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Application of extraction with 0.03 M CH_3COOH as the universal method in orchard soil analysis

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ABSTRACT

Investigations were carried out in 2002 – 2003 in six apple tree orchards localized on the heavy soils. Egner-Riehm's (P and K) and Schachtschabel's (Mg) methods of soil analysis were compared with common extraction with 0.03 M CH_3COOH (universal method). Significant correlations between the compared methods of analyses were found. The highest correlation coefficient was calculated in the case of K (r = 0.83 at significance level 0.05), for P and Mg this values were 0.65 and 0.45, respectively. By using the universal method 44,1% P and 35,4% K (on average) extracted from the soil by calcium lactate (Egner-Riehm method) and 40,3% Mg soluble in Schachtschabel's extract were estimated. According to the obtained results the universal method can be applied for estimation of the nutrient needs of the orchard plants, however, the temporary ranges of soil abundance in the available phosphorus, potassium and magnesium as well as the fertilizer doses proposed for them by Nowosielski (1988) should be verified.

INTRODUCTION

Fertilizer recommendations for the orchard plants are elaborated on the base of soil analysis, nutrient contents in the leaves and crop estimation (Sadowski et al. 1990, Mika 1998). In the soil only three macronutrients e.g. phosphorus and potassium by the Egner-Riehm method and magnesium by the Schachtchabel method are determined. The optimal ranges in soil test levels the available P, K and Mg for the orchards were presented in Poland for first time by Kłosowski in 1967 and modified in the eighties by Sadowski et al. (1983). The next correction of the fertilization recommendations in 1990 did not change distinctly either the limit numbers or the optimum nutrient rates (Sadowski et al. 1990). The method of Egner-Riehm, applied in the orchard production has been criticized mainly as the laborious one (Ca precipitation before K measurement), limiting the estimation of macronutrients to two only and poorly suitable for the carbonate and organic soil analysis (Trębski et al. 1971, Nowosielski 1988, Bednarek and Lipiński 1995, Komosa and Stafecka 2002). On the other hand, many authors emphasize the good correlation of that method with the plant parameters in many pot and field experiments (Fotyma and Fotyma 1995, Fotyma et al. 1996, Gosek 2000).

In Poland, in the sixties of the twentieth century, Nowosielski and co-authors introduced the common extract for macroelements, sodium, chlorine and boron determination in the soils and substrates. They modified the method of Spurway, by changing the acetate concentration from 0.02 M to 0.03 M and the soil: extractant ratio (1:10) as well as prolonging the extraction time to 30 minutes (Nowosielski et al. 1984). This method, called „universal" was calibrated and introduced to the fertilization advising system. It has been used until now in soil and horticultural substrate analysis in vegetable, ornamental plant and seed production. The universal method is not applied in the orchard production, however, Nowosielski (1988) fixed the temporary limit numbers of abundance in P, K and Mg for the orchard soils. Possibility of the application of the common method with 0.03 M CH_3 COOH extraction in the orchard soil analysis are reported by Bednarek and Lipiński (1995), Stafecka and Komosa (1998), Komosa (2000), Wrona and Sadowski (1998). In Wielkopolska region, Komosa and Stafecka (2002) estimated the macro and microelement indices for the orchard soils, analyzed by the universal method. The common extraction methods, including that of 0.03 M CH_3 COOH extraction, allow detecting in one extract many of the nutrients available for plants, to increase the effectiveness of the laboratory work as well as to reduce the costs of analyses.

The purpose of the present study was to estimate the usefulness of the universal method and the limit numbers, elaborated by Nowosielski by application of 0.03 M CH_3COOH in diagnostics of nutrient needs for the orchard plants in comparison with routine methods of soil abundance applied recently.

MATERIAL AND METHODS

The detailed characteristics of the apple tree orchards, selected for the experiment is presented in Table 1. Investigations were carried out in 2002 – 2003 in the orchards localized on the heavy soils with the 35-42% and 37-52% of the loam fraction (<0.02 mm) contents in the plough and in the subsoil level, respectively. The pH_{KCl} value in the herbicide strips and in the grass strips was 4.02-5.52 and 3.76-5.17, respectively. The organic carbon content determined in the soil layer of 0-20 cm depth was 0.71-0.97% (Table 2).

