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Potato Crop Monitoring Using Veris Mobile Sensor Platform

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Abstract. The paper contains a set of experimental results obtained after the soil electrical onductivity measurements, performed at the INCDCSZ Brasov. The Veris 3100 cart, an on-the-go sensor platform that records soil electrical conductibility (EC), has been successfully used to identify spatial patterns in soil within fields. We used the cart to identify spatial variation in soil EC and thus, on a full moisture profile.

Keywords: Precision agriculture, electrical conductibility

INTRODUCTION

Mapping variation in soil properties is one strategy to understand which factor, or factors, contributed to site-specific variation in potato yield. Soil mapping can be conducted via remotely-carried sensors, such as airborne or satellite-derived imagery, or via direct recording sensors that capture variation while moving across the field.The Veris 3100 cart (www.veristech.com) is a direct sensor capable of measuring variation in soil electrical conductivity (EC) to 30 and 90-cm depth. The device is made up of pairs of coulter electrodes that penetrate the soil surface. One coulter pair directs an electrical current into the soil, and the other pairs measure the voltage drop (Fig.1). The readings, then, are essentially an average of the EC found throughout that profile depth (ACPA 2001).

Moore *et al.*(2001) measured the soil electrical conductivity to found a correlation between soil texture, organic matter, soil nutrients and crop yield. Measuring electrical conductivity in soil has been investigated as a way to determine its fertility and productivity. This may help farmers make site-specific fertilizer applications. The goal of current research was to evaluate the possibility to use the mobile sensor platform Veris 3100 (fig.2) for electrical conductibility measurements, and to correlate the results of the measurements with the physical and chemical parameters of the soil.

MATERIAL AND METHOD

The research activity was performed on the 1150 plot (20 ha), in 1781 points with a depth variation between 0 – 90 cm. Were conducted four representative soil profiles in order to correlate the physical and chemical parameters with soil electrical conductibility. The GPS positions of the measurements points were determined with Trimble GeoExplorer in order to georeference the date and to correlate them with the available digital maps (ArcGIS – ESRI system). The electrical conductibility (EC) is the ability of a material to transmit (conduct) an electrical current and is usually expressed in miliSiemens/meter (MS/m). (www.inma.ro).

The soil EC principle measurement using the contact sensors involves the use of three pairs of knife electrodes. Each pair of electrodes is used to generate an electric current in the soil, while the other two are used to measure the voltage drop (Fig.1). The electrode assemblies is mounted on a bar which is pulled by a motor device. The control unit of the mobile platform VERIS measures the soil EC in real time and georeferences the results using a GPS.

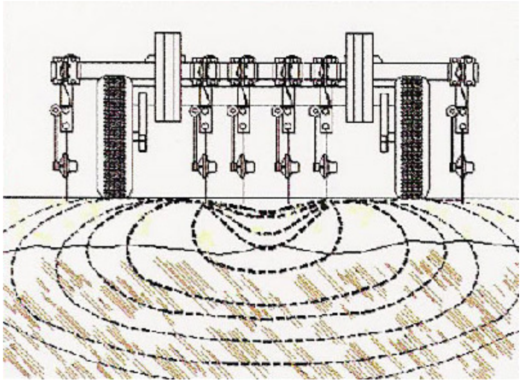

Fig. 1. Soil electrical conductibility measurement

Fig. 2. Soil electrical conductivity monitoring with VERIS (Mobile Sensor Platform)

RESULTS AND DISCUSSION

Soil texture results

The table 1 shows that 9.18 and 19 representative profies are included in clay class. The mean analytical values for the profile 8 show a sandy loam soil at 0 – 30 cm depth and silty sand soil at 0 – 90 cm depth (Tab.2).

Tab. 1.

Soil texture on 0–30 cm depth, (INCDCSZ Brasov)

Profile	Clay < 0.002 mm		Dust 0.002–0.02 mm		Sand 2–0.02 mm		Textural classes**
	%	Duncan Test *	%	Duncan Test *	%	Duncan Test *	
8	15.6	b	12.8	b	70,6	a	Sandy loam
9	32.4	a	22.3	ab	45,1	b	Clay
18	34.3	a	25.3	a	40,4	b	Clay
19	32.9	a	20.7	ab	46,9	b	Clay
* p = 0.05 %							
Min	10.4		7.1		39.6		
Max	34.8		25.7		80.9		
Mean	**28.8**		**20.2**		**50.7**		
(VC%)	**(29.9)**		**(28.7)**		**(27.0)**		

Tab.2.

