 5 mm) according to variety about 40-55%.

Surface application of commercial fertilizers within destoning technology is ineffective, since during furrowing and separation fertilizers are incorporated into the whole topsoil profile and large amount of nutrients is unavailable for potato plants. Local fertilizer application, particularly nitrogen application, at planting could be a solution.

This way allows reduction in nitrogen rate about 25-30% compared to classical "broadcasting". It is based on exact dosage and nutrient placement into root zone, what increases a possibility of plant nutrient utilization from fertilizer. Nutrient availability is also provided in dry season, when lack of soil moisture can hinder effective utilization of fertilizer applied on the soil surface. From incorporated nitrogen fertilizer, nitrogen slowly releases in soil and production of soil nitrate nitrogen is similar to using slow-release fertilizer and nutrient utilization is improved.

Keywords: potatoes; destoning; local fertilizer application; tuber yield

INTRODUCTION

The technology of potato growing in the Czech Republic has been subjected to essential changes since the beginning of 90s. New technological trends influence almost all the elements; most significant changes appear in soil preparation prior to crop establishment and in crop establishment. It is an essential shift from so-called conventional or classical technology towards technology of potato growing in stone-free ridges. Surface application of commercial fertilizers within destoning technology is ineffective, since during furrowing and separation fertilizers are incorporated into the whole topsoil profile and large amount of nutrients is unavailable for potato plants. Local fertilizer application, particularly nitrogen application, at harvest could be a solution.

MATERIAL AND METHOD

Technology of growing potatoes in stone-free ridges

This technology was developed in Scotland, where it is applied on 80% of areas. It was introduced into the Czech Republic at the beginning of 90s last century; according to our estimates more than 110 destoning devices are in operation there at present and they are used for establishment of approximately one third of potato crop areas. This technology is used by most growers in potato-growing region specialized in intensive potato growing on the area more than 80 hectares.

Technology of potato growing in stone-free ridges differs from the classical technology as regard as spring soil preparation and crop establishment. Leveling of soil surface and soil loosening in spring is not carried out. Potato crop establishment consists of three procedures. The first is furrow formation in the depth of 200-250 mm under initial soil surface in the width of double interrow distance i.e. mostly 1500 mm. The second one is stone and clod separation with separators and putting of small-sized and intermediate-sized stones and clods into the furrows. Separators with various construction

of sifting device are used i.e. band or star sifting device and/or combination. Large stones (more than 150 mm) are picked into the container, from which they are turned out at the end of the row. A sifted bed prepared for planting of two potato rows is formed in this way. This technique replaces spring soil cultivation using classical technology of soil preparation, especially loosening.

Technology of potato growing in stone-free ridges is mainly a solution for elimination of negative stone and clod influence in topsoil in potato growing. Presence of stones and clods sized more than 20 mm prevent even acting of active ingredient at herbicide application, stones complicate sprouting of potato plants, they are a potential cause of tuber deformation, they make difficult preparation of harvest and harvest. During harvest, transport and handling stones cause mechanical damage on potato tubers.

After introduction into the practice, excellent quality of soil preparation and good state of soil physical characteristics are shown to be significant indices for the whole growing period using this technology. Soils with quite low content of stones give evidence on utilization of destoning technology by several potato growers in early potato-growing region of the Czech Republic.

Using destoning technology there is not possible to carry out any post-planting cultural practice and weeds are only managed with herbicide application. In context of destoning, higher weed occurrence is recorded. Presence of weeds is not only connected with the fact that no mechanical cultivation is done, but also with the fact that due to deeper soil loosening more weed seeds come near soil surface and sprout. This technology puts higher demands on herbicide applications. A suitable choice of herbicides and reasonable applications could help to control weeds in potato crops established with destoning technology. Timing of treatment under favourable weather conditions and favourable soil status is important. Pre-emergence and post-emergence application is effective using suitable herbicide combinations based on present weed species.

Local fertilizer application at planting

Besides positive effects of growing potatoes in stone-free ridges on tuber yield and mechanical damage reduction, higher intensity of soil mineralization and nitrification procedures occurs, namely in the period, when potato plants are not able to fully utilized released nutrients. Putting of separated stones into the furrow is another acting factor. In this operation, stones have a positive effect on soil characteristics and compared to stone picking and/or stone crushing it is less energy consuming and reduction in topsoil profile does not occur. Putting the stones into the furrow, to a certain degree, means formation of drainage layer and in its surrounding, soil moisture relations and also soil nutrient movement are subjected to changes. It is necessary to take into account that traditional soil preparation causes fertilizer distribution up to the depth of 10-15 cm, destoning technology up to the depth of 25 cm and fertilizer concentration in the soil is reduced incl. the zone adjacent to tubers.

Local application of mineral fertilizers at planting, particularly nitrogen fertilizers, is a solution how to avoid nutrient loss and supply sufficient amount of mineral fertilizers for plants from early crop developmental stages. This way allows reducing nitrogen rate about 25-30% compared to classical "broadcasting". It is based on exact dosage and nutrient placement into root zone, what increases a possibility of plant nutrient utilization from fertilizer. Nutrient availability is also provided in dry season, when lack of soil moisture can prevent effective utilization of fertilizer applied on the soil surface. From incorporated nitrogen fertilizer, nitrogen slowly releases in the soil and production of soil nitrate nitrogen is similar like after using fertilizer with slow release. Nutrient utilization is also better.

In addition to use of solid mineral fertilizers, liquid fertilizers could also be applied. Local application is realized using adapters on the planter, which enables fertilizer incorporation in the optimum distance from tubers. Tank is placed on the front three-point hitch of the tractor. Knives for liquid fertilizer incorporation are fitted in the planter frame or special frame between three-point hitch of the tractor and the planter.

System of local application of mineral fertilizers at planting has an importance in potato growing. It could limit nutrient leaching on light loam sandy soils, which prevail in potato-growing regions. Risk of surface water and ground water contamination with nitrates is reduced, which is higher in potatoes than in other crops.

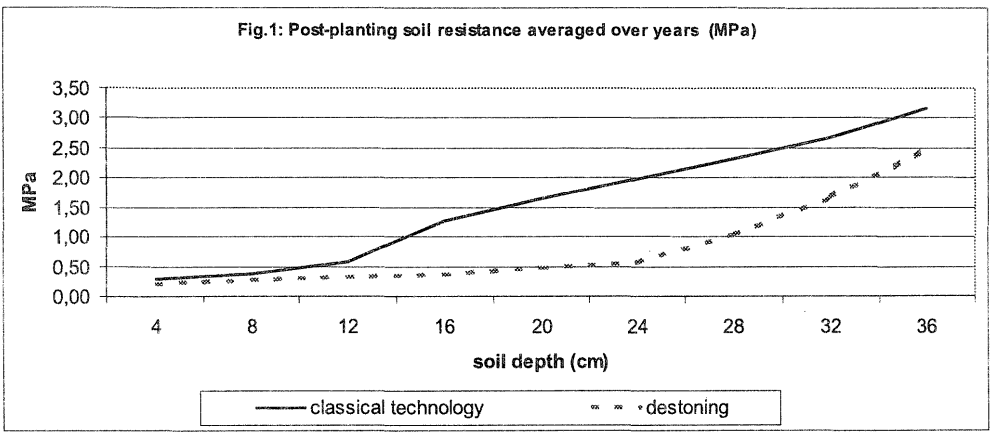
RESULTS AND DISCUSSION

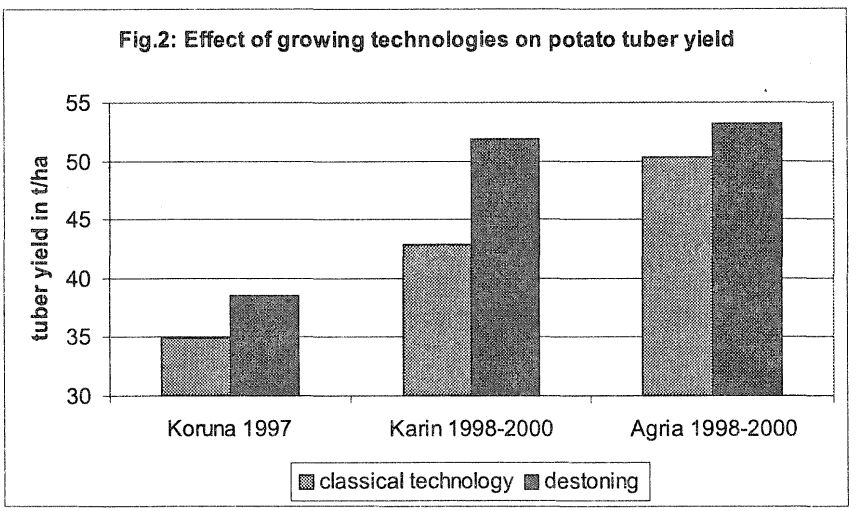
The results of trials performed at the Valečov Research Station of the Potato Research Institute Havlíčkův Brod give evidence on advantages of soil cultivation using destoning technology. Efficacy of destoning (i.e. percent of separated stones from the whole soil volume) ranged between 60 and 80% dependent on machine type (results of observation are reported in Tab. 1). Presence of clods sized more than 20 mm in topsoil was markedly reduced compared to classical technology of soil preparation and clods more than 50 mm were not present in soil after separation. Post-planting and pre-harvest soil compaction was measured with digital penetrometer (Fig. 1) in spring respect. autumn. From results we can conclude reduction in soil compaction using destoning technology compared to classical technology. Increasing values of soil compaction were observed in classical technology from the depth of 120 mm, however using destoning technology soil compaction increased up to 240 mm. A large positive influence of the technology was found on porosity and soil volume weight; on the contrary, a negative influence was recorded for maximum capillary water capacity, immediate soil moisture and relative soil moisture. In other words we can say that soil remained loose for the whole growing period, however loose soil appeared to dry out compared to classical soil preparation. Tuber yield was not negatively influenced by this fact; it was increased by 12% averaged over four experimental years and three potato varieties (Fig. 2). In literature, a yield increase about 33% is reported. Lower

mechanical damage was estimated for harvested tubers (i.e. mechanical damage up to the depth more than 5 mm) according to variety about 40-55%.

Tab. 1: Efficacy of stone separation

Observation year	Type of sifting bodies of separator	Efficacy of de-stoning in %
1996	band	61
1997	band	75
1998	star	68
1999	star	77
2000	star	79





CONCLUSIONS

Destoning technology meant an important change for Czech potato growers. During last ten years it has been distributed into every agricultural enterprise specialized in intensive potato growing. In spite of high purchase costs, it brings an economic effect. The technology has a significant influence on soil physical characteristics. A positive effect was found on porosity, soil volume weight and soil compaction. Reduction in topsoil stone content and reduction in clod content, in particular clods sized above 20 and 50 mm, is an advantage of the technology Tuber yields, percent of marketable tubers are significantly increased, tuber mechanical damage is decreased. Further growing measures need to be adapted for destoning technology, especially commercial fertilizer application. Technology of local fertilizer application at planting allows exact nutrient placement into the positions optimal for plant uptake and achieving of higher yields in existing technology of pre-planting surface application of mineral fertilizers. Elimination of surface run-off of nutrients is another advantage of this technology. Nutrients are in ready state in the soil, environmental loading is avoided, and rate of applied nutrients can be reduced about a third.

NOI TENDINȚE ÎN CULTIVAREA CARTOFULUI PRIN UTILIZAREA TEHNOLOGIEI DE ELIMINARE A PIETRELOR

Rezumat

Tehnologia de cultivare a cartofului a fost subiectul a mai multor schimbări esențiale în Republica Cehă de la începutul anilor 1990. Noile tendințe tehnologice influențează aproape toate elementele; cele mai semnificative schimbări au loc în domeniul pregătirii solului înaintea înființării culturii și în înființarea culturii. Este o schimbare esențială de la așa numita tehnologie convențională sau clasică spre tehnologia de cultivare a cartofului în biloane fără piatră.

Tehnologia de eliminare a pietrelor a însemnat o schimbare importantă pentru cultivatorii cehi de cartofi. În ultimii 10 ani, această tehnologie a fost distribuită la fiecare întreprindere agricolă specializată în cultivarea intensivă a cartofului. În ciuda costului de achiziționare ridicat, tehnologia aduce profit financiar.

Rezultatele experimentelor desfășurate la Stațiunea de Cercetare Valecov din cadrul Institutului de Cercetare a Cartofului Havlickuv Brod, atestă avantajele cultivării solului prin tehnologia de eliminare a pietrelor. Prezența bulgărilor mai mari de 20 mm în straturile superioare ale solului a fost redusă simțitor în comparație cu tehnologia clasică de pregătire a solului, iar după formarea biloanelor, bulgării mai mari de 50 mm nu mai erau prezente. S-a determinat gradul de compactare a solului după plantare și înainte de recoltare, cu ajutorul unui penetrometru digital, în timpul primăverii și/sau toamnei. Din rezultatele obținute, putem analiza reducerea compactării solului folosind tehnologia de eliminare a pietrelor în comparație cu tehnologia clasică. Valori crescute ale compactării solului au

fost observate la tehnologia clasică de la adâncimea de 120 mm, iar pentru tehnologia nouă, compactarea solului a început de la adâncimea de 240 mm. O influență pozitivă importantă a acestei tehnologii a fost observată asupra porozității și masei volumetrice de sol; în schimb, s-a înregistrat o influență negativă în privința capacității maxime de apă capilară, în privința umidității imediate a solului și a umidității relative a solului. Cu alte cuvinte, putem spune că solul a rămas afânat pe întreaga perioadă de vegetație, însă solul afânat s-a uscat mai repede decât în cazul pregătirii clasice a solului. Producția de tuberculi nu a fost influențată negativ de acest fapt ci a crescut cu o medie de 12% în timpul celor 4 ani de experimentare și la cele 3 soiuri. S-a estimat un grad mai mic de vătămare mecanică pentru tuberculii recoltați (adică o vătămare mecanică mai mare de 5 mm), în funcție de soi, de aprox. 40-55%.

Aplicarea îngrășămintelor chimice de suprafață în cadrul tehnologiei moderne de eliminare a pietrelor este ineficientă, deoarece în timpul efectuării brazdelor și al separării, îngrășămintele sunt incorporate în toată masa solului și o mare cantitate de îngrășăminte nu mai este disponibilă pentru planta de cartof. Aplicarea locală a îngrășmintelor, în special aplicarea de N la plantare, ar putea fi o soluție.

Această modalitate permite reducerea aplicării de N cu aprox. 25-30% în comparație cu metoda clasică. Ea are la bază o dozare și o plasare exactă a îngrășămintelor în zona rădăcinilor, ceea ce dă posibilitatea plantei de a folosi elementelor nutritive din îngrășământ. Elementele nutritive sunt astfel disponibile și în sezonul uscat, când lipsa umezelii solului poate împiedica folosirea îngrășămintelor aplicate pe suprafața solului. Din îngrășământul cu azot încorporat, azotul este eliberat încet în sol, producția de nitrat este similară ca în cazul folosirii îngrășămintelor cu eliberare încetinită, iar folosirea nutrienților se îmbunătățește.

Cuvinte cheie: cartof, eliminare a pietrelor, aplicare de îngrășăminte, producție de tuberculi.

Tabele:

1. Eficiența sfărâmării pietrelor

Figuri:

1. Rezistența solului după plantare – media pe mai mulți ani.(Mpa);
2. Efectele tehnologiilor de cultivare asupra producției de tuberculi.

TEHNOLOGII MODERNE DE CONSERVARE A CARTOFULUI

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REZUMAT

Cerinţele tehnologice şi de calitate impuse cartofului pentru consum şi celui destinat prelucrării industriale necesită adoptarea unor tehnologii de depozitare moderne, nepoluante, ieftine şi uşor accesibile. Lucrarea vizează stabilirea condiţiilor tehnice de aplicare a unor noi metode neconvenţionale de păstrare: tratamente cu inhibitori naturali. Astfel de cercetări au mai fost efectuate cu ani în urmă în special în Olanda, având ca principal inhibitor carvona, extrasă din seminţele mature de Carum carvi.

S-au efectuat tratamente cu uleiuri extrase de la 3 specii de plante medicinale şi aromatice (chimion - Carum carvi L., mentă - Mentha crispa L. şi mărar - *Anethum graveolens* L.). Experienţele s-au derulat în depozitul de cercetare al ICDCSZ Braşov. Tratamentele s-au aplicat în a doua parte a perioadei de păstrare, după ieşirea din repaus a tuberculilor. S-au folosit 4 soiuri de cartof (Roclas, Romano, Sante şi Desiree) care au fost tratate cu fiecare din cele 3 extracte naturale. S-a urmărit influenţa tratamentelor asupra pierderilor prin încolţire, pierderilor în greutate şi a pierderilor totale.