Table 1. The detailed characteristics of the orchards selected for the experiment

Orchard number	Cultivar	Rootstock	Spacing tree (m)	Planting year
1	Ligol	M 26	2.5 x 3.5	1998
2	Gala	P 22	1.5 x 2.5	1999
3	Jonagold	M 26	3.0 x 3.5	1988
4	Champion	M 26	2.5 x 3.5	1998
5	Elise	M 9	1.5 x 3.5	1998
6	Jonagored	M 9	1.5 x 3.5	1999

In the middle of July the leaf and soil samples were taken for analysis, separately from the herbicide strips (HS), grass strips (GS), as well as from the layers of 0-20 and 20-40 cm depth. The soil abundance in the nutrients was estimated according to the Egner-Riehm (P and K) and Schachtschabel (Mg) methods and also by the universal method. In the 0.03 M CH_3COOH extract mineral nitrogen ($N\text{-}NH_4$ and $N\text{-}NO_3$) was measured by the microdestilation method, P was determined by the colorimetric method with vanadium- ammonium molibdate, K, Mg and Ca were detected by the atomic absorption spectrometer (Ostrowska et al. 1991). In the soil samples the volume weight as well as the granulometric analysis by the aerometric method of Prószynski (Sady et al. 1994) was determined. The pH in water suspension (pH_{H2O}) and in 1 M KCl (pH_{KCl}) at the soil : water (or soil : solution) ratio 1:2 as well as the organic carbon content by Turin's method (Litynski 1976) were measured.

The plant material after drying at 70^{o}C was mineralized in the mixture of acids HNO_3:$HClO_4$:H_2SO_4. Contents of K, Mg and Ca were detected by the atomic absorption spectrometer, P content was estimated by the blue method with ammonium molybdate. Total nitrogen level was determined by the Kjeldhal method (Ostrowska et al. 1991).

The obtained results were statistically verified according to the variance analysis. The investigated factors were soil localization, orchard cultivation system (herbicide/grass strips) and the soil layer depth (0-20 cm or 20-40 cm). The correlation coefficients were calculated to compare the methods of phosphorus, potassium and magnesium determination as well as those between N, P, K, Mg and Ca contents detected in the leaves of apple trees and their available forms extracted from the soil with calcium lactate and with acetic acid.

Table 2. Contents of P and K determined by the Egner-Riehm's metod and Mg by Schachtschabel in the orchard soils

Orchard	Place	Soil layer (cm)	pH_{KCl}	$C_{org.}$ (%)	P (mg 100 g^{-1})	K	Mg	K/Mg
1	HS*	0-20	5.52	0.97	10.2	11.6	7,0	1.7
		20-40	5.37	0.66	4.1	6.1	7.0	0.9
	GS	0-20	5.03	0.83	9.1	12.2	6.8	1.8
		20-40	5.17	0.68	3.9	8.4	7.3	1.1
2	HS	0-20	4.02	0.97	6.9	10.7	5.2	2.1
		20-40	4.46	0.62	2.8	8.0	7.1	1.1
	GS	0-20	4.30	0.91	6.0	10.0	6.5	1.5
		20-40	4.73	0.53	2.4	7.5	7.6	1.0
3	HS	0-20	4.65	0.83	5.0	17.8	10.5	1.7
		20-40	4.57	0.59	3.4	13.2	12.7	1.0
	GS	0-20	4.55	0.85	3.0	9.7	11.0	0.9
		20-40	4.46	0.49	1.6	8.8	13.3	0.7
4	HS	0-20	4.21	0.79	6.5	26.4	11.4	2.3
		20-40	4.42	0.23	3.7	15.0	13.2	1.1
	GS	0-20	4.47	0.71	5.2	16.8	10.6	1.6
		20-40	4.41	0.21	3.1	13.7	13.6	1.0
5	HS	0-20	4.83	0.88	9.1	29.3	8.4	3.5
		20-40	4.60	0.38	5.0	21.1	9.1	2.3
	GS	0-20	4.43	0.86	6.5	23.3	8.1	2.9
		20-40	4.27	0.36	4.1	17.4	8.3	2.1
6	HS	0-20	4.20	0.92	6.7	24.7	6.6	3.8
		20-40	3.96	0.27	5.1	20.3	8.2	2.5
	GS	0-20	3.78	0.85	6.3	20.5	6.0	3.4
		20-40	3.76	0.29	4.1	18.3	6.9	2.7
$LSD_{0.05}$ for:			pH_{KCl}	$C_{org.}$	P	K	Mg	
Orchard			0.32	0.11	0.92	2.61	1.51	
Place			n.s.	n.s.	1.00	2.32	n.s.	
Soil layer			n.s.	0.04	0.75	1.15	0.41	