Soil texture on 0–90 cm depth, (INCDCSZ Brasov)

Profile	Clay < 0.002 mm		Dust 0.002–0.02 mm		Sand 2–0.02 mm		Textural classes**
	%	Duncan Test *	%	Duncan Test *	%	Duncan Test *	
8	11.2	b	9.1	b	78,9	a	Silty sand
9	31.0	a	22.0	a	47,0	b	Clay
18	31.8	a	25.3	a	43,8	b	Clay
19	29.5	a	19.9	a	50,6	b	Clay
* p = 0.05 %							
Min	2.5		1.8		34.2		
Max	36.1		35.7		95.6		
Mean	**27.9**		**20.5**		**51.7**		
(VC %)	**(29.5)**		**(32.1)**		**(26.6)**		

**Dumitru M. *et al*, (2011)

The textural differences between the 4 representative profiles explains the high value of variability coefficients which are calculated for the percentage of clay, dust and sand.

Soil agrochemical parameters results

The mean pH value on 0-30 cm depth for the four representative profiles is 6.6 with a VC of 11.8%, indicating a weak acid soil. Even if the pH differences are significant from statistic point of view for the 8, 18, 9 and 19 profiles, the values fall in two acid classes, low alkaline and low acid (Tab. 3).

The average quantity of the organic matter is 5,7%, having a variation coefficient of 24,4 %. The determinations demonstrate significant differences among studied profiles.

The average quantity of the organic matter obtained for 0 – 90 cm (tab.4) depth is slightly reduced (4.3 %), having a variation coefficient of 50.20%.The cation exchange capacity has a variation coefficient of 23.0%, which indicate that the soil is oligomezobazic. Analysing the variation coefficients for the studied profiles, results that the soil from profile 8 has a saturation degree significantly reduced compared to the other profiles (it is an oligobasic soil).

Tab.3

The agochemical soil properties on 0 – 30 cm depth (INCDCSZ Braşov)

Profile	pH			Organic matter			Cation exchange capacity		
	Value	Duncan Test *	Class**	%	Duncan Test *	Class**	me/100 g soil	Duncan Test **	Class**
8	7.8	a	low alkaline	3,9	c	Medium	22,5	b	oligobazic
9	6.1	c	low acid	7,0	a	Large	41,2	a	oligomezobazic
18	6.6	b	low acid	5,3	bc	Medium	37,9	a	oligomezobazic
19	6.0	c	low acid	6,7	ab	Large	40,3	a	oligomezobazic
*p = 0.05 %									
Min	6.0			3.1			22.5		
Max	7.9			7.0			41.8		
Mean	**6.6**			**5.7**			**35.4**		
(VC%)	**(11.8)**			**(24.4)**			**(23.0)**		

Tab.4

The agochemical soil properties on 0 – 90 cm depth (INCDCSZ Braşov)

Profile	pH			Organic matter			Cation exchange capacity		
	Value	Duncan Test **	Class**	%	Duncan Test *	Class**	me/100 g soil	Duncan Test **	Class**
8	7.9	a	low alkaline	3,9	a	Medium	22,5	b	oligobazic
9	6.3	c	low acid	5,4	a	Medium	36,9	a	oligomezobazic
18	6.9	b	neutral	3,3	a	Medium	34,7	a	oligomezobazic
19	6.5	bc	low acid	4,3	a	Medium	35,6	a	oligomezobazic
*p = 0.05 %									
Min	6.0			0.6			22.5		
Max	8.2			7.2			22.5		
Mean	**6.8**			**4.3**			**22.5**		
(VC%)	**(9.2)**			**(50.2)**			**(-)**		

Soil NPK results

After analyzing the four soil profiles we can conclude that the soil contains only 50 % of the required nitrogen (Tab.5).

The percentage of phosphorus in the soil has large variations between profiles, requiring high/low phosphor fertilization (Tab.6). The same tendency was identified also for potassium, but with a lower variation.