Cele mai bune rezultate s-au obţinut prin folosirea uleiului volatil extras din chimion, cu o reducere în medie de 56,25% a pierderilor prin încolţire şi de 48,86% a lungimii colţilor la toate soiurile comparativ cu varianta martor. Toate soiurile de cartof au reacţionat favorabil la aplicarea tratamentelor, nivelul pierderilor fiind însă specific fiecărui soi în parte.

Cuvinte cheie: cartof, păstrare, iradiere, uleiuri volatile, pierderi, încolţire.

INTRODUCERE

În general se păstrează aproximativ 2/3 din producţia de cartof obţinută, doar o treime fiind utilizată imediat. Pe lîngă valorificarea în stare proaspătă, cartoful a cunoscut în ultimul timp, în special în ţările dezvoltate, o puternică diversificare a formelor de prelucrare precum şi a formelor de prezentare (Niculescu, 1990). Pornind de la tendinţele ce au câştigat teren tot mai mult în ceea ce priveşte aplicarea metodelor nepoluante pentru păstrarea produselor horti-viticole şi prelungirea acestei perioade în scopul asigurării populaţiei cu produse proaspete o perioadă cât mai lungă de timp, am iniţiat această cercetare pentru a găsi formula cea mai bună şi în cazul cartofului.

Prin pornirea în vegetaţie a mugurilor dorminzi de pe suprafaţa tuberculului, se produce o depreciere calitativă şi cantitativă a produsului, ceea ce duce la pierderi

însemnate pe perioada depozitării. Încolțirea masivă a cartofilor în depozit creează serioase probleme prin pierderile fiziologice mărite, favorizarea dezvoltării bolilor și nu în ultimul rând prin greutățile provocate la manipularea tuberculilor în momentul valorificării. Problematica este la fel de importantă pentru micul producător, pentru marile unități cultivatoare de cartof din țară, ca și pentru depozitele de cartof (Donescu, 1998).

În contextul intrării țării noastre în Comunitatea Europeană, reducerea contaminării produselor prin eliminarea tratamentelor cu substanțe chimice dăunătoare, menținerea calităților culinare și tehnologice concomitent cu încadrarea în normele unei agriculturi ecologice, durabile, pledează pentru utilizarea metodelor moderne, nepoluante, de conservare și de prelungire a duratei de păstrare a cartofilor.

Combaterea încolțirii se realizează cu mijloace chimice sau fizice. Dintre mijloacele fizice, iradierea cu raza gamma a fost cel mai mult experimentată, obținându-se până în prezent o serie de rezultate notabile în acest sens. Tehnologiile de conservare prin iradiere s-au dovedit a fi cele mai satisfăcătoare procedee, la care, în urma a peste 40 de ani de cercetare și investigații științifice, s-a dovedit caracterul inofensiv al produselor alimentare tratate cu radiații ionizante, utilizându-se cu precădere iradierea gamma cu sursa Co^{60}. Riscurile utilizării unei surse nucleare de mare putere precum și necesitatea unor construcții de protecție voluminoase și costisitoare a impus extinderea cercetărilor pentru găsirea altor soluții: iradierea cu raze ultraviolete, electroni accelerați, tratarea în atmosferă de ozon, etc., mai ieftine, ușor de implementat într-un flux tehnologic de depozitare a cartofului, cu consum minim de energie (Cramariuc și colab., 2002).

Substanțele chimice utilizate în prezent sunt eficiente pe o durată de 6 - 7 luni de la aplicare, dar prezintă o serie de dezavantaje: alterarea gustului, reziduuri potențial toxice în produs, modificarea aspectului tuberculilor, poluarea mediului înconjurător.

Se prefigurează astfel perspectiva utilizării inhibitorilor naturali, de tipul S-carvonei, substanță conținută în uleiurile volatile ale unor plante medicinale sau aromatice cultivate sau din flora spontană. Cercetări întreprinse în Olanda evidențiază efectul de reducere a încolțirii fără afectarea calităților culinare și tehnologice a tuberculilor de cartof, în condițiile conservării la temperaturi mai ridicate (8–12°C) precum și un efect antifungic în cazul unor boli de depozitare (HARTMANS și colab., 1994, DIEPENHORST și colab., 1993, GORRIS și colab., 1993, OOSTERHAVEN și colab., 1992).

MATERIAL ȘI METODĂ

În cadrul obiectivelor propuse, pentru prelungirea perioadei de păstrare a cartofului în depozit au fost utilizate uleiurile volatile obținute din plantele medicinale și aromatice din culturile autohtone. S-au utilizat câteva tipuri de uleiuri volatile stabilite anterior pe baza studiilor și a documentării. Este vorba despre uleiul volatil obținut în urma distilării prin antrenare cu vapori de apă a materialului vegetal proaspăt, provenit de la speciile *Mentha crispa L.* și *Anethum graveolens L.*, sau a fructelor aflate la maturitatea deplină ca în cazul speciei *Carum carvi L.* Uleiurile sunt în majoritatea cazurilor, lichide limpezi,

incolore sau colorate, cu miros aromat, caracteristic de obicei componentei principale şi cu gust arzător.

Menthae Aetheroleum (ulei volatil de *Mentha crispa L*)

Mentha crispa L. este un chenotip al speciei *Mentha piperita*, care se caracterizează prin prezenţa ca şi component principal al uleiului volatil a carvonei (60%), linalolului, acetat de linalil, limonen, cineol. Uleiul volatil utilizat în experimentul nostru obţinut prin distilare în anul 2003, este clar, limpede, transparent, de culoare galben auriu, cu miros caracteristic şi pregnant de carvonă şi o uşoară nuanţă de mentol.

Carvi Aetheroleum (ulei volatil de *Carum carvi L.*)

Carum carviL. este o specie aromatică şi medicinală, cu un conţinut bogat în ulei volatil atât în herba proaspătă în stadiul de « fructe la maturitatea în lapte », cât şi în fructele aflate în stadiul de maturitate fiziologică. Uleiul volatil utilizat în experimentul nostru a fost obţinut prin distilarea fructelor mature provenite din cultivarea populaţiei omologate «De Ghimbav » în anul 2003. Se prezintă sub forma unui lichid limpede, clar, transparent şi uşor gălbui, cu miros caracteristic, având un conţinut de carvonă de 50-60% şi limonen 40%.

Anethum Aetheroleum (ulei volatil de *Anethum graveolens L.)*

Anethum graveolens L. este o specie aromată şi medicinală care prezintă atât în herba cât şi în fructele ajunse la maturitate, un conţinut de 40-60% carvonă. Uleiul volatil utilizat în experimentul nostru este limpede, transparent, de culoare galben - pai, cu miros caracteristic obţinut prin distilare (Farmacopeea română, Ed. a X-a).

Materialul biologic vegetal

Ca material biologic vegetal au fost utilizate patru soiuri de cartof : ROCLAS, ROMANO, SANTE, DESIREE. Cartofii au fost recoltaţi la maturitatea deplină din culturi înfiinţate în câmpul experimental al ICDCSZ Braşov, la care s-au aplicat în timpul vegetaţiei toate tratamentele recomandate pentru combaterea bolilor şi dăunătorilor. După recoltare materialul a fost sortat, calibrat şi introdus la păstrare în depozitul experimental, separat pe soiuri. In timpul depozitării au fost menţinuţi parametrii recomandaţi pentru o conservare de calitate (temperatura 4–6°C, umiditatea relativă a aerului 85–90%, ventilaţie normală, condiţii de întuneric).

Metoda de lucru

Tratamentul cu uleiuri volatile, provenite de la diferite plante, pentru inhibarea încolţirii cartofilor în timpul păstrării, a fost executat în condiţii de depozit. Aplicarea s-a efectuat în a doua parte a perioadei de păstrare, când pe baza determinărilor făcute s-a ajuns la concluzia că soiurile au ieşit din repaus şi tuberculii de cartof se află în stadiul de iniţiere a încolţirii. S-au format probe egalizate în săculeţi care au fost amplasaţe în containere de metal (oţel inoxidabil). Tratamentul s-a realizat cu câte un dispozitiv electric dispersor

de aerosoli (fig. 1). Dispersarea uleiurilor volatile s-a făcut în şase reprize, a câte 30 minute, în 24 ore, cu ajutorul unui ceas programator electric, astfel încât în fiecare container s-a administrat o doză de 0,16 ml ulei volatil / zi, ceea ce corespunde unui consum de 0,007ml ulei volatil / kg / 24 ore.

La începutul experimentului temperatura din spaţiul de păstrare a fost ridicată la cca 12°C, cu ajutorul unui calorifer electric, pentru a se creea condiţii de favorizare a încolţirii naturale. Parametrii de temperatură şi umiditate au fost urmăriţi zilnic. Temperatura medie înregistrată a fost de 12°C cu o variaţie redusă. Umiditatea relativă a aerului s-a menţinut în jurul valorii de 95%. Pentru eliminarea condensului containerele au fost aerisite zilnic.

Durata tratamentului a fost de cca 2 luni (17 februarie – 12 martie), tratamentul fiind aplicat pentru ultima perioadă de păstrare, când tuberculii încep să încolţească masiv în depozit datorită creşterii temperaturii şi ieşirii acestora din repausul vegetativ.

S-au constituit următoarele variante de lucru aplicate similar la cele 4 soiuri de cartof luate în studiu.:

V_0 - Martor -netratat cu ulei volatil ;

V_1- ulei volatil de *Mentha crispa L. ;*

V_2- ulei volatil de *Carum carvi L. ;*

V_3- ulei volatil de *Anethum graveolens L.*

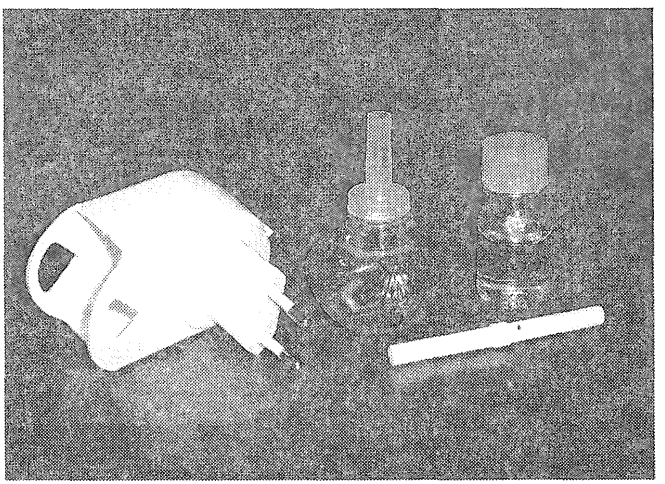


Fig. 1. Dispozitivul dispersor de aerosoli

Observaţiile şi măsurătorile referitoare la încolţire s-au efectuat la scoaterea din depozit, dată care a coincis la Braşov cu perioada optimă de plantare a cartofului. Rezultatele au fost prelucrate statistic prin analiza varianţei bifactorială, iar comparaţia diferitelor tratamente, în medie şi pe soiuri s-a realizat prin testul Duncan.

REZULTATE ŞI DISCUŢII

Lungimea colţilor a fost puternic influenţată de soiul de cartof. În cazul variantelor martor, la soiurile Sante şi Desiree s-au înregistrat cei mai lungi colţi, respectiv 27,8 şi 32,3 cm. Semnificativ mai redusă a fost lungimea colţilor la soiul Romano (16 cm), iar la soiul Roclas media lungimii colţilor a fost doar de 12,2 cm (tabelul 1).

Lungimea colţilor a fost semnificativ mai redusă la toate variantele tratate. În medie acest parametru a fost cel mai puternic inhibat de uleiul volatil de chimion (*Carum carvi*). Prin acest tratament lungimea colţilor a fost redusă cu cca 53% faţă de martorul netratat (22,1 cm). Prin folosirea uleiurilor volatile de *Mentha crispa* şi *Anethum graveolens* lungimea colţilor a fost de cca 13 cm, acestea fiind mai reduse cu 43–41% faţă de martor.

Reacţia soiurilor la tratmentele cu uleiuri volatile a fost diferită. Soiurile cu lungimea colţilor mai redusă, Roclas şi Romano, la care lungimea colţilor la martorul netratat a fost de 12,2 şi 16,0 cm, prin tratamentul aplicat s-a constatat o reducere a lungimii colţilor de cca 40%, neexistând diferenţe semnificative între tratamente. La soiurile cu încolţire puternică, Sante şi Desiree, la care în varianta netratată s-au înregistrat colţi cu lungimi maxime de 27,8 şi 32,3 cm, prin tratmentele cu uleiuri volatile inhibarea a fost mai energică şi mai diferenţiată. Prin tratarea cu ulei volatil de *Carum carvi* lungimea colţilor s-a redus cu 55% la soiul Santé şi cu 62% la soiul Desiree, reduceri semnificativ mai mari decât cele înregistrate prin folosirea uleiurilor volatile de *Mentha crispa* şi *Anethum graveolens* (44-54%)

Tabelul 1

Efectul tratamentelor cu diferite uleiuri volatile asupra lungimii colţilor în timpul păstrării

Var.	Tratamentul	Lungimea colţilor									
		ROCLAS		ROMANO		SANTE		DESIREE		Media	
		cm	Test Duncan	cm	Test Duncan	cm	Test Duncan	cm	Test Duncan	cm	Test Duncan
1	Martor netratat	12,2	DE	16,0	CD	27,8	B	32,3	A	**22,1**	**A**
2	Mentha crispa	7,5	F	10,7	EF	17,5	C	15,2	CD	**12,7**	**B**
3	Carum carvi	7,7	F	10,7	EF	12,6	DE	12,3	DE	**10,8**	**C**
4	Anethum graveolens	8,8	EF	12,5	DE	15,7	CD	15,0	CD	**13,0**	**B**
Media		9,0	c	12,5	b	18,4	a	18,7	a	**14,7**	

$DI\ 5\%_{(soi)} = 2,8$ cm
$DI\ 5\%_{(tratament)} = 1,8$ cm
$DI\ 5\%_{(soi * tratament)} = 3,6$ cm

Pierderile prin încolţire (greutatea colţilor, care practic se rup şi se îndepărtează în cursul operaţiilor de condiţionare – prelucrare a cartofilor) la variantele netratate sunt semnificativ mai mari la soiurile Sante şi Desiree (în medie 4,1-4,7%), faţă de soiurile Roclas şi Romano (în medie 2,8-2,3%) (tabelul 2).

Prin tratamentele cu uleiurile volatile reducerea medie a pierderilor față de variantele netratate este de 1,2–2,1%, diferențele între variante fiind la prag de semnificație.

Diferențe semnificative între diferitele uleiuri volatile s-au constatat numai la soiul Sante la care, prin folosirea uleiului volatil de chimion (*Carum carvi*), pierderile datorate colților s-au redus la 3,3%, față de 5,5% la martorul netratat. La celelalte soiuri studiate nu s-au înregistrat diferențe semnificative datorate tipului uleiului volatil folosit.

Tabelul 2

Efectul tratamentelor cu diferite uleiuri volatile asupra greutății colților în timpul păstrării

Var.	Tratamentul	% greutate colți									
		ROCLAS		ROMANO		SANTE		DESIREE		Media	
		cm	Test Duncan	cm	Test Duncan	cm	Test Duncan	cm	Test Duncan	cm	Test Duncan
1	Martor netratat	3,9	CD	2,9	EFG	5,5	B	6,9	A	**4,8**	A
2	Mentha crispa	2,5	FGH	2,2	GH	3,7	CDE	3,8	CDE	**3,0**	BC
3	Carum carvi	2,2	GH	1,7	H	3,3	DEF	3,7	CDE	**2,7**	C
4	Anethum graveolens	2,4	EFG	2,4	FGH	4,1	CD	4,5	C	**3,6**	B
Media		2,8	b	2,3	b	4,2	a	4,7	a	**3,5**	

DI $5\%_{(soi)} = 0,8\%$

DI $5\%_{(tratament)} = 0,4\%$

DI $5\%_{(soi * tratament)} = 0,8\%$

Pierderile totale. Tratamentele aplicate au avut efecte favorabile în sensul reducerii acestora la toate soiurile și variantele, comparativ cu martorul netratat (tabelul 3).

La soiul Roclas prin folosirea uleiurilor volatile extrase din cele trei plante, s-a înregistrat reducerea pierderilor totale cu cca 2%, neînregistrându-se diferențe semnificative între variante. Reducerea pierderilor totale a fost mai energică la soiul Sante, la care prin folosirea uleiurilor volatile de mentă și chimion, pierderile totale s-au redus de la 13,4% la 9,7- 9,9%. La soiul Desiree, reducerea pierderilor totale a fost cea mai puternică. Prin folosirea uleiurilor volatile s-au micșorat pierderile de la 15,1% la 10,2–11,9%, pierderile cele mai mici înregistrându-se la varianta care s-a tratat cu ulei volatil de mentă.