*HS – herbicide strip, GS – grass strip
n.s. - not significant

RESULTS AND DISCUSSION

Egner-Riehm and Schachtschabel methods

Phosphorus content estimated by the Egner-Riehm method in the herbicide strips (HS) layer 0-20 cm ranged between 5.0-10.2 mg P 100 g^{-1} and was significantly higher than that in 20-40 cm deep layer (2.8-5.1 mg P 100 g^{-1}) (Table 2). The similar interdependence was found for samples taken from the two soil levels of the grass strips, which is connected with the so called „humus effect”, increasing availability of phosphorus. Organic matter affects P mobility by phosphate absorption and, indirectly, by chelating of ions of Ca, Al and Fe, and also by formation of protective layers on the surface of the hydrated iron and aluminum oxides, responsible for P immobilization (Fotyma et al. 1987). According to the statistical analysis the significantly higher P content was found in the herbicide strips soils (5.7 mg P 100 g^{-1} on average) than in the grass strips (4.6 mg P). Considering the soil abundance in P in the HS layer 0-20 cm, in all 6 orchards the high (e.g. higher than 4 mg P 100 g^{-1}) phosphorus level was found (Table 4). According to the common recommendations, when the phosphorus content in the soil was supplemented before the orchard setting, P fertilization in the fruiting orchard is not applied because of the low mobility of this compound and its poor translocation to the tree rhisosphere (Sadowski et al. 1990).

All experiment factors e.g. soil, localization of place and depth of the soil samples significantly affected potassium content detected in the calcium lactate extracts (Table 2). The herbicide strips soils contained 10.7-29.3 mg K 100 g^{-1} and 6.1-21.1 mg K 100g^{-1} in 0-20 cm and in 20-40 cm layers, respectively. Except for the orchard No 1, potassium content determined in the samples of the grass strips was lower than in those of the herbicide strips, irrespectively of the depth of sample taking. Increase of the nutrients in the soil of the herbicide strips, mainly nitrogen and potassium, resulting from the transfer of the moved grass to the fallow, were reported by Jadczuk (1990) and Wrona and Sadowski (1998). According to estimation of the fertilization needs based on the soil abundance in K in HS layer 0-20 cm, in three of the investigated orchards (No. 4, 5 and 6) the high potassium content, higher than 21 mg K 100 g^{-1} for the heavy soils was found, in two of them the low (lower than 13 mg K 100 g^{-1}, orchards No. 1 and 2) and the medium one (13-21 mg K 100 g^{-1}, orchard No. 3) were observed. The fertilization needs of potassium for the fruiting orchards were on average 80-120 kg of K_2O ha^{-1} in the case of orchards No. 1 and 2, and 50-80 kg of K_2O for the orchard No. 3 (Table 4).

Abundance in magnesium, determined in the soil samples, treated with 0.025 M $CaCl_2$ and taken from the herbicide strips, ranged from the medium to high level both in the layer 0-20 cm (5.2-11.4 mg Mg 100 g^{-1}) and in that 20-40 cm deep (7.0-13.2 mg 100 g^{-1}) (Table 2). No significant differences of Mg content between the herbicide strips and grass strips soils were found, however, the higher magnesium level in 20-40 cm layer in comparison with 0-20 cm one was observed. Only in the case of the orchard No. 2, where the medium (4-6 mg Mg 100 g^{-1}) Mg content for the heavy soils in 0-20 cm layer was determined, was the increase of the soil fertility necessary, in the other orchards magnesium content was high and exceeded 6 mg Mg 100 g^{-1} (Table 4).

The universal method

The way of the soil cultivation in the orchard (herbicide/grass strips) affected distinctly the $N-NH_4$, potassium and calcium concentration in the soil solution, however, did not significantly influence $N-NO_3$ and the available phosphorus and magnesium. The pH_{H2O} as well as P, K, Mg and Ca contents depended on the depth of the soil samples (0-20 cm and 20-40 cm) (Table 3).