Tab.5

The macronutrients soil requirements on 0–30 cm depth (INCDCSZ Braşov)

Profile	N total			P			K		
	%	Duncan Test*	Clasa**	mg / kg	Duncan Test*	Clasa**	mg / kg	Duncan Test*	Clasa**
8	0.18	c	Medium	40,8	a	Good	84,4	a	Medium
9	0.29	a	Large	29,4	a	Medium	83,8	a	Medium
18	0.19	c	Medium	44,0	a	Good	105,0	a	Medium
19	0.24	b	Medium	92,0	a	Very good	107,5	a	Medium
*p = 0.05 %									
Min	0.17			26.10			65.10		
Max	0.31			122.00			125.40		
Mean	**0.23**			**51.54**			**95.16**		
(VC%)	**(21.7)**			**(60.1)**			**(20.4)**		

** Vintilă Irina *et* al, 1984

Tab.6

The macronutrients soil requirements on 0–90 cm depth (INCDCSZ Braşov)

Profile	N total			P			K		
	%	Duncan Test*	Clasa**	mg / kg	Duncan Test*	Clasa**	mg / kg	Duncan Test*	Clasa**
8	0.17	ab	Medium	40,8	a	Good	84,4	a	Medium
9	0.26	a	Medium	16,9	a	Weak	72,8	a	Medium
18	0.14	b	Medium	24,0	a	Medium	83,6	a	Medium
19	0.20	ab	Medium	48,2	a	Good	89,6	a	Medium
*p = 0.05 %									
Min	0.083			2.6			61.4		
Max	0.305			122.0			125.4		
Mean	**0.200**			**31.2**			**82.3**		
(VC%)	**(31.2)**			**(106.5)**			**(25.9)**		

Electrical conductibility results

Mean values of soil electrical conductibility were 17.0 (mS/m) for 0-30 cm depth and 18.7 (mS/m) for 0-90 depth.The soil electrical conductibility varies between 5.4-36,2 (mS/m) for 0-30 cm depth respective 5.9-35.7 (mS/m) for 0-90 cm depth.In Fig. 3 is represented the histogram with EC values in the 0-30 cm depth which shows that 42.7 % of the values are between 15 – 20 (Ms/m), medium class. The remaining values higher or lower were almost equal frequency with class limits 10–15(Ms/m) and 20–25(Ms/m).

In Fig. 4 is represented the histogram with EC values in the 0-90 cm depth. The analyses of the figure 2 reviles that the EC values are concentrated in two central frequency classes of 629 (Hz) and 641 (Hz). In the first frequency class the EC was 15-20 (Ms/m), respective 20-25 (Ms/m), for the second class. This two classes represent 71.3%. In the other cases, the frequency drops down to 334 for 10 - 15 (Ms/m) and 109 for 25 – 30 (Ms/m).

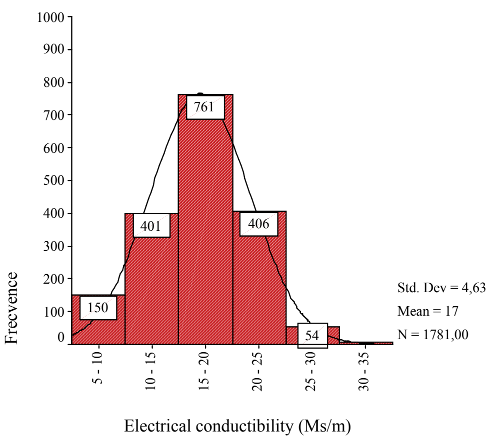

Fig. 3. EC histogram at 0-30 cm depth, 1150 plot

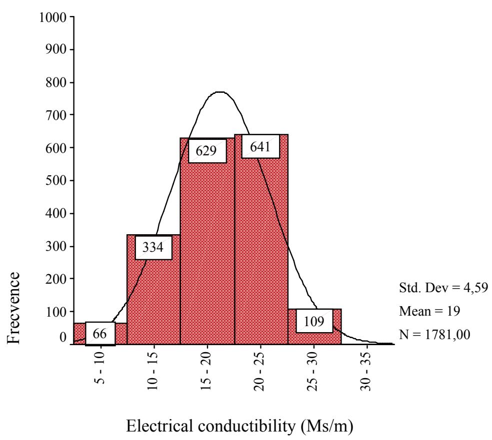

Fig. 4. EC histogram at 0-90 cm depth, 1150 plot

CONCLUSIONS

Textural differences (the percentage of clay and sand) among investigated profiles explains the big value of the variability coefficient.

The soil sample from 8 profile has a reduced saturation degree (with less basic components and nutritive elements) in comparison with the soil from other profiles.

The phosphor percentage has big variations between soil profiles (indicating or not the need to phosphor fertilization). The same variation was identified also for potassium (the soil sample profiles has medium quantity of potassium).

The obtained variation coefficients (27.23% and 24.62%) indicate a medium spatial variation of soil electrical conductibility.

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