Diferențele între soiuri apar mai evident la analiza graficelor reprezentând pierderile înregistrate la tuberculii de cartof tratați cu uleiuri volatile în timpul păstrării (fig. 2). Astfel, încolțirea a fost mai puternică la soiul Desiree, comparativ cu a celorlalte soiuri, soi care este în general mai sensibil la păstrare. Celelalte soiuri au avut pierderi mai reduse. Dintre uleiurile folosite, uleiul de chimion a avut efectul cel mai bun, încolțirea variantelor tratate cu acest ulei fiind cea mai redusă.

Structura generală a pierderilor este în mică măsură influențată de tratamentul aplicat. Efectul asupra încolțirii este evident și influențat de soi și în mai mică măsură de natura uleiului folosit. Cel mai bun efect l-a avut uleiul de chimion, urmat de uleiul de mentă.

Tabelul 3

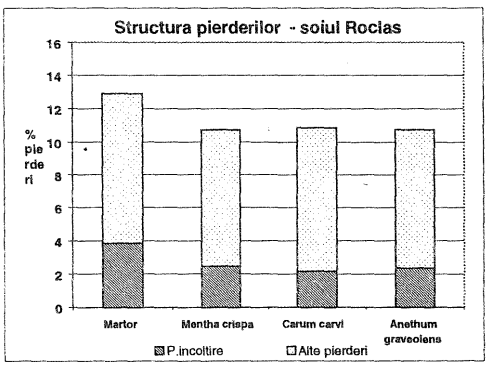
Efectul tratamentelor cu diferite uleiuri volatile asupra pierderilor totale în timpul păstrării

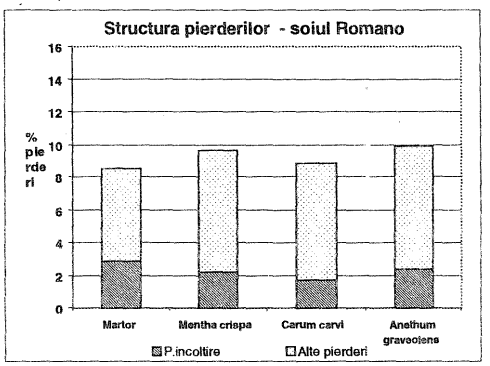
Var.	Tratamentul	% pierderi totale									
		ROCLAS		ROMANO		SANTE		DESIREE		Media	
		cm	Test Duncan	cm	Test Duncan	cm	Test Duncan	cm	Test Duncan	cm	Test Duncan
1	Martor netratat	12,9	ABC	8,5	E	13,4	AB	15,1	A	**12,5**	**A**
2	Mentha crispa	10,7	CDE	9,6	DE	9,7	DE	10,2	DE	**10,0**	**B**
3	Carum carvi	10,8	CDE	8,8	E	9,9	DE	11,9	BCD	**10,3**	**B**
4	Anethum graveolens	10,7	CDE	9,9	E	13,4	AB	11,9	BCD	**11,5**	**A**
Media		11,2	A	9,2	b	11,6	a	12,3	a	**11,7**	

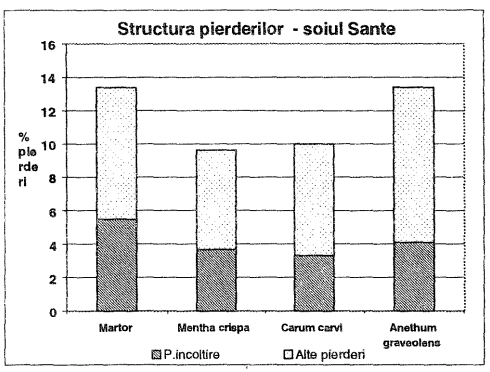
DI $5\%_{(soi)} = 1,1\%$

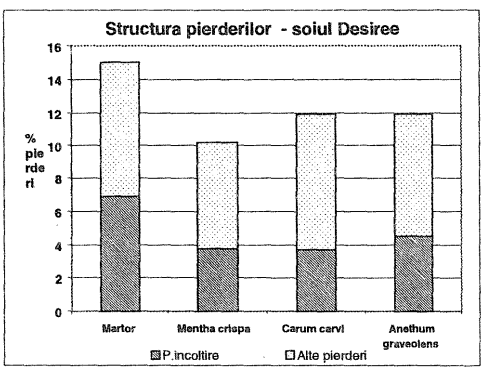
DI $5\%_{(tratament)} = 1,1\%$

DI $5\%_{(soi * tratament)} = 2,2\%$









CONCLUZII

- Tratamentul aplicat asupra tuberculilor de cartof depozitaţi a avut efectele scontate : reducerea încolţirii tuberculilor în timpul păstrării şi posibilitatea menţinerii lor neîncolţiţi pe o durată mărită, în condiţii de temperatură ridicată (12°C).

- Toate uleiurile folosite au avut efect favorabil, cel mai bun fiind uleiul de chimion (conţinut de S-carvonă cca. 60%).

- Nivelul pierderilor prin încolţire a fost influenţat de soiul de cartof.

- Posibilitatea păstrării cartofilor la temperatură mărită (peste 12°C) are efect favorabil asupra calităţii produselor industrializate (chips, pommes-frites, etc) prin micşorarea conţinutului de zaharuri reducătoare din tuberculi.

- Tratarea cartofilor cu uleiuri volatile nu afectează calităţile culinare şi tehnologice a tuberculilor şi nu diminuează valoarea lor alimentară.

- Folosirea uleiurilor naturale, extrase din plante medicinale şi aromatice, ca înlocuitori ai inhibitorilor chimici utilizaţi în mod curent pentru reducerea încolţirii şi creşterea duratei de păstrare a cartofilor, contribuie la diminuarea poluării produselor, îmbunătăţirea calităţii şi încadrarea în cerinţele agriculturii ecologice.

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MODERN TECHNOLOGY FOR POTATO STORAGE

Abstract

Technological and quality requirements imposed upon table potato and those destined to industrial processing demand adopting the modern technology of storage, unpolluted, cheap, easy of access.

This paper intends to establish the technical conditions to apply new, unconventional methods of storage: applications with natural sprout inhibitors. Similar research have been done years ago in Netherlands, having as main inhibitor carvone, extracted from mature caraway seed (*Carum carvi)*.

Application were done with oils extracted from three different medicinal and essential plants (*Carum carvi* L., *Mentha crispa* L., *Anethum graveolens* L.,). The experiments were done on ICDCSZ Braşov research storage. The application were made on the second part of storage period, after sprouting of potato tubers. Four different potato cultivars were used (Roclas, Romano, Sante, and Desiree) which were treated with each natural extract. The influence of application upon losses due to sprouting, upon weight losses and total losses were followed.

The best results were obtained using the oil of caraway seed. Sprouting losses were diminished with an average of 56.25%, and the lenght of sprouts with 48.86%. These results were similar for all cultivars comparatively with the control. The potato cultivars responded favourably to application and the level of losses was specific to each cultivar.

Keywords: potato, storage, essential oil, losses, sprout.

Tables:

1. Effect of essential oils application on the lengh of sprout during storage.
2. Effect of essential oils application on sprout weight during storage.
3. Effect of essential oils application on total losses during storage.

Figures:

1. Device for aerosol scatter.
2. Structure of losses during storage of potato varieties treated with essential oils.

RESEARCHES CONCERNING THE ECONOMIC IMPACT OF BT TECHNOLOGY UTILIZATION IN POTATO CULTURE IN ROMANIA

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SUMMARY

The present work represents a start-up for the scientific and economic literature in Romania since it shows the partial results concerning the economic efficiency of the genetically modified crops against the classic technology for potatoes.

In the case of this crop, there is a high level of high profitability due to the cost savings related to differential technologies (savings in Regent, in the case of potatoes).

Keywords: genetically modified plants, classic technology, RR technology, fix costs, variable costs, monovariable functions.

INTRODUCTION

The economic efficiency of cultivating GM crops (GMC's) represents a complex issue which has a multitude of influence factors. In principle, the economic efficiency (E) (or the profitability degree or level) on the farm's gate for a certain agricultural product is function of two variables:

E = f (V,C,),

where:

V – incomes (turnover) from the product's sale;

C – costs generates by the product's release;

The two independent variables, V and C, on their turn, as absolute values are depending on the price (p), sold quantity (Q_v), unit costs (c), and the harvested and sotred quantity (Q_r), meaning:

$V = p \times Q_v$

$C = c \times Q_r$

If the traded quantity is equal to the harvested quantity (when the entire harvest is sold), the ideal situation for the farmer, then the profit volume he records is:

$$P = Q\ (p-c)$$

RESULTS AND DISCUTIONS

From the previous formula we can observe that the factor **product quantity (harvest) Q_v** is very important for the profit volume and for the profitability degree (efficiency) of the farm. Therefore the "market" element by its "demand" component is determinant for the GM crops.

From here we can withdraw a first conclusion important for the farmers: **the GM crops profitability depend both on factors internal to the farm (cultivating technology) but also to external factors – market demand and price.**

The attractivity for the farmers on introducing GM crops depends therefore on the **crop economic advantages,** compared to the conventional crops (PC), but also on the **technological facilities** of cultivating GMC's comparative to the conventional crops as well as the guarantee for the farmers that the genetically modified harvest can be sell under conditions that can offer a competitive price. Certainly, that the guarantee of obtaining sure incomes by selling GM products does not depend on the farmer primarily but especially on the market (national, international and EU trade regulations), the interest or the refuse of the customers for food containing GMC's raw materia, the processors' demand for GMO's, the price volume of the GMO's compared to the PC's, the customers' attitude towards GMC's etc.).

Stimulating or not stimulating the farmers to cultivate GMC's is another important factor for the GMC's efficiency which depends mainly on the politic (attitude) of the governments and international bodies concerning the extension, the limitation or the exclusion of the GMC's from farming. In those countries where feeding the animals with fodder that contains GM maize and soybean, the market can extend and the farmers will be interested to cultivate breeds of GM maize and soybean. By difference, in those states where the policy towards the GMC's is restrictive, by granting primes for the agricultural products which are not GM, the farmers will not be attracted to introduce and cultivate and extend these crops. In many countries, and firstly in the European Union member states, the legislation demands expressively the conservation of the origin and of the identity of the GM harvests.

Conserving the identity and the origin, labelling the GM products, as referred in the literature, includes extra costs in trading which amounts 5-25 Euro/t (4–20 $/t), meaning 6-17% from the production costs at the farm's gate.

The customers' reserve and not only their can be explained by the inertial system (sometimes excessively high) in assimilating new products based on revolutionary methods. It is sufficient to recall the opposition has recoded the maize hybrids introduction or the tetraploid beet obtained my genetic mutations employing colchicines from the farmers' side, but also of many "scientists" from agriculture, even in the field of genetics and plant breeding.

The resistance reaction on employing food products originating from GMC's or animals feed with GM maize or soybeans have many explanations, but mainly relays on four reasons:

- Insufficient explanation of the genetic modification mechanism and its involvement over the human and animal body;
- The strong aversive "commercial" reaction from the side of the conventional seed multiplication companies and input producers (herbicides, insecticides) employed in conventional cultivating technologies, including the participation to this process of the so

called political or civic and ecological forces which are motivated rather by financial or material reasons than a scientific one (many of these claimed ecological movements have nothing to do with ecology or biology, generally speaking);

- The GMO's obtained by agro-bio-technological methods in public or private companies (laboratories) dealing with research and production, are submitted to new severe accreditation and screening rules compared with the conventional breeds. Also, the accreditation of the living agro-bio-technological products is more complicated and strict compared with the accreditation of the agrochemicals or mechanical means for agriculture. In many countries, including Romania, GMC's cannot be assimilated to the BIO products (or ecological products), while certain chemicals employed in cultivation are assimilated to the BIO crops (Romanian Government Decision no. 49–2000).

The reasons described above have an important influence both on the **demand** of GM agricultural products and, implicitly, over the **price**. Under such circumstances, the GMC's harvests do not have yet a **certain market** and the **prices** of these products are **not yet comparable** with those of the conventional products. But, the above mentioned elements are estimations as in Romania, as well in the main part of the East European countries there is no market for the GM products and we have no possibility to quantify (monitor) the market related to the GM products.

Regarding the costs of the **agricultural GM products** today we have observations form the experimental fields for GM Bt potatoes from the Banat's University of Agricultural Sciences Timişoara.

The analysis of the cost variance for the GMC's and non-GMC's is realised by the **analysis of the comparable costs (fix costs)** and by **differentiate costs (variable costs).**

Even if the year 2000 was severely unfavourable for the potatoes, especially in the Banat's plane in the un-irrigated area, due to the serious drought, we still have the possibility to estimate certain aspects concerning the production costs based on the recorded experimental data for this crop at the Research Facility Farm of the Banat's University of Agricultural Sciences Timişoara.

The variable costs which differentiate the costs for the two breeds are referring to the insecticides for Colorado beetle control and mechanical works required to complete the chemicals application. For the Colorado beetle control two treatments were employed (300.000 lei/ha, 13,6 USD/ha) with Regent (0,2 l/ha; 340.000 lei/ha, 15,5 USD/ha). The total expenditure for the conventional potatoes were higher with 851.700 lei/ha, respectively 38,7 USD/ha, representing + 10,5% compared to the Bt potatoes. Over passing the expenditures for the conventional potatoes with 851.700 lei/ha originates, as we mentioned, 340.000lei/ha consumption of Regent (40%), 300.000 lei/ha mechanical treatment (35%) and 211.700 lei/ha common expenditure (indirect) (25%).

On the country level, where about 250.000 ha are cultivated with potatoes, employing the Bt seeding material, evaluates the Regent economy at around 3,9–4,0 million USD, and the other connected expenditure at about 5,8–6,0 million USD, meaning a total of 9,7–10,0 million USD on Romania's scale.

Table 1. Production costs for the Bt and conventional potatoes (Lei/ha)

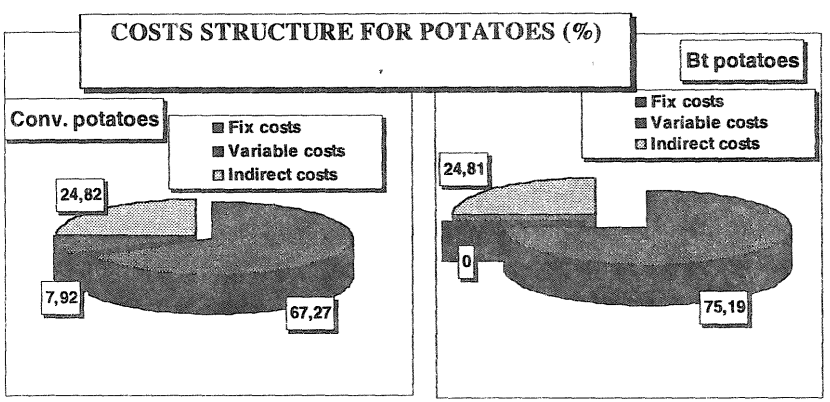
Description	Breeds		$D_{2/1}$
	Ostara	Bt Potatoes (1)	
Fix costs	5.437.800	5.437.800	-
- mechanical works	**2.521.000**	**2.521.000**	-
- manual works	**1.380.000**	**1.380.000**	-
- materials	**1.536.800**	**1.536.800**	-
Variable costs	640.000	-	-640.000
- mechanical works	**300.000**	-	**-300.000**
- materials	**340.000**	-	**-340.000**
Direct costs	6.077.800	5.437.800	-640.000
Indirect costs (social and other taxes)	2.006.000	1.794.300	-211.700
Total expenditure	8.083.800	7.232.100	-851.700

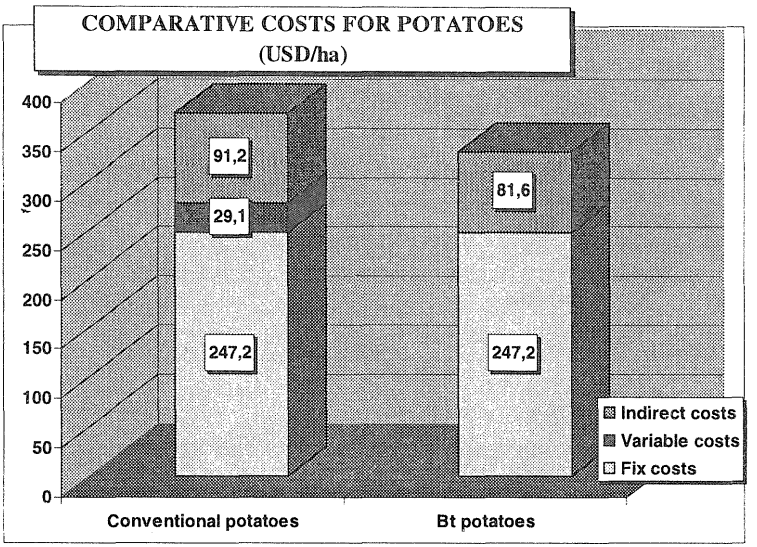
Source: Authors' research

Table 2. Production costs for the Bt and conventional potatoes (USD/ha)

Description	Breeds		$D_{2/1}$
	Ostara	Bt potatoes (1)	
Fix costs	247,2	247,2	-
- mechanical works	**114,7**	**114,7**	-
- manual works	**62,7**	**62,7**	-
- materials	**69,8**	**69,8**	-
Variable costs	29,1	-	-29,1
- mechanical works	**13,6**	-	**-13,6**
- materials	**15,5**	-	**-15,5**
Direct costs	276,3	247,2	-29,1
Indirect costs (social and other taxes)	91,2	81,6	-9,6
Total expenditure	367,4	328,7	-38,7

Source: Authors' research





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CERCETĂRI PRIVIND IMPACTUL ECONOMIC AL TEHNOLOGIEI BT FOLOSITĂ ÎN CULTURA CARTOFULUI DIN ROMÂNIA

Rezumat

Lucrarea de față reprezintă un lucru inedit pentru literatura științifică și economică din România, deoarece se expun rezultatele parțiale privind eficiența economică a culturilor modificate genetic în comparație cu tehnologia clasică de cultivare a cartofului.

În cazul acestei culturi, există un nivel ridicat de profitabilitate datorat reducerii cheltuielilor cu diferite tehnologii (economisire la Regent, în cazul cartofilor).

Cuvinte cheie: plante modificate genetic, tehnologie clasică, tehnologie RR, costuri fixe, costuri variabile, funcții monovariabile.

Tabele

1. Costuri de producție pentru cartofii convenționali și Bt (Lei/ha)
2. Costuri de producție pentru cartofii convenționali și Bt (USD/ha)

Figuri

1. Structura costurilor la cartof (convențional și Bt) (%)
2. Costuri comparative la cartof (USD/ha)

ECONOMY OF POTATO PRODUCTION IN THE CZECH REPUBLIC

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SUMMARY

Potatoes belong to crops with demanding growing from financial, organizational and technological viewpoints. Assessment of potato growing economy is strongly affected by development of potato areas, total production, realization prices in individual growing years, potato import and export etc.

Besides intensity and market assessment of production, total level of costs (cost rate) is the main precondition of grower's success in potato production. For determination of total costs we can use model calculation consisting of following items:

- seed cost
- fertilizer cost (commercial fertilizers and farmyard manure)
- chemical protection cost
- cost of foreign subject services
- wage cost
- machinery variable costs (fuels, spare parts, repairs)
- other variable costs
- fixed costs (production and administration overheads, depreciation, taxes, rent...)

Calculation of total costs results from so-called managerial approach of economy, which is particularly focused on direct (variable) costs, directly allocating to growing of certain crop, in this case potatoes. In next stage indirect (fixed) costs are calculated, which remain unaltered with volume of production.

In general, we can say that with yield increase cost rate per 1 ton of product decreases, although total costs per hectare increase.

For economical assessment of potato production results of economical analyses of management of selected agricultural enterprises from 1997-2002 were used. However, they only present a small part of potato areas in the Czech Republic. Therefore results of sample survey of agricultural enterprise cost rate in FADN CZ net. were included for comparison. Potatoes ranked among profitable crops in studied years – total costs per hectare and per ton of potatoes were increased, however, mean yielding level was 25,2 $t.ha^{-1}$ and realization prices were increased about 7%. Rate of profitability of potato

growing in selected growers ranged between 19,3 and 35,7%, potatoes could be considered interesting and profitable marketable crop in given years. Potato production was always assessed as a whole, since most selected enterprises produced table, seed, starch and unmarketable potatoes.

Assessment of cost development and structure of chemical potato pest control is a part of the presentation. Protection against weed infestation, stem canker, insect (aphids, Colorado potato beetle etc.), especially a set of control measures, which allows to protect tops and tubers against potato late blight, is most important. Levels of chemical protection costs considerably differ in dependence on utility type of potato growing, weather conditions, ecological site conditions, variety assortment etc. In years with high infection pressure of fungal diseases, costs of chemical protection increase and cause potato production too expensive. Underestimation of potato protection often depreciates not inconsiderable efforts and costs expending by potato growers for achieving expected production and its application on the market.

Keywords: economy, total costs, gross margin, rate of profitability, chemical protection costs

INTRODUCTION

Potato areas have sharply decreased due to large variations in realization prices of agricultural products in the Czech Republic during recent period. Beginning 1990s potato growing area ranged between 100 and 110 thousand hectares, while in 2003 it was only 43 480 hectares (35 984 hectares for agricultural sector, 7 496 hectares for households, by the Czech Statistical Institute). For determination of current state of potato industry in the Czech Republic it was necessary to analyze economic results of potato growing in last years (1997–2002). Only then, trends in development of production intensity, realization prices, total costs per hectare and per ton of production (unit costs), potato production profitability etc. can be measured. Potatoes belong to crops with demanding growing from financial, organizational and technological viewpoints. Assessment of potato growing economy is strongly affected by development of potato areas, total production, realization prices in individual growing years, potato import and export etc. Assessment of cost development and structure of chemical potato protection against pests is a part of the presentation. Levels of chemical protection costs considerably differ in dependence on utility type of potato growing, weather conditions, ecological site conditions, variety assortment etc. Underestimation of potato protection often depreciates not inconsiderable efforts and costs expending by potato growers for achieving expected production and its application on the market.

MATERIAL AND METHOD

Besides intensity and market assessment of production, total level of costs (cost rate) is the main precondition of grower's success in potato production. For determination of total costs we can use model calculation consisting of following items:

- seed cost
- fertilizer cost (commercial fertilizers and farmyard manure)
- chemical protection cost
- cost of foreign subject services
- wage cost
- machinery variable costs (fuels, spare parts, repairs)
- other variable costs
- fixed costs (production and administrative overheads, depreciation, taxes, rent...)

Calculation of total costs results from so-called managerial approach of economy (calculation method of "gross margin"). It is particularly focused on direct (variable) costs, directly allocating to growing of certain crop, in this case potatoes. In next stage indirect (fixed) costs are calculated, which remain unaltered with volume of production. All calculations result from the price level of inputs and production in the year 2002. The calculation method of gross margin differs in estimate of calculation of farmyard manure (FYM) production in comparison with conventional calculations; all costs associated with FYM production and field application are costs of animal production. Value of manure produced in animal production (in CZK) is distributed in the whole crop rotation, so it does not charge only crops with direct application of FYM (in this case potatoes). Further difference from conventional calculations we can find in evaluation of own production. Only market prices are always calculated both in harvested production and evaluation of own seed. Therefore using own seed it is necessary to calculate a price, for which own seed could be realized on the market.

A hectare of agricultural land was determined as a unit of calculation for estimation of fixed costs. Other calculations could result from estimation of level of variable costs, in such case potatoes are often excessively charged with fixed costs compared to other crops.

In general we can say that cost rate per ton of product declines with growth of yields, although total costs per hectare are increased.

The aim of the assessment of cost development and structure of chemical potato protection against pests was economical expression of costs of potato protection against major pests, share in variable and total costs per hectare of potatoes in selected potato growers during 1997–2002. Own six-year results of economical analyses of selected agricultural enterprise management were included in the assessment and they were compared with published results of State Phytosanitary Administration (output reviews).

RESULTS AND DISCUSSION

For economical assessment of potato production results of economical analyses of management of selected agricultural enterprises from 1997-2002 were used. However, they only present a small part of potato areas in the Czech Republic. Therefore results of sample survey of agricultural product cost rate in FADN CZ net. are included for comparison.

Table 1. Economy of potato production of selected potato growers (CZK.ha^{-1})

Potato area (ha)	1102,6	1217,3	1063,2	1038,1	1225,0	1408,9
Year	1997	1998	1999	2000	2001	2002
Direct (variable) costs						
Seed	16 768	19 837	20 945	21 773	20 912	27 129
Fertilizers	4 263	5 041	4 097	5 595	5 937	5 896
Chemical protection	5 162	6 970	6 792	7 176	9 170	9 555
Services of foreign subjects	3 393	6 786	7 531	6 310	7 032	3 974
Insurance	527	389	385	472	248	352
Variable machinery costs	5 383	5 350	4 973	5 646	6 419	7 315
Labour costs	9 426	9 556	13 343	7 675	9 064	8 308
Other direct costs	6 456	10 254	8 411	5 944	7 548	5 462
Total direct costs	**51 378**	**64 182**	**66 477**	**60 591**	**66 330**	**67 990**
Indirect-fixed costs						
Real estate tax	320	320	395	405	337	330
Depreciations	1 934	927	1 041	651	1 663	3 122
Production overheads	1 276	993	1 055	949	902	1 199
Aministrative overheads	1 504	2 613	1 850	2 544	2 406	2 892
Premium	211	126	105	72	48	44
Total indirect costs	**5 244**	**4 978**	**4 445**	**4 621**	**5 355**	**7 587**
Total costs	**56 622**	**69 160**	**70 922**	**65 212**	**71 685**	**75 577**
Yield (t)	22,70	25,97	22,04	28,72	26,08	26,21
Average realization price	3 385	3 573	3 968	2 708	3 430	3 626
Costs per ton of production	**2 494**	**2 663**	**3 218**	**2 270**	**2 748**	**2 884**
Rate of profitability (%)	35,7%	34,2%	23,3%	19,3%	24,8%	25,7%

From assessment of selected potato producers following conclusions could be drawn:

1/ growth of average realization price of potatoes by 7% to 3 626 CZK.t^{-1}, growth of average stated potato production per hectare by 15% to 26,2 t.ha^{-1} i.e. growth of total sales (incl. subsidies) per hectare of potatoes by 29% to 99 412 CZK

2/ growth of direct costs per hectare of potatoes by 32%, total costs per hectare by 34% and per ton of potatoes by 16% to 2 884 CZK

3/ balance of sales – total costs was positive in all years studied, rate of profitability of growing ranged between 19,3 and 35,7%

4/ value of gross margin was increased by 23% to 31 422 CZK

5/ potato production was always assessed as a whole, since most selected enterprises produced table, seed, unmarketable and also starch potatoes

6/ studied potato area ranged between 1 038 and 1 409 ha, number of selected enterprises between 10 and 13, potato area of individual growers varied between 5 and 250 hectares

Given results only illustrate low number of potato growers in the Czech Republic. For general overview it is possible to present results of surveys on cost rate of late table potato production in FADN CZ net, performed by Research Institute of Agricultural Economics Prague.

Table 2. Results of sample survey on potato production cost rate in FADN CZ (CZK.ha^{-1})

Cost item	1997	1998	1999	2000	2001	2002
	CZK	CZK	CZK	CZK	CZK	CZK
Direct (variable) costs						
Seed (purchased + own)	10 517	13 216	13 600	14 827	16 710	19 070
Fertilizers (purchased + own)	3 691	3 575	3 155	3 037	4 296	3 925
Chemical protection	4 780	5 111	4 953	5 528	6 444	7 717
Variable machinery costs	8 563	7 847	8 724	8 545	7 940	10 763
Labour costs	13 582	14 408	12 658	12 862	15 719	14 664
Other direct costs	5 595	5 716	5 769	5 916	8 164	5 512
Total direct costs	**46 728**	**49 873**	**48 859**	**50 715**	**59 273**	**61 651**
Indirect-fixed costs						
Material fixed assets depreciations	2 049	2 051	2 570	2 743	6 092	2 410
Production overheads	7 654	6 805	7 250	6 908	4 875	6 354
Administrative overheads	2 435	3 152	3 747	3 254	2 994	4 717
Total indirect costs	**12 138**	**12 008**	**13 568**	**12 906**	**13 961**	**13 481**
Total costs (ÚVN)	**58 866**	**61 881**	**62 427**	**63 621**	**73 234**	**75 132**
Yield (t)	**23,38**	**25,64**	**22,14**	**26,29**	**28,27**	**24,85**
Average realization price	2 353	2 501	2 943	3 106	2 971	3 300
Costs per ton of production	2 518	2 413	2 819	2 420	2 591	3 023
Profit (loss) per ton of production	-165	88	123	686	380	277
Total price of production in CZK	53 547	64 513	61 057	59 759	65 028	64 319
Sold quantity	22,76	25,79	20,75	19,24	21,89	19,49
Rate of profitability (%)	**-9,04%**	**4,25%**	**-2,19%**	**-6,07%**	**-11,21%**	**-14,39%**
Number of enterprises	123	117	111	101	85	87

Source: Cost rate of agricultural products 1997, 1998, 1999, 2000, 2001,2002.

From FADN CZ survey on potato production cost rate, following conclusions could be drawn:

1/ growth of average realization price of potatoes by 40% to 3 300 CZK.t^{-1}, growth of average stated potato production per hectare by 6% to 24,9 t.ha^{-1} resulting in growth of production price per hectare of potatoes by 20% to 64 319 CZK

2/ growth of direct costs per hectare of potatoes by 32%, total costs per hectare by 28% and per ton by 20% to 3 023 CZK

3/ late table potatoes were surveyed in respondents using double-entry bookkeeping

4/ number of surveyed (tested) enterprises was significantly higher, i.e. 85 – 123

5/ total price of production in CZK includes sold quantity of table potatoes multiplied by average realization price

6/ negative rate of profitability of late table potato growing is recorded in all years studied.

Table 3. Costs of chemical protection of potatoes in selected agricultural enterprises

Year	Total potato ha	Costs of chemical protection of potatoes in CZK.ha^{-1}					
		Herbicides	Fungicides	Insecticides	Desiccants	Other	Total
1997	1 107	1 018	2 353	399	1 092	17	4 879
1998	1 217	1 497	2 911	462	1 291	43	6 205
1999	1 063	1 385	2 912	506	1 453	438	6 693
2000	1 038	1 466	3 307	583	1 241	674	7 270
2001	1 225	1 383	4 342	649	1 808	972	9 153
2002	1 409	2 079	4 392	735	1 555	793	9 555
Average	**1 177**	**1 471**	**3 369**	**556**	**1 407**	**490**	**7 293**
		Percentage of individual components of chemical protection					
1997	1 107	20,9	48,2	8,2	22,4	0,4	100,0
1998	1 217	24,1	46,9	7,4	20,8	0,7	100,0
1999	1 063	20,7	43,5	7,6	21,7	6,6	100,0
2000	1 038	20,2	45,5	8,0	17,1	9,3	100,0
2001	1 225	15,1	47,4	7,1	19,7	10,6	100,0
2002	1 409	21,8	46,0	7,7	16,3	8,3	100,0
Average	**1 177**	**20,5**	**46,3**	**7,7**	**19,7**	**6,0**	**100,0**

In studied period, costs of chemical protection were increased from 4 879 CZK per hectare in 1997 to 9 555 CZK in 2002, i.e. growth by 96%. From individual cost items the most important were fungicide costs (46,3%) and herbicide costs (20,5%), followed by desiccant (19,7%), insecticide (7,7%) and other chemical (6,0%) costs.

Table 4. Costs of chemical protection of potatoes according to SPA (output reviews)

Year	Total potato ha	Costs of chemical protection of potatoes in CZK.ha^{-1}					
		Herbicides	Fungicides	Insecticides	Desiccants	Other	Total
1997	69 316	1 025	1 218	171		24	2 438
1998	66 099	989	1 435	256		21	2 701
1999	68 729	1 005	1 492	344		54	2 895
2000	67 102	1 193	1 603	394		104	3 294
2001	54 290	1 277	2 116	253		104	3 751
2002	35 509	1 346	2 290	282		138	4 057
*since 1997 SPA has included herbicides and desiccants in one item							
Average	**60 174**	**1 139**	**1 692**	**283**		**74**	**3 189**
		Percentage of individual components of chemical protection					
1997	69 316	42,04%	49,96%	7,01%		0,99%	100,00%
1998	66 099	36,63%	53,14%	9,46%		0,77%	100,00%
1999	68 729	34,70%	51,56%	11,88%		1,86%	100,00%
2000	67 102	36,22%	48,66%	11,96%		3,17%	100,00%
2001	54 290	34,06%	56,42%	6,75%		2,77%	100,00%
2002	35 509	33,19%	56,44%	6,96%		3,41%	100,00%
Average		**36,14%**	**52,70%**	**9,00%**		**2,16%**	**100,00%**

Data of State Phytosanitary Administration (SPA) involve costs of chemical protection of potatoes on the whole potato area in the Czech Republic. In contrast to small group of potato growers, mentioned in Table 3, data of SPA are general and summarize all treated potato areas in given year regardless intensity and volume of production, specialization, level of chemical protection etc. Therefore cost items are lower compared to specialized potato producers. Since 1997, SPA data have included herbicide and desiccant costs in one cost item; that is why share of herbicide costs is higher than mentioned in Table 3.

Table 5. Share of costs of chemical potato protection in direct and total costs of potato growing

Year	Total potato ha	Direct costs in CZK.ha^{-1}	Total costs in CZK.ha^{-1}	Costs of protection in CZK.ha^{-1}	Share protection in direct costs in %	Share protection in total costs in %
1997	1 107	45 789	50 742	4 879	10,65	9,61
1998	1 217	52 768	57 169	6 205	11,76	10,85
1999	1 063	52 410	57 237	6 694	12,77	11,70
2000	1 038	53 416	57 217	7 270	13,61	12,71
2001	1 225	60 988	65 423	9 153	15,01	13,99
2002	1 409	67 990	75 577	9 555	14,05	12,64
Average	1 177	55 560	60 561	7 293	12,98	11,92

Share of chemical protection costs in direct and/or total costs per hectare of potatoes increases to average 12% of total costs in studied period. Increasing intensity of potato production, costs per hectare of potatoes (incl. protection costs) also increase. However, it is significant that unit costs (per ton of potatoes) gradually decrease.

From sample of potato growers, 75% of potatoes are grown using technology of de-stoning, 25% are grown under conventional technology. Average costs of chemical protection were 9 555 CZK per hectare in 2002 and they did not record substantial differences according to applied technology of potato growing. From own study, dependence of cost level of chemical potato protection on applied technology of growing could not be evidenced.

CONCLUSIONS

In general it is concluded that increase of production intensity and realization price of potatoes was found in recent years (1997–2002); however, this increase is not sufficient for covering growth of input prices (growth of total costs per hectare and per ton of potatoes). Considering comparable costs of growing 1 hectare of potatoes, home production with low average hectare yield after conversion to 1 ton of potatoes requires about 25-30% higher costs compared to EU countries.

In recent years, we can observe growth of costs of chemical potato protection due to price growth of chemicals, services, machinery for pesticide applications and also increasing level of chemical protection. This growth is compensated by higher production intensity, so unit costs are decreased. For example, yield growth by 1,29 t.ha^{-1} should be necessary for average realization price of 3 626 CZK.t^{-1} in 2002 for this compensation.

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ECONOMIA PRODUCȚIEI DE CARTOF ÎN REPUBLICA CEHĂ

Rezumat

Cartoful face parte din culturile cu cerințe mari din punct de vedere financiar, organizațional și tehnologic. Evaluarea economiei cultivării cartofului este influențată puternic de dezvoltarea suprafețelor cu cartof, de producția totală, de prețul de producție în zonele de cultivare individuală, de importul și exportul cartofului etc.

Alături de evaluarea cantitativă și de piață a producției, nivelul total al cheltuielilor (rata de cost) este principala premiză pentru succesul cultivatorului de cartof. Pentru determinarea costului total, putem folosi un model de calcul cu următoarele elemente:

- costul materialului de plantat;
- costul îngrășămintelor (chimici și organici - gunoi de grajd);
- cheltuieli cu protecția pe cale chimică;
- cheltuieli cu lucrările prestate de terți;

- cheltuieli cu salariile;
- cheltuieli variabile cu mecanizarea (combustibil, piese de schimb, reparații);
- alte costuri variabile;
- cheltuieli fixe (taxe cu producția și administrația, devalorizări, taxe, chirii etc.).

Calculul cheltuielilor totale rezultă din așa numita abordare managerială a economiei, care se axează în special pe costurile directe (variabile), alocate direct cultivării unei anumite culturi, în acest caz cea a cartofului. În următoarea etapă sunt calculate cheltuielile indirecte (fixe), cele care rămân aceleași indiferent de volumul producției.

În general, putem spune că o dată cu creșterea producției, rata de cost la 1 tonă de produs descreşte, deşi cheltuielile totale la hectar cresc.

Pentru evaluarea economică a producției de cartof s-au folosit rezultate ale analizelor economice ale managementului din anumite întreprinderi agricole, în perioada 1997-2002. Cu toate acestea, aceste date reprezintă doar o mică parte din suprafața de cultivare a cartofului din Republica Cehă. De aceea, au fost incluse rezultatele unui studiu al ratei de cost dintr-o întreprindere agricolă din rețeaua FADN CZ net. Cartoful s-a situat printre culturile profitabile în anii studiați – cheltuielile totale la ha și la tonă au fost ridicate, însă nivelul mediu de producție a fost de 25,2 $t.ha^{-1}$ iar prețul de producție a crescut cu aprox. 7 %. Rata de profitabilitate a cartofului la cultivatorii incluși în studiu s-a situat între 19,3 and 35,7 %; cartoful poate fi considerat, astfel, o cultură de interes și profitabilă în anii studiați. De fiecare dată, producția de cartof a fost luată ca și întreg, de vreme ce majoritatea întreprinderilor studiate produc atât cartofi de consum cât și pentru sămânță, pentru fabricarea amidonului și cartofi necomercializabili.

Evaluarea evoluției costurilor și structura combaterii pe cale chimică a dăunătorilor fac parte din acest studiu. Protecția împotriva atacului buruienilor, al râiei comune, al insectelor (afide, gândacul din Colorado etc.), în special un set de măsuri de combatere care să permită protejarea foliajului și a tuberculilor împotriva manei, toate acestea sunt foarte importante. Nivelul cheltuielilor cu protecția chimică diferă considerabil în funcție de destinația culturii de cartof, de condițiile de climă, de condițiile specifice zonei ecologice, de soi etc. În anii cu presiune ridicată de infecție cu boli fungice, cheltuielile cu protecția chimică cresc și determină producții prea scumpe de cartof. Subestimarea necesarului de substanțe de protecție anulează adesea eforturile și cheltuielle destul de mari făcute de cultivatori pentru realizarea producției dorite și pentru comercializarea ei.

Cuvinte cheie: economie, cheltuieli totale, rată de profitabilitate, cheltuieli cu protecția culturii

Tabele:

1. Economia producției de cartofi la cultivatorii incluși în studiu ($CZK.ha^{-1}$)
2. Rezultatele studiului asupra ratei de cost a producției de cartof în FADN CZ ($CZK.ha^{-1}$)
3. Cheltuielile cu protecția chimică a cartofului în întreprinderile agricole studiate
4. Cheltuielile cu protecția chimică a cartofului conform SPA (revizuirea rezultatelor)
5. Cota deținută de cheltuielile cu protecția chimică în cadrul costurilor directe și al costurilor totale ale cultivării cartofului.

ACTUAL SITUATION OF POTATO IN EUROPE

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SUMMARY

In 2003, potato has been grown on 19.2 million hectares with a total production of 311.4 million tonnes in the world.

In comparison with the positive evolution of potato in the last decade (1993-2003) on the world level (increase of area with 5.5 %, increase of total production with 3.5%, increase of trade with 2.6%), there has been recorded a negative situation in Europe (decrease of area by 17%, decrease of production by 24%, decrease of yield by 8%, decrease of seed potato used by 20%, but a positive situation regarding the trade of potato (increase of quantity with 15% and increase of value of trade with 33%. The highest decrease has been recorded in the group of ten countries (Czech Republic, Cyprus, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia and Slovenia) which became members of the EU since May 1st: approx. 52% of area, 59% of production, approx. 47% of seed potato used and 80% of export.

For the forst time in the last ten years, Europe has lost the world supremacy reagrding area and production of potato.

There is a big gap regarding the level of potato yield between the groups of the countries in Europe: around 30 to/ha in the EU-15 (with over 40 to/ha in the United Kingdom, The Netherlands, Denmark, followed by France and Germany with nearly 40 to/ha), approx. 17 tonnes/ha in the EU-10 and approx. 11 to/ha in the Russian Federation.

The main factors which can improve the potato yield in the Central and Eastern Europe countries, including the Russian Federation, are the following: concentration of potato crops in bigger farms, using of healthy (certified) seed potato, improvement of technology level, development of potato processing. A strong help for the development of potato industry in the central and East-European countries could come from the EU-15 + EU-10 countries, by training of the young scientists and technical staff (farmers).

Keywords: potato area, production, yield, trade, seed potato, variety

INTRODUCTION

The precise time that potato was first used in cultivation is unknown, but it is thought to be some 7 to 10,000 years ago in the region of Lake Titicaca of Peru/Bolivia (Hawkes, 1993).

Potato is a younger crop is Europe and potatoes were shipped during the second half of the 16th centrury (1567-1574).

Potato (*Solanum tuberosum L.*) is one of the world's food crops. It may come as a surprise to many people to learn that potato is very widely grown on the world scale and ranks fourth in food production, following wheat, maize and rice.

According to the Food and Agriculture Organization (FAO) of the United Nations, between 1960s and 1990s, wheat, maize and rice production have increased at annual rates of 4.3%, 3.9% and 2.9%, respectively, in the developing countries. Despite of the fact that potato crop has received less emphasis, the annual increase of potato production during the same period was 4.0% in the developing countries (Guenther, 2001).

Potatoes are becoming quite important in many developing countries. Potato area and production have increased more rapidly in the Third World than the rest of the world. Significant potato production in the Third World countries may even go uncounted by government sources because of the abundance of subsistence farmers who produce potatoes on small plots for their own consumption (Van der Zaag, 1987).

Taking into account the following advantages: high yield potential, excelent nutrient source, high proportion of edible biomass, easiness to prepare for consumption, wide acceptance as an adaptability for extension and intensive cultivation, wide range of cultivars, security of production under stress conditions, short crop season, potato had a positive development in the last 10 years and represents a staple food for the 3rd millenium (Draica and Caciuc, 1997).

Potato (as a crop and tubers) is affected by a large number of pest and diseases, usually spread by planting material, by stress conditions (high temperature, drought) and by the level of technology. Therefore, the average potato yield is situated between less than 5 tonnes/ha in some african and east-european countries, to more than 40 tonnes/ha in the USA, Great Britain, France, Germany, The Netherlands etc.

This paper gives a general view of the situation of potato in the world and especially in Europe in the last decade (1993-2003) which can give the opportunity of thinking for the future development of potato in Europe, mostly in the Central and East-European countries.

MATERIAL AND METHOD

FAO data regarding area, production, yield and trade of potato from 2003 in comparison with 1993 were taken into account for analyses (FAO, 1992-2003).

RESULTS AND DISCUSSION

1. Potato area

1.1. Potato area in the world

In the last ten years (1993-2003) an increase of 5.5% of potato area was recorded, from 18.2 million hectares in 1993 to 19.22 million hectares in 2003 (table 1). A great

increase was recorded in Africa (cir 61%, over 0.43 million ha) and Asia (40.3%, over 2.25 million ha). A great reduction of potato area is recorded in Europe.

For the first time in the last years, Europe has lost the supremacy of potato area in the world. The reduction of potato area in Europe was mentioned by Van der Zaag (1986)

Table 1. Evolution of potato area in the world during 1993-2003 period*

World and Continents	1993		2003		2003/1993	
	Hectares	%	Hectares	%	Hectares	%
WORLD	**18,218,572**	**100**	**19,217,910**	**100**	**+ 999,338**	**105.50**
AFRICA	707,881	3.88	1,139,559	5.92	+ 431,678	160.98
CENTRAL and NORD AMERICA	758,606	4.16	790,884	4.11	+ 32,278	104.25
SOUTH AMERICA	911,338	5.00	934,493	4.86	+ 23,155	102.54
ASIA	5,593,899	30.70	7,848,906	40.84	+ 2,255,007	140.31
EUROPE	**10,198,169**	**56.00**	**8,451,708**	**44.00**	**- 1,746,461**	**82.87**
OCEANIA	48,679	0.26	52,360	0.27	+ 3,681	107.56

* Faostat Database Results

1.1. Potato area in Europe

In the same period, a great reduction of potato area was recorded in Europe (cir 17%), from 10.20 million hectares to 8.45 million hectares, especially in the new members of the European Union (more than 52%), from 2.26 million ha to 1.07 million ha (table 2). Enlarged Europe is ranked third, following Russian Federation and the group of other European countries. The countries which belong to the Russian Federation and to the group of "other countries" still have a very large area of potato (3.29 million and respectively 2.93 million ha) with a very low change in the last ten years (table 2).

The highest reduction of potato area was recorded in the following countries: Czech Republic (65%), Estonia (57%), Hungary (56%), Poland (55%), Spain (51%). Romania, Belgium and Luxembourg, Bosnia & Herzegovina and Bulgaria increased potato area by more than 10% (table 3).

Table 2. Evolution of potato area in Europe during 1993-2003 period *

Countries	1993		2003		2003/1993
	Hectares	%	Hectares	%	%
Total EUROPE	**10,198,169**	**100**	**8,451,708**	**100**	**82.7**
EU-15[1)]	1,479,324	14.5	1,265,326	15.02	85.5
EU-10[2)]	2,255,981	22.1	1,069,752	12.6	47.4
EU 15+10	3,735,305	36.6	2,335,078	27.6	62.5
RUSSIAN FED.	3,547,800	34.8	3,290,000	38.9	92.7
The other countries	2,915,064	28.6	2,926,630	33.4	97.0

*Faostat Database Results

1) Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, The Netherlands, Portugal, Spain, Sweden and United Kingdom;

2) Czech Republic, Cyprus, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia and Slovenia.

Table 3. Evolution of potato area in the European countries during 1993-2003 period*

Crt No	Countries	1993		2003		2003/1993
		Hectares	%	Hectares	%	%
1	**Total Europe**	**10,198,169**	**100.0**	**8,451,708**	**100.0**	**82.9**
2	Albania	10,313	0.10	11,300	0.13	109.6
3	Austria	31,090	0.30	22,500	0.27	72.34
4	Belarus	749,000	7.34	600,000	7.10	80.1
5	Belgium+Luxemburg	48,120	0.47	60,014	0.71	124.7
6	Bosnia and Herzegovina	38,200	0.37	47,000	0.56	123.0
7	Bulgaria	39,000	0.38	51,000	0.60	130.8
8	Croatia	64,754	0.63	64,500	0.76	99.6
9	Czech Republic	102,816	1.00	35,982	0.42	35.0
10	Denmark	45,000	0.44	37,693	0.45	83.7
11	Estonia	42,600	0.41	18,300	0.22	42.9
12	Faeroe Islands	110	0.001	110	0.001	100.0
13	Finland	36,400	0.36	30,000	0.35	82.4
14	France	164,000	1.60	162,000	1.92	98.8
15	Germany	322,334	3.16	283,624	3.36	88.0
16	Greece	49,094	0.48	48,000	0.57	97.8
17	Hungary	79,445	0.78	35,000	0.41	44.0
18	Iceland	800	0.007	800	0.009	100.0
19	Ireland	21,600	0.21	15,000	0.18	69.4
20	Italy	93,442	0.92	75,335	0.89	80.6
21	Latvia	87,700	0.86	45,000	0.53	51.3
22	Lithuania	121,900	1.19	102,000	1.20	83.7
23	Macedonia,The Fmr Yug Rp	12,851	0.13	14,000	0.16	108.9
24	Malta	1,200	0.01	1,140	0.01	95.0
25	Moldova, Republic of	71,058	0.70	45,000	0.53	63.3
26	Netherlands	166,000	1.63	157,129	1.85	94.6
27	Norway	18,670	0.18	15,320	0.18	82.0
28	Poland	1760,676	17.26	800,000	9.46	45.4
29	Portugal	87,903	0.86	80,000	0.95	91.0
30	Romania	249,003	2.44	285,000	3.37	114.4
31	Russian Federation	3,547,800	34.78	3,290,000	38.92	92.7
32	Serbia and Montenegro	108,705	1.07	80,400	0.95	73.9
33	Slovakia	47,210	0.46	25,130	0.30	53.2
34	Slovenia	12,434	0.12	7,200	0.08	57.9
35	Spain	207,971	2.04	102,300	1.21	49.2
36	Sweden	36,284	0.36	31,731	0.37	87.4
37	Switzerland	18,600	0.18	12,200	0.14	65.6
38	Ukraine	1,534,000	15.04	1,600,000	18.93	104.3
39	United Kingdom	170,086	1.67	160,000	1.89	94.1

* Faostat Database Results

1. Potato production

1.1. Potato production in the world

In the last decade (1993-2003) a 3.5% increase of potato production was recorded, from 300.85 million tonnes in 1993 to 311.42 million tonnes in 2003 (table 4). A great increase was recorded in Africa (58%), Asia (cir 47%) and South America (26.5%). An important reduction of potato production was recorded in Europe. Also, for the first time in the last decade, Europe has lost the supremacy of potato production in the world.

Taking into account the following advantages: high yield potential, excelent nutrient source; high proportion of edible biomass, easiness to prepare for consumption, wide acceptance as a daily adaptability for extension and intensive cultivation, wide range of cultivars, security of production under stress conditions, short crop season, potato had a positive development in the last 10 years and represents a staple food for the 3rd millenium (Draica and Caciuc, 1997).

Table 4. Evolution of potato production in the world during 1993-2003 period*

World and Continents	1993		2003		2003/1993
	000 tonnes	%	000 tonnes	%	%
WORLD	**300,850.9**	**100.0**	**311,416.3**	**100.0**	**103.5**
AFRICA	7,734.2	2.57	12,224.4	3.93	158.1
CENTRAL and NORD AMERICA	24,478.3	8.14	28,695.9	9.21	117.2
SOUTH AMERICA	11,163.5	3.71	14,118.4	4.53	126.5
ASIA	84,311.6	28.02	23,779.4	39.75	146.8
EUROPE	**171,620.8**	**57.05**	**130,825.2**	**42.01**	**76.2**
OCEANIA	1,542.5	0.51	1,773.1	0.57	114.9

* Faostat Database Results

1.1. Potato production in Europe

In the same interval a great reduction was recorded in Europe (cir 24%), from 171.65 million tonnes to 130.83 million tonnes (table 5). The highest reduction (59%) of potato area was registered in the group of the 10 new members of the European Union, from 44.35 million tonnes in 1993 to 18.1 million tonnes in 2003 (table 5). With no big changes in the last ten years, the countries which belong to the Russian Federation and the group of "other countries" summarized a big production of potato (35.9 million tonnes and 40.45 million tonnes respectively).

A high increase of potato production was recorded in Macedonia (69%), Albania (67.4%), Bulgaria (48.4%), Croatia (44.7%). On the other hand, a significant reduction of potato production was registered in the Czech Republic and Poland (63%), Republic of Moldova (56%), Slovakia (50%), Latvia (49%) and Estonia (47%), as it is mentioned in table 6.

Table 5. Evolution of potato production in Europe during the 1993-2003 period*

Continent/Group of Countries	1993		2003		2003/1993
	000 tonnes	%	000 tonnes	%	%
Total EUROPE	**171,620.8**	**100.0**	**130,825.2**	**100.0**	**76.2**
EU-15	49,173.3	28.6	36,343.6	27.8	73.9
EU-10	44,346.7	25.8	18,124.0	13.8	40.8
EU-15+10	93,520.0	54.5	54,467.6	41.6	58.2
RUSSIAN FED.	37,650.4	21.9	35,900.0	27.5	95.4
The other countries	40,450.4	23.6	40,457.6	30.9	100.0

* Faostat Database Results

Table. 6 Evolution of potato production in the European countries during 1993-2003 period*

Crt. No	Countries	1993		2003		2003/1993
		000 tonnes	%	000 tonnes	%	%
1	**Europe**	**171,620,789**	**100**	**130,825,174**	**100**	**76.2**
2	Albania	101,527	0.06	170,000	0.13	167.4
3	Austria	885,833	0.52	685,000	0.52	77.3
4	Belarus	11,644,000	6.78	8,500,000	6.50	73.0
5	Belgium+Luxemburg	2,402,995	1.40	2,255,569	1.72	93.9
6	Bosnia and Herzegovina	325,000	0.18	400,000	0.30	123.1
7	Bulgaria	357,079	0.20	530,000	0.40	148.4
8	Croatia	507,898	0.29	735,000	0.56	144.7
9	Czech Republic	2,395,810	1.40	877,306	0.67	36.6
10	Danemark	1,740,495	1.01	1,530,000	1.17	87.9
11	Estonia	538,600	0.31	285,693	0.22	53.0
12	Faeroe Islands	1,500	0.0008	1,500	0.001	100.0
13	Finland	777,200	0.45	780,000	0.60	100.4
14	France	5,859,700	3.41	6,400,000	4.90	109.2
15	Germany	12,645,520	7.37	10,170,000	7.77	80.4
16	Greece	1,000,000	0.58	900,000	0.68	90.0
17	Hungary	1,057,411	0.62	800,000	0.61	75.6
18	Iceland	8,900	0.0005	8,800	0.006	98.9
19	Ireland	569,000	0.33	500,000	0.38	87.9
20	Italy	2,098,400	1.22	1,829,590	1.40	87.2
21	Latvia	1,271,700	0.74	650,000	0.50	51.1
22	Lithuania	1,772,600	1.03	1,400,000	1.07	79.0
23	Macedonia,The Fmr Yug Rp	107,763	0.06	182,088	0.13	169.7
24	Malta	27,000	0.01	27,500	0.02	101.9
25	Moldova, Republic of	725,965	0.42	320,000	0.24	44.1
26	Netherlands	7,698,600	4.48	6,399,000	4.89	83.1
27	Norway	446,960	0.26	340,000	0.26	76.1
28	Poland	36,270,544	21.13	13,493,400	10.31	37.2
29	Portugal	1,241,192	0.72	1,250,000	1.05	100.7
30	Romania	3,708,903	2.16	3,500,000	2.67	94.4
31	Russian Federation	37,650,368	22.03	35,900,000	37.44	95.3
32	Serbia and Montenegro	646,927	0.37	724,322	0.55	112.0
33	Slovakia	856,689	0.50	426,106	0.32	49.7
34	Slovenia	156,345	0.10	164,000	0.12	104.9
35	Spain	3,821,365	2.22	2,724,400	2.08	71.3
36	Sweden	1,361,000	0.80	920,000	0.70	67.6
37	Switzerland	859,000	0.50	468,000	0.35	54.5
38	Ukraine	21,009,000	12.24	17,606,000	13.45	83.8
39	United Kingdom	7,072,000	4.12	6,971,000	5.32	98.6

* Faostat Database Results

1. Potato yield

1.1. Potato yield in the world

It may be hard to believe, but there is not an important change in the average potato yield in the last decade in the world, with a reduction of 2%, from 16.5 tonnes/ha in 1993 to 16.2 tonnes/ha in 2003 (table 7). An increase of yield was recorded in South America (23.4%), Central and North America (12.4%), Oceania (6.9%) and Asia. It is very important to mention that potato yield in North America and Oceania is more than double compared to the world potato yield. Also it is necessary to mention that in Africa and the Russian Federation, potato yield is around 11 tonnes/ha, i.e. 67% of the world yield.

Table 7. Evolution of average potato yield in the world during 1993-2003 period*

World and Continents	1993		2003		2003/1993
	To/ha	%	To/ha	%	%
WORLD	**16.51**	**100**	**16.20**	**100**	**98.1**
AFRICA	10.93	66.2	10.73	66.2	98.2
CENTRAL and NORD AMERICA	32.27	195.5	36.28	224.0	112.4
SOUTH AMERICA	12.25	74.2	15.11	93.3	123.4
ASIA	15.07	91.3	15.77	97.3	104.6
EUROPE	**16.83**	**101.9**	**15.48**	**95.5**	**92.0**
OCEANIA	31.67	191.8	33.86	209.0	106.9
RUSSIAN FED.	10.61	64.3	10.91	67.3	102.8

* Faostat Database Results

1.1. Potato yield in Europe

In 2003 there was recorded a reduction by 8% of potato yield in Europe in comparison with 1993 (table 8). The biggest reduction (15.6%) was recorded in the EU-15 countries which have the highest yield in Europe (over 30 tonnes/ha, except year 2003). The lowest potato yield is registered in the Russian Federation (10.9 tonnes/ha) which means around 1/3 of EU-15 potato yield.

Table 8. Evolution of average potato yield in Europe during 1993-2003 period*

Continent/Group of Countries	1993		2003		2003/1993
	To/ha	%	To/ha	%	%
Total EUROPE	**16.83**	**100**	**15.48**	**100**	**92.0**
EU-15	33.24	197.5	28.72	185.5	86.4
EU-10	19.65	116.7	16.94	109.4	86.2
EU-15+10	25.04	148.8	23.23	150.7	92.8
RUSSIAN FED.	10.61	63.0	10.91	70.5	102.8
The other countries	13.88	82.5	14.31	92.4	103.1

* Faostat Database Results

Taking into account the average potato yield, the most important countries that usually harvest between 35 tonnes/ha and 45 tonnes/ha are the following: Great Britain, The Netherlands, Germany, France, Belgium/Luxembourg and Switzerland (table 9).

On the other hand, there are some countries which harvest less than 12 tonnes/ha: Bulgaria, Croatia, Iceland, Russian Federation and Ukraine, or less than 9 tonnes/ha: Bosnia-Herzegovina, Republic of Moldava, Serbia and Montenegro.

Table 9. Evolution of average yield of potato in the European countries during 1993-2003 period*

Crt No	Countries	1993		2003		2003/1993
		Tonnes/ha	%	Tonnes/ha	%	%
1	**Europe**	**16.8**	**100.0**	**15.5**	**100.0**	**91.9**
2	Albania	9.8	58.6	15.0	96.8	152.8
3	Austria	28.5	169.6	30.4	196.2	106.8
4	Belarus	15.5	92.3	14.2	91.6	91.1
5	Belgium+Luxemburg	49.9	297.0	37.6	242.6	75.2
6	Bosnia and Herzegovina	8.5	50.6	8.5	54.8	100.0
7	Bulgaria	9.2	54.8	10.4	67.1	113.5
8	Croatia	7.8	46.4	11.4	73.5	145.3
9	Czech Republic	23.3	138.7	24.4	157.4	104.6
10	Denmark	38.7	230.3	40.5	261.3	104.7
11	Estonia	12.6	75.0	15.6	100.6	123.5
12	Faeroe Islands	13.6	80.9	13.6	87.7	100.0
13	Finland	21.4	127.4	26.0	167.7	121.8
14	France	35.7	212.5	39.5	254.8	110.6
15	Germany	39.2	233.3	35.9	231.6	91.4
16	Greece	20.4	121.4	18.7	120.6	92.0
17	Hungary	13.3	79.2	22.8	147.1	171.7
18	Iceland	11.1	66.1	11.0	71.0	98.9
19	Ireland	26.3	156.5	33.3	214.8	126.5
20	Italy	22.5	133.9	24.3	156.8	108.1
21	Latvia	14.5	86.3	14.4	92.9	99.6
22	Lithuania	14.5	86.3	13.7	88.4	94.4
23	Macedonia,The Fmr Yug Rp	8.4	50.0	13.0	88.9	155.1
24	Malta	22.5	133.9	24.1	155.5	107.2
25	Moldova, Republic of	10.2	60.7	7.1	45.8	69.6
26	Netherlands	46.4	276.2	40.7	262.6	87.8
27	Norway	23.9	142.3	22.2	143.2	94.2
28	Poland	20.6	122.6	16.8	108.4	81.9
29	Portugal	14.1	83.9	15.6	100.6	110.6
30	Romania	14.9	88.7	12.3	79.3	82.4
31	Russian Federation	10.6	63.1	10.9	70.3	102.8
32	Serbia and Montenegro	5.9	35.1	9.0	58.1	151.4
33	Slovakia	18.1	107.7	16.9	109.0	93.4
34	Slovenia	12.6	75.0	22.8	147.1	181.1
35	Spain	18.4	109.5	26.6	171.6	145.0
36	Sweden	37.5	223.2	29.0	187.1	77.3
37	Switzerland	46.2	275.0	38.4	247.7	83.1
38	Ukraine	13.7	81.5	11.0	71.0	80.3
39	United Kingdom	41.6	247.6	43.6	281.3	104.8

* Faostat Database Results

1. Potato trade

1.1. Potato trade in the world

Over 16 million tonnes of potatoes are traded every year (table 10) which represents more than 3.3 billion USD (table 11). In the last ten years (1992-2002) a low increase of potato trade was recorded (2.6%). A high increase of potato trade was registered in the Central and North America (over 44%), Oceania and Africa (table 10).

The highest import of potato was recorded in Africa (114.8% of quantity and 110.8% of value) determined by seed potato import and the highest export was registered in Oceania (over 75% of quantity and over 16% of value) and in the Central and North America (35.7% of quantity and 78% of value) determined by the export of potato processed products.

The largest potato trader in the world is Europe (approx. 75%) which traded more than 12.2 million tonnes in the last years. An increase of potato trade quantity with cir 7% was registered in the last decade (table 10), with a reduction of value of cir 5% (table 11).

The highest augment of potato value in the last ten years (around 84%) has been registered in the Central and North America (table 11).

Table 10. Evolution of potato trade in the world during 1992-2002 period (000 tonnes)*

World and Continents	1992			2002		2002/1992
		000 tonnes	%	000 tonnes	%	%
WORLD	**I**	**8,020.57**	**100**	**8,472.53**	**100**	**105.6**
	E	**8,023.19**	**100**	**7,994.96**	**100**	**99.6**
	Total	**16,043.76**	**100**	**16,467.49**	**100**	**102.6**
AFRICA	I	224.37	2.8	482.07	5.7	214.8
	E	346.17	4.3	312.52	3.9	90.3
	Total	570.54	3.6	794.59	4.8	139.3
CENTRAL and NORD AMERICA	I	565.06	7.0	865.56	10.2	153.2
	E	572.52	7.1	777.01	9.7	135.7
	Total	1,137.58	7.1	1,642.57	10.0	144.4
SOUTH AMERICA	I	139.65	1.7	77.70	0.9	55.6
	E	59.52	0.7	45.73	0.6	76.8
	Total	199.17	1.2	123.43	0.7	62.0
ASIA	I	1,428.12	17.8	747.40	8.8	52.3
	E	1,156.16	14.4	776.02	9.7	67.1
	Total	2,584.28	16.1	1,523.42	9.3	58.9
EUROPE	**I**	**5,643.45**	**70.5**	**6,276.93**	**74.1**	**111.2**
	E	**5,854.71**	**73.1**	**6,001.95**	**75.2**	**102.7**
	Total	**11,498.16**	**71.7**	**12,288.88**	**74.6**	**106.9**
OCEANIA	I	19.93	0.2	22.87	0.3	114.7
	E	34.12	0.4	71.74	0.9	210.3
	Total	54.05	0.3	94.61	0.6	175.04

* Faostat Database Results; I – import , E - export

Table 11. Evolution of world potato trade during 1992-2002 period (000 000 $)*

World and Continents		1992		2002		2002/1992
		000 000 $	%	000 000 $	%	%
WORLD	**I**	**1,861.89**	**100**	**1,785.64**	**100**	**95.9**
	E	**1,616.08**	**100**	**1,613.05**	**100**	**99.8**
	Total	**3,477.97**	**100**	**3,398.69**	**100**	**97.7**
AFRICA	I	84.17	4.5	177.40	9.9	210.8
	E	82.87	5.1	66.89	4.1	80.7
	Total	167.04	4.8	244.29	7.2	146.3
CENTRAL and NORD AMERICA	I	137.34	7.4	260.15	14.6	189.4
	E	135.65	8.4	241.49	15.0	178.0
	Total	272.99	7.8	501.64	14.8	183.8
SOUTH AMERICA	I	31.30	1.7	19.27	1.1	61.6
	E	14.12	0.9	9.16	0.6	64.9
	Total	45.42	1.3	28.43	0.8	62.6
ASIA	I	323.57	17.4	171.45	9.6	53.0
	E	232.44	14.4	125.45	7.8	54.0
	Total	556.01	16.0	296.90	8.7	53.4
EUROPE	**I**	**1,279.55**	**68.7**	**1,151.51**	**64.5**	**90.0**
	E	**1,143.20**	**70.7**	**1,151.13**	**71.4**	**80.4**
	Total	**2,422.75**	**69.7**	**2,303.13**	**67.8**	**95.1**
OCEANIA	I	5.95	0.3	5.87	0.3	98.7
	E	7.80	0.5	18.43	1.1	236.3
	Total	13.75	0.4	24.30	0.7	176.7

* Faostat Database Results, ; I – import , E - export

1.1. Potato trade in Europe

An increase of over 15% of potato quantity traded in Europe was recorded, from 10.67 million tonnes in 1993 to 12.29 million tonnes in 2002 (table 12), as well as an increase of 33% of potato value traded in Europe, from $1.73 billion in 1993 to $2.3 billion in 2002 (table 13). The highest increase (26% in quantity and 40% in value) was recorded in the actual 15 members of the European Union, and the highest reduction (over 61%) was in the new 10 members of the European Union.

Nevertheless, he Europe-15 countries predominated potato trade in Europe, with around 95% in the last years.

It is necessary to mention that the EU-15 imports more potatoes (as quantity and value) than exports, usualy as early potato as well as potato processed products.

Table 12. Evolution of potato trade in Europe during 1993-2002 period (000 tonnes)*

Continent/Group of Countries		1993		2002		2002/1992
		000 Tonnes	%	000 Tonnes	%	%
Total EUROPE	I	**4,928,988**	**100**	**6,276,934**	**100**	**127.3**
	E	**5,742,721**	**100**	**6,011,949**	**100**	**104.7**
	Total	**10,671,721**	**100**	**12,288,883**	**100**	**115.2**
EU-15	I	4,343,805	88.1	5,766,826	91.9	132.7
	E	4,906,666	85.4	5,873,583	97.7	119.7
	Total	9,250,471	86.7	11,640,409	94.7	125.8
EU-10	I	159,321	3.2	131,744	2.1	82.7
	E	363,544	6.3	70,600	1.2	19.4
	Total	522,865	4.9	202,344	1.6	38.7
EU-15+10	I	4,503,126	91.4	5,898,570	94.0	131.0
	E	5,270,210	90.8	5,944,183	98.9	112.8
	Total	9,773,336	91.6	11,842,753	96.4	121.2
RUSSIAN FED.	I	226,000	4.6	192,971	3.0	85.4
	E	147,000	2.6	9,724	0.2	6.6
	Total	373,000	3.5	202,695	1.6	54.3
The other countries	I	199,862	4.0	185,393	2.9	92.8
	E	325,511	5.7	58,042	1.0	17.8
	Total	523,373	4.9	243,435	2.0	46.5

* Faostat Database Results; I – import , E - export

Table 13. Evolution of potato trade in Europe during 1993-2002 period (000 $)*

Continent/Group of Countries		1993		2002		2003/1993
		000 $	%	000 $	%	%
Total EUROPE	I	**866,379**	**100**	**1,151,505**	**100**	**132.9**
	E	**864,091**	**100**	**1,151,624**	**100**	**133.3**
	Total	**1,730,470**	**100**	**2,302,129**	**100**	**133.0**
EU-15	I	745,127	86.0	1,025,076	89.0	137.6
	E	796,402	92.2	1,137,090	98.7	142.8
	Total	1,544,529	89.1	2,162,166	93.8	140.0
EU-10	I	22,302	2.6	49,186	4.3	220.5
	E	35,817	4.1	8,032	0.7	22.4
	Total	58,119	3.4	57,218	2.5	98.4
EU-15+10	I	767,429	88.6	1,074,262	93.3	140.0
	E	832,219	96.3	1,145,122	99.4	137.6
	Total	1,599,648	92.3	2,219,384	96.3	138.7
RUSSIAN FED.	I	57,000	6.6	31,718	2.7	55.6
	E	19,000	2.2	1,243	0.1	6.5
	Total	76,000	4.4	32,961	1.4	43.4
The other countries	I	39,662	4.6	45,644	4.0	115.1
	E	12,872	1.5	5,259	0.5	40.8
	Total	52,534	3.0	50,903	2.2	96.9

*Faostat Database Results; I – import , E – export

1. Seed potato

1.1. Seed potato used in the world

Seed potato represents one of the main factors for a high yield and quality.

In the last ten years, seed potato quantity in the world has decrased with about 8%, from 37.3 million tonnes in 1993 to 34.4 million tonnes in 2003 (table 14), which means about 1.8 tonnes/ha. The highest increase of seed potato was recorded in Africa (61.4%) and Asia (18.7%) and the highest reduction was in Europe.

Table 14. Evolution of seed potato used in the world during 1993-2003 period (000 tonnes)*

World and Continents	1993		2003		2003/1993
	000 tonnes	%	000 tonnes	%	%
WORLD	**37,297.8**	**100.0**	**34,426.1**	**100.0**	**92.3**
AFRICA	766.6	2.0	1,237.6	3.6	161.4
CENTRAL and NORD AMERICA	1,639.1	4.4	1,621.9	4.7	98.9
SOUTH AMERICA	1,232.5	3.3	1,127.4	3.3	91.5
ASIA	6,605.4	17.7	7,842.9	22.8	118.7
EUROPE	**27,897.9**	**74.8**	**22,424.0**	**65.1**	**80.4**
OCEANIA	156.2	0.4	172.3	0.5	110.3

* FAOSTAT Database Results

1.1. Seed potato used in Europe

Seed potato quantity decreased in Europe with about 20%, from 27.9 million tonnes in 1993 to 22.2 million tonnes in 2003. The highest reduction was recorded in the new 10 members of the European Union (table 15) determined by the reduction of potato area with more than 50% (tabel 2).

Seed potatoes are vital to the health of potato industry; since potato is propagated vegetatively, diseases of mother plant are passed to the next generation. Therefore, for seed potato, certification programmes are often administrated by government agencies which enforce rules about production practice and inspect seed potatoes plants and tubers to determine which lots meet certification standards. The most seed potato certification programmes commonly use the rapid multiplication methods to improve the health quality and to promote very fast the best varieties (Van der Zaag, 1986; Draica et al., 1992).

Therefore in the most central and Eastern Europe countries it is necessary to reorganize the local seed potato programmes or to import certified seed potato.

Table 15. Evolution of seed potato used in Europe during 1993-2003 period (000 Tonnes)*

Continent/Group of Countries	1993		2003		2003/1993
	000 Tonnes	%	000 Tonnes	%	%
Total EUROPE	**27,897.9**	**100**	**22,424.0**	**100**	**80.4**
EU-15	3,028.8	10,8	2,750.1	12.3	90.8
EU-10	5,518.3	19.8	2,933.6	13.1	53.2
EU-15+10	8,547.1	30.6	5,683.7	25.3	66.5
RUSSIAN FED.	10,036.0	36.0	8,500.0	37.9	84.7
The other countries	9,314.8	33.4	8,240.3	36.7	88.5

* Faostat Database Results

1. Potato varieties

In 2003, 748 potato varieties were registered in the *"Catalogue of varieties in the European Union"*. Each country has a different number of grown varieties, from 19 varieties in Luxembourg to 321 varieties in The Netherlands (tabel 16).

According to the available data, over 95,000 ha of seed potato have been planted in 2003, from which about 39,000 ha were cultivated in The Netherlands, 17,677 ha in Germany, 14,770 ha in France and 11,459 ha in Scotland (table 16).

The most important varieties grown as seed potato (over 300 ha) in the most important seed potato grower countries in the EU-15 are the following:

- Ditta in Austria;
- Bintje and Spunta in Belgium;
- Kennebec, Oleva, Saturna, Sava, Spunta in Denmark;
- Amandine, Atlas, Bintje, Charlotte, Desirée, Kaptan, Vandel, Monalisa, Nicola and Punta in France;
- Agria, Cilena, Elkana, Granola, Karlena, Kuras, Marabel, Princess, Quatra, Satina, Saturna, Solana and Tomensa in Germany;
- Desirée in Ireland;
- Maris Peer in Great Britain;
- Cara, Desirée, Estima, Hermes, Maris Peer, Maris Piper, Nicola, Pentland Deal and Saturna in Scotland;
- Agria in Switzerland;
- Agata, Agria, Arinda, Asterix, Bintje, Desirée, Diamant, Estima, Fabula, Felsina, Frislander, Inovator, Jaerla, Kondor, Lady Claire, Lady Roseta, Liseta, Marfona, Markies, Monalisa, Mondial, Nicola, Premiere, Santana, Saturna, Seresta, Spunta, Timate, Victoria in The Netherlands.

Table 16. Situation of seed potato area in the EU-15 in 2003 year *

Country	Total		From which									
			Over 300 ha		201-300 ha		101-200 ha		51-100 ha		25-50 ha	
	No	ha	No	ha	No	ha	No	ha	No	ha	No	ha
Austria	57	1402	1	372	-	-	1	123	3	210	7	257
Belgium	67	2019	2	986	-	-	2	310	5	447	3	86
Denmark	75	4495	5	2324	1	251	4	703	8	503	9	323
France	192	14770	9	6619	6	1491	16	2230	16	1182	28	1126
Germany	270	17677	13	7999	5	1249	22	2822	28	2039	51	1822
Ireland Nord	41	1012	1	341	-	-	1	193	2	131	2	50
Luxembourg	19	425	-	-	-	-	1	125	2	172	2	50
Great Britain and Wales	85	2333	1	388	2	512	5	718	4	233	5	172
Scotland	160	11459	8	6968	4	1006	11	1515	12	765	17	589
Nederlands	321	38951	29	24525	12	2988	26	3543	35	2283	36	1341
Sweden	29	803	-	-	-	-	2	281	14	277	4	136
TOTAL	**748**	**95346**	x	**50522**	x	**7497**	x	**11463**	x	**8242**	x	**5952**

*) Catalogue of potato varieties in European Union

CONCLUSIONS

Potato remains one of the most important crop in the world, with a positive evolution in the last decade (1993-2003), especially in Africa and Asia, and potato will represent a staple food for the 3rd millenium.

In the last decade, for the first time, Europe has lost the supremacy of potato production in the world by reduction of area as well as potato production, especially in the Central and Eastern Europe countries.

As the most important seed potato grower and a big potato processor, Europe dominates the world potato trade with approx. 75% of quantity and over 65% of value. Over 95% of potato trade belong to the EU-15 countries. That is why potato can be more than a simple indicator of the stage of economical development of a country.

Europe remains the most important potato breeder and seed potato grower. In year 2003, 748 potato varieties were recorded in the EU catalogue of potato varieties, which cover over 95,000 hectares of seed potato in 10 of the EU-15 countries: Scotland, France, Germany, and especially The Netherlands remain the most important potato breeders and seed potato growers and exporters.

Although the EU-15 countries possessed only 15% of potato area and used only 12% of total seed potato used in Europe in 2003, due to the high technological level and to the "free market" principles, they succeded in obtaning 27.8% of Europe's potato production, 94.7% of quantity and 93.8% of value of imported and exported potato.

For the improvement of potato situation in the Central and East-European countries the following main measures have to be taken into consideration: concentration of potato crops in bigger farms, use of healthy (certificated) seed potato, improvement of technology, development of potato processing. A strong help could come from the EU-15 + EU-10(12) countries by training of the young scientists and technical staff (farmers) by promoting projects with financial support from EU and national programmes.

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SITUAȚIA ACTUALĂ A CARTOFULUI ÎN EUROPA

Rezumat

În anul 2003, cartoful a fost cultivat pe o suprafață de 19,2 milioane ha la nivel mondial, cu o producție totală de 311,4 milioane tone.

În comparație cu evoluția pozitivă a cartofului în ultimul deceniu (1993-2003) la nivel mondial (creșterea suprafeței cu 5,5%, creșterea producției totale cu 3,5% și creșterea comerțului cu cartof (import+export) cu 2,6%), în Europa s-a înregistrat o situație negativă prin reducerea suprafeței cu 17%, reducerea producției totale cu 24%, diminuarea producției medii cu 8%, reducerea cantității de cartof pentru sămânță folosite cu 20%. În schimb, s-a înregistrat o creștere cantitativă (cca. 15%) și valorică (33%) a comerțului cu cartof.

Pentru prima dată în ultimii ani, Europa a pierdut supremația mondială privind suprafața și producția totală de cartof.

Cea mai mare reducere s-a înregistrat în cele 10 țări (Cipru, Estonia, Letonia, Lituania, Malta, Polonia, Republica Cehă, Slovacia, Slovenia și Ungaria) care au devenit membre ale Uniunii Europene (EU) la 1 mai 2004: reducerea suprafeței cu cca. 52%, scăderea producției totale cu cca. 59%, reducerea cantității de "sămânță" folosite cu cca. 24% și a exportului de cartof cu cca. 80%.

Există o mare diferență între producția medie realizată de primele 15 țări membre (EU-15) ale EU (cca. 30 to/ha, dar cu producții de peste 40 to/ha în Marea Britanie, Olanda și Danemarca, urmate de Franța și Germania, cu aproape 40 to/ha) și noile 10 țări membre (EU-10) ale EU cu o producție medie de cca. 17 to/ha și mai ales Federația Rusă și alte țări din estul Europei care realizează o producție de cca. 11 to/ha.

Țările din Uniunea Europeană (EU-15), cu toate că au deținut în anul 2003 numai 15% din suprafața cultivată cu cartof și au utilizat numai 12% din cantitatea de "sămânță" folosită în Europa, datorită nivelului tehnologic ridicat și organizării valorificării producției pe principiile economiei de piață (piața liberă), au reușit să realizeze 27,8% din producția totală a Europei, 94,7% din cantitate și 93,8% din valoarea cartofului importat și exportat.

Principalii factori care pot contribui la îmbunătățirea situației în țările din zona central și, mai ales, est-europeană, sunt următorii: concentrarea suprafețelor de cartof în ferme mai mari, folosirea unui material de plantat sănătos (certificat), îmbunătățirea tehnologiei și dezvoltarea industrializării cartofului. Un ajutor esențial pentru redresarea culturii

cartofului în țările din zona central și est-europeană, poate veni din partea țărilor membre ale UE (UE-15 + UE-10) prin instruirea personalului științific și tehnic.

Cuvinte cheie: cartof, suprafață, producție totală, producție medie, comerț, soi, cartof sămânță.

Tabele:

ABSTRACTS

IMPORTANCE OF VARIETIES AND SEED QUALITY ON YIELD INCREASING IN REPUBLIC OF MOLDOVA

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Potato production in Moldova for the moment is characterized as reducing the areas in the last 5-6 years from 53000 ha till 41000 ha in 2003. The average potato yield in this period show a slightly increasing from 8-9 t/ha till 9-10 t/ha. In the same time there are many farmers which obtain under the irrigation condition 30-40 t/ha. According to the program for potato development adopted by Agricultural Ministry the potato area should established at 40000 ha and average yield should reach 15t/ha.

It is very well known that in potato production the choice of variety and quality of seed are one of the most important factors in yield increasing and tubers quality. Starting from 1991 year, when in the National List of potato varieties was included only 5 varieties, a large activity of varieties trailing start. Later parallel with the official testing a lot of voluntary demonstration fields in different localities where organized. Step by step varieties trailing has been undergoing modification in response to the changing requirements of producers and consumers. At the beginning we have been looked only for yield and some consumer quality – color of skin and flesh. Then for pests and diseases resistance, adaptation on high tempe- rature and drought growing condition, suitability for one two years multiplication of seed for own use, consumer quality, storage characteristics. Now in the official list are registered 20 varieties, from different grope of maturity and destination. More adopted for South part of country are early and middle early varieties: Agata, Impala, Flavia, Velox, Minerva, Amorosa, Rosara, Tresor, Arnova, Romano. For the North part – second early and middle varieties: Romano Kondor, Kuroda, Baltica, Raja, Sante, Desiree. This reduce to the minimum the using of unknown varieties mostly supplied from the temporary source.

In the same time a big work was done for improve the seed quality. For example the seed of registered varieties can be introduced in country only of class E or A. Import of seed of non registered varieties, or at least not in the testing process is not allowed. This is very important for our country because for the moment seed quality determined about 70% from the yield, and in the same time seed cost from all expensive in potato production is around 65-70%, when potato seed are imported directly from seed produce country

In view of the above a new variety can be imported in Moldova only after official testing procedure as for seed only of registered varieties, which meet the class E or A.

Having a sufficiently good condition for consumption potato production especially for early potatoes, there practical are not condition for seed potato production, due to it the best seed mostly are imported from abroad especially from Holland and Germany, the rest from Romania and Poland. From the last source mostly low quality of seed of unknown varieties mostly named as variety Irga.

On the other hand if potato is growing by farmers under the irrigation condition with a good pest and disease control and normal storage condition, one two year multiplication could be done successful, than yield of mostly varieties is reducing drastically. That is why is recommended to use for table potato production seed of class A or B and not lower. In the contrary yield will be very low, and expensive very high.

POTATOES VARIETIES ADAPTATION AND USES ACROSS DIFFERENT AGRO-ECOLOGICAL ZONES OF NIGERIA

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This paper examines the variations in the adaptation and uses of potatoes varieties across different ecological zones in Nigeria. This is predicated on the fact that a high degree of differentiation exist in terms of the eco-climatic nature and the socio-cultural milieu of the country. In this way the genetic diversity of potatoes is exploited.. These variations have serious implications for the adoption of extension messages on potatoes for planting, processing and uses. The climatic setting of each of the five agricultural zones in Nigeria informs the careful import and assemblage of different genotypes fro intensive selection programmes. From 228 ascensions from world wide provenances field grown in south western Nigeria , 20 have been found adaptable in Nigeria. These have been adapted in different agro-ecological setting in Nigeria. The paper conclude with the result gathered from a rapid rural appraisal indicating that variety preferred for each ecological zone and the prevalent product generated in each zone. The adaptation and uses would go a long way to set the agenda for potato research and extension in this part of the world.

ANTISERA (IMMUNOGLOBULIN AND CONJUGATES) FOR THE IDENTIFICATION OF PVM AND PVY INFECTIONS IN SEED POTATO PRODUCTION BY ELISA METHOD

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Potato virus M (PVM) propagation was made on Solanum tuberosum, Santé variety and the two isolates of Potato virus Y (PVY^0 and PVY^N) on Nicotiana tabacum, Samsun variety and White Burley respectively. Frozen leaves were used for virus extraction from infected material in the case of PVM and fresh leaves for PVY. In both cases, leaves were homogenizing in Waring Blender with Tris-Citric acid buffer 0,1 mol/l Tris, pH 8 for PVM and MacIlvane buffer 0,18 mol/l, pH 7 for PVY. To prevent oxidation and virus particles aggregation, sodium sulfite, sodium thyoglycolate, thyoglycolic acid, citric acid, TritonX-100, urea and sodium diethyldithiocarbamate (DIECA) were added to the respectively buffers. Organic solvents like diethyl ether and carbon tetrachloride în equal quantities were used to clarify the extracts (juice).

Further, two cycles of differential centrifugation were performed followed by two density-gradient centrifugation, the first in sucrose gradient (10-40%) and the second in cesium chloride ~ 30% to separate the virus particles from the normal plant protein. Glycerine was added to the virus suspension, in the ratio 1:1 and this was stored at –18°C until the rabbits immunization. Electronic microscope analysis of the virus suspensions pointed out that these were clean and presented a high particles density (10^{10}-10^{20}).

Rabbits immunization was performed by two injections/rabbit, the first subcutaneous and the second intramuscularly after 14 days with a mixture of virus suspension and Freund's complete adjuvant in equal quantities. 10 partial bleedings /rabbit were performed at two week intervals finally resulting over 200 ml of immune antiserum for each virus. The specificity of the obtained antisera was very good (zero reaction to the crude sap of healthy potato plants). The maximum titre relatively the homologous antigen was 1:4096 for PVM antisera (the bleedings II and III) and for PVY antisera 1:8192 (the bleedings V-VIII). The antisera were stored separately per rabbit and bleeding at 4°C with addition of Sodium azide.

To separate the G fraction of immunoglobulin (IgG) antiserum from the bleedings with the highest titre was used. The antiserum was diluted with distilled water in ratio 1:9 and the antibodies were precipitated with a saturated solution of amonium sulfate (V/V) and sedimentarily by centrifugation at 10°C for 10-15 minutes at 6000 rpm. After the resuspension of the sediment in PBS buffer " and dialytically in the same buffer, the resulted

suspension was filtered through an DEAE 52 Cellulose column and 10 fractions of 1,5-1,8 ml per each antiserum were collected. The extinction of these fractions at 280nm UV-measurement varied between 0.177-3,714 for PVM antiserum and 0,057-3,620 for PVY antiserum. By mixing the fractions with E280nm e"0,5 plus buffer, the concentration of IgG was adjusted to 1,623 for PVM and 1,740 for PVY which represents approximately 1 mg/ml.

To prepare the antibody conjugates, a part from IgG was conjugated with alkaline phosphatase ~ 2500 U/mg protein în ratio 0,7 mg enzyme to 1 mg IgG. Glutaraldehyde 25% 1,25ml/500 ml of PBS buffer was used as conjugating agent. After the enzyme was conjugated with the antibodies, this mixture was dialyze for 24 hours with PBS buffer. Both IgG and the conjugate were stored at 4^0C in siliconized vials (bottles).

To determine the optimum testing dilution, of IgG, plant extracts and enzyme conjugates, three dilutions of homologous virus were used (1:10; 1:100; 1:1000), two of healthy plant sap (1:10; 1:100), extraction buffer and three dilutions from IgG (1:300; 1:900; 1:2700) and enzyme conjugates (1:400; 1:1200; 1:3600). On the basis of the resulted recorded, the dilution 1:1500 for both viruses was chosen to be used in routine testing. This dilution allowed a reliable detection of the two viruses even at very low concentrations of these (1:1000).

Also resulted that in seed potato production, where testing play a selecting role, testis can be made with a mixture of antisera for the two viruses, without significantly affecting their detection reliability, comparatively to single antisera testing. Testing with a mixture of IgG and enzyme conjugates for both viruses allows an important reduction of testing costs.

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FORMATION OF POTATO YIELD AND ITS QUALITY ACCORDING TO SEED TUBER PRE-PLANTING PREPARATION AND AGROTECHNOLOGY

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The yield of potato may vary 2–5-fold depending on pedoclimatic conditions. Summarizing of the results of fertilization experiments with potato, conducted in Estonia during several decades, allows to conclude that the effect of pedoclimatic conditions accounts for 45% and fertilization for 35% general yield dispersion. The yield of potato obtained at the expense of soil fertility is 270 kg per soil fertility point.

Agronomically effective amounts of nitrogen fertilizer which ensure the maximum potato yield depend on soil humus content, climatic conditions, preceding crop and its fertilization. On moderately moist soils with a humus content of 2–4% the average effectiveness of the N_{60} fertilizer norm for potato is 30–70 kg N kg^{-1}. On gleyic and gley soils with a humus content of 6–8%, the effectiveness of nitrogen ferilizer is 5–40 kg N kg^{-1}. In the case of potato, very important factors influencing the effectiveness of nitrogen fertilizers are the PK fertilizer background and the soil's requirement for phosphorus and potassium fertilizers. Non-application of PK fertilizers results in a significantly lower effectiveness of nitrogen fertilizers and involves higher risk on humus-rich soils.

On potassium-poor soils the average effectiveness of the fertilizer norm K_{50} is 80–100 kg per kg of K, while in favourable years it can be as high as 150–180 kg. An increase of 10 mg in soil potassium content results in the average reduction of the effectiveness of the K_{50} norm by 8 kg. The effectiveness of phosphorus fertilizers depends even to a greater degree on the differences between years compared with the effectiveness of nitrogen and potassium fertilizers. The difference in the effectiveness of phosphorus fetrilizers between favourable and unfavourable years is up to 225 kg per kg of P. Phosphorus fetrilizers produce an effect every other year on soils whose content of lactate soluble P is below 90 mg/kg. On phosphorus-poor soils (below 30 mg) the effect of phosphorus fertilizers is evident almost every year, and the effectiveness of the use of low phosphorus amounts (P_{26}) is on the average higher than 100 kg per kg of P. An increase of 10 mg in the amount of soil lactate soluble phosphorus results in the average reduction of the effectiveness of the P_{26} norm by 17 kg.

In order maintain high yield potential, all essential measures need to be taken to increase the yield while preparing for planting. One of these measures, the pre-planting thermal treatment of the tubers, or pre-sprouting, is widely used not only for early potato but also for late potato. Each seed batch has a storage history consisting of the treatment, cooling, storing and preparation periods. The parameters of all these periods have a direct effect on the overall durability of potato as well as on the yield potential of the tubers.

The experiment was performed in 2000-2002 in the Department of Field Crop Husbandry of the Estonia Agricultural University with the aim to investigate the possibilities of growing potato using different methods of treating the tubers before planting. The tubers were treated as follows: pre-sprouting (PS); thermal treatment (TT) and zero treatment (0). The medium late variety 'Ants' and the medium early variety 'Piret', developed at the Jõgeva Plant Breeding Institute, and the early variety 'Agrie dzeltenie', developed at the Latvian Priekuli Plant Breeding Institute, were used in the experiments. The dynamics of tuber yield formation was determined by taking samples from all treatments for each variety. The purpose was to find out which treatment is the best for cultivating potato varieties with different growig periods in the climatic conditions of Estonia in order to ensure higher yield and better quality per vegetation period. The results were processed using regression analysis.

The soil type was glossisol by FAO classification and Stagnic Luvisol by WRB classification. The trial soil was weakly acid: pH_{KCl} 6.2; humus 2.4%; N 0.11%; P 183 mg kg^{-1} (AL); K 164 mg kg^{-1} (AL); Ca 674 mg kg^{-1}; Mg 101 mg kg^{-1} for the soil. Agricultural technology typical of potato experiments were employed. The dynamics of yield formation was determined after every 3 to 5 days.

As different tuber treatment methods were used, the first samples were taken at different times. The sampling time and the number of samples were different for different treatments. The number of samplings also depended on the length of the vegetation period. As the varieties used in different treatments started to develop tubers at different times, the number of samplings fluctuated each year +/- 3 samples.

The dynamics of yield formation in the vegetation period was significantly affected by weather conditions. In this respect, the most favourable year for potato growth was 2001. In 2000 and 2002 the weather was not so good for the growth and development of potato and the yield was lower than the three years' average.

Physiological age proved very important for formation of the tuber yield. A physiologically older seed accelerates the growth rhythm of potato, as a result of which the yield is formed earlier, while yield formation capacity decreases. The results also showed that the earlier is the variety, the greater is the effect of treatment, and that the yield develops uniformly throughout the vegetation period in the case of varieties with a longer growing period. Obviously, any thermal treatment of seed tubers increases their physiological age. Thus, both pre-sprouting and thermal treatment increase to some extent the physiological age of tubers.

The main purpose of pre-sprouting is to obtain an earlier yield. In order to obtain the yield as early as possible, pre-sprouting should also start earlier, while sprouting will still take 4 or 5 weeks. If it is too late for pre-sprouting, the tubers can be stimulated using thermal treatment, which makes them develop faster.

The average results of three years demonstrated that the time for potato to realise its full potential was insufficient and a maximum yield was not reached. Pre-sprouting and thermal treatment had a positive effect on the entire vegetation period. This effect was initially stronger and then decreased gradually.

Thermal treatment of the tubers before planting had a different effect on varieties with different growing periods.

Comparison of the varieties showed that 'Piret' and 'Agrie dzeltenie' started to form tubers early and outgrew the variety 'Ants' by the 60th day of growth. 'Ants' reached a maximum yield, 47.0 t ha^{-1}, already by the 114th day, followed by the fast-ripening 'Agrie dzeltenie' and the medium-ripening 'Piret'. Thermal treatment did not represent any advantage in terms of total yield formation in comparison with untreated seeds, except for the pre-planting germination variant of the variety 'Agrie dzeltenie', the total yield of which exceeded the yield of its untreated variant by 7.1 t ha^{-1}.

THE QUALITY PERSISTENCE OF TABLE POTATO

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Keywords: potatoes, field experiments, pre-sprouting, vitamin C, chlorogenic acid, tuber quality.

Introduction

In Estonian conditions the growing period of potato is relatively short, so it is essential to improve agricultural technique and avoid plants diseases during growing period. The good quality of the tuber yield received by exploiting the whole growing period remains also at storing. The aim of the carried out research work was to explain the quality resistance of tuber yield and according to that estimate the duration of consumption period.

Material and methods

The field experiments were established in 2000-2003 on the field plot of Estonian Research Institute of Agriculture at Saku. The agrochemical data of the field plot were the following: Soil type and characteristics. The trial was situated on sod-calcareous sandy loam soil. Content of humus 2.3%; P 91 mg/kg, K 75 mg/kg; pH_{KCl} 5.8. The experimental design was a randomised complete block with 4 replicates and the plot size was 25.2 m^2. Previous crop - pea. The fertilization was carried out before planting. Fertilizer, Kemira Cropcare (10:4:17) was applied to potato kg ha^{-1} N 100 P 40 K170.

The amount of storage samples was 14-20 kg. The content of chlorogenic acid and vitamin C and after-cooking discoloration of tubers was determined.

Results and discussion

The quality of varieties with higher content of vitamin C remained during the longer period and so the consumption period of these varieties was longer. The content of chlorogenic acid in potato was lower in all varieties but it increased after dormancy period ended. It was obviously favoured by the essential decrease of C content from antioxidants by the end of dormancy period. The level of chlorogenic acid in a potato was determined by genetic and by nutritional factors. Of agrometeorological factors the dry and hot summer decreased the duration of dormancy period of potato, like the growing year of 2002.

Conclusion

Consumers demand a consistently high quality of tubers. The experimental results showed that existed relationship between the amount of chlorogenic acid and of tubers discolouration.

The higher content of chlorogenic acid caused more intensive after-cooking discolouration of tubers. The content of chlorogenic acid differed by varieties, the variety Ants having the highest. There was less chlorogenic acid in tubers in case of balanced fertilization.

THE EVOLUTION OF THE POTATO INDUSTRY IN LAST TEN YEARS IN PORTUGAL

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The potato crop in Portugal has suffered a constant reduction in area cropped and total production of potatoes in the last decade, since the increase in yield was insufficient to compensate the reduction in area.

In the Fig. 1, we can see the evolution of the area planted and the production obtained from 1970 till 2000:

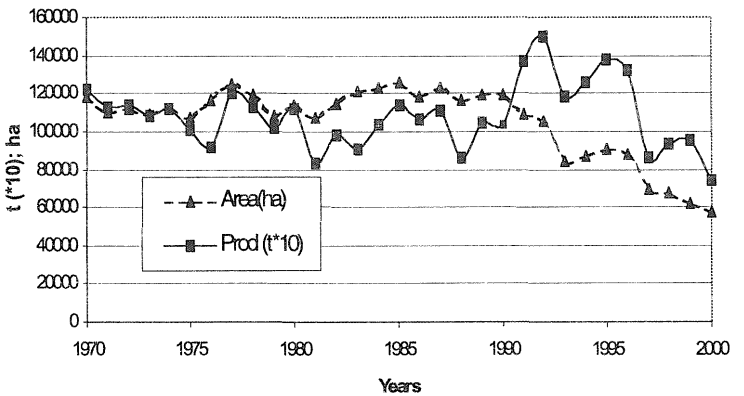

Fig. 1 – Evolution of the area and total production of potatoes in Portugal from 1970 to 2000.

The reduction in the area cropped with potatoes is due mainly to the low yield obtained (Fig. 2). This is the "calculated" yield, obtained dividing the total production by the total area devoted to the crop. A large number of farmers get better yields, but this is not the rule.

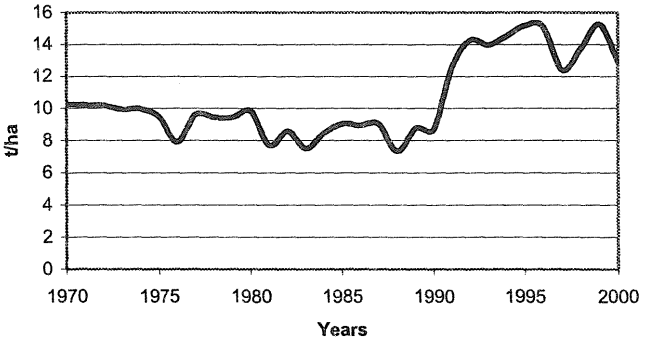

Fig. 2 – Evolution of the potato yield in the period of 1970 - 2000

The potato industry will have many difficulties to survive in countries where high yields are not obtained and where low cost production is not achieved (the seed tubers account for about 50% of the production cost). So, it may be it is useful to understand what had happened in Portugal, and try to avoid a similar evolution.

1 - The reduction of the importance of the potato crop is basically related with the lower yield obtained by the crop, which causes very high production costs with a consequent reduction on the competitiveness of the crop. A large part of potatoes consumed in Portugal are produced in other European countries just as Spain, France, Netherlands and Belgium.

2 - The low yield obtained is related with the natural climatic conditions: Portugal has a Mediterranean type climate, with hot and dry summers and mild winters, with rain. Traditionally, the potato crop was produced in the interior of the country, where the lack of proper irrigation is the main constraint to get high yields.

In last years, the crop moved to the coastal area, where it can be planted earlier, where the winter is milder and allows an earlier plantation, from February onwards. In this part of the country, late blight can be a severe disease. The temperature is normally above 10 şC and if humidity is high enough, the attack is very severe, affecting the final production.

3 - The changes occurred in the Portuguese society during the period 1970 – 2000 are also responsible for the lack of competitiveness of the potato crop:

- In 1974, we change from a dictatorship system, with a market strictly controlled by the authorities, to a democracy system.

- In 1986, Portugal joints the European Community and in 1992 boundaries were totally banned. It becomes possible that any merchant could go abroad, with his own truck to load it of potatoes and bring them to Portugal to sell.
- More or less by the same time, the large supermarkets started operating, and the small producers start to fell more and more difficulties to sell the production, since they are not able to organize themselves through Associations and Cooperatives.
- In the beginnings of the nineties, a large factory of American chips start operating, near Lisbon, but most of the row material used is produced abroad, mainly in Spain.

The potato crop has a very high social value, especially in rural areas with small producers. So, it is economical and social relevant to maintain the potato industry. Therefore, the competitiveness of the crop is an important issue and the lowering of the costs through an increase in yields is the main goal. Consequently, technical tools need to be optimised and farmers must look for sounded support for decisions undertaken during the crop season.

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