The $N-NO_3$ content was affected only by the soil localization (orchard), while the N- NH_4 level was related to the place of the sample taking (HS/GS). Significantly more ammonium nitrogen was determined in the soils of the herbicide strips (0.22-1.53 mg $N-NH_4$ 100 g^{-1}) than of the grass strips (trace to 0.52 mg $N-NH_4$). The similar results were obtained by Kozanecka (1995) and Wrona and Sadowski (1998). The total mineral nitrogen in 0-20 cm layer of the herbicide strips ranged between 0.71 to 2.46 mg 100 g^{-1} (Table 3). According to Komosa and Stafecka (2002) the optimum N_{min} concentration estimated in the 0.03 M CH_3COOH extract for the orchard soils can be 0.6-2.0 mg $N-NH_4$ + $N-NO_3$ 100 g^{-1}. In investigations of the nutrient nitrogen needs, based on the soil analysis of ammonium and nitrate nitrogen forms, the samples should not be taken both in the intensive dry weather and rainfall conditions. In the orchard production the soil samples are usually taken in the second half of July or at the beginning of August. The long-term dry weather in that time during the experiment years might have affected the obtained results. According to many reports, the soil samples for the mineral nitrogen detection should be taken in the early spring and the mineral nitrogen should be measured in them just after taking from the field (Nowosielski 1974, Fotyma and Fotyma 1995).

Similarly, as in the case of the Egner-Riehm method, phosphorus content determined by the universal method was significantly higher in the layer 0-20 cm than in that 20-40 cm deep, both in the herbicide strips and the grass strips soil (Table 3). According to the estimation of the phosphorus nutrient needs, based of the HS soil analysis in the 0-20 cm layer, the optimum soil abundance in P was found in orchards No. 1 and 2, the medium in orchards No. 3, 4, 5, and the low one in orchard No. 6. (Table 4). Nowosielski (1988) reported the nutrient needs of the orchards with the medium and low phosphorus level as high as 20 and 40 kg P ha^{-1}, respectively. According to Komosa and Stafecka (2002), the range between 3.0-6.0 mg P 100 g^{-1} can be used as the optimum for the orchard soils, analyzed by the universal method. In the present experiment only two orchards (No. 1 and 2) were characterized by the available phosphorus content of this range (Table 4).

The soil of the herbicide strips contained significantly more potassium, determined by the universal method, in comparison with the grass strips also in the layer 0-20 cm more potassium was found than in 20-40 cm one. In the herbicide strips soils 3.3-11.7 mg K 100 g^{-1} in 0-20 cm layer were found (Table 3).

Table 3. The nutrient contents determined by the universal method in the orchard soils

Orchard	Place	Soil layer (cm)	pH_{H2O}	EC ($mS\ cm^{-1}$)	N-NH_4	N-NO_3	Σ $N_{min.}$	P	K	Mg	Ca
					($mg\ 100\ g^{-1}$)						
1	HS	0-20	6.20	0.16	0.47	0.79	1.26	3.5	5.0	3.4	58.0
		20-40	6.31	0.14	0.38	0.46	0.84	1.7	3.6	2.9	42.8
	GS	0-20	5.73	0.12	0.41	1.09	1.50	6.0	7.0	4.3	57.1
		20-40	6.11	0.09	0.21	0.50	0.71	1.4	4.1	2.4	35.2
2	HS	0-20	4.84	0.21	1.53	0.93	2.46	4.5	3.3	3.1	42.0
		20-40	5.54	0.15	1.46	0.56	2.02	1.5	1.8	2.1	26.5
	GS	0-20	5.51	0.08	0.14	traces	0.14	2.9	2.6	2.7	33.3
		20-40	6.00	0.08	traces	traces	traces	1.0	1.5	2.5	29.3
3	HS	0-20	5.73	0.16	0.58	0.26	0.84	2.6	7.9	5.3	45.6
		20-40	5.76	0.18	0.22	traces	0.22	1.7	3.3	3.5	33.3
	GS	0-20	5.81	0.07	0.47	traces	0.47	1.9	4.2	4.8	41.5
		20-40	5.88	0.07	0.25	traces	0.25	1.1	1.7	3.5	28.6
4	HS	0-20	5.40	0.08	0.35	0.36	0.71	2.0	9.2	3.6	32.9
		20-40	5.68	0.08	0.60	traces	0.60	2.1	4.1	4.2	33.6
	GS	0-20	5.58	0.07	0.52	0.61	1.13	2.6	4.3	3.4	37.0
		20-40	5.69	0.05	traces	0.44	0.45	1.5	2.8	3.6	30.3
5	HS	0-20	5.70	0.11	0.60	0.52	1.13	2.8	11.7	3.8	41.6
		20-40	5.67	0.09	0.82	0.55	1.14	2.4	11.0	3.9	35.8
	GS	0-20	5.48	0.07	0.44	0.45	0.89	1.3	7.8	3.2	27.9
		20-40	5.54	0.06	0.41	0.47	0.88	1.3	5.0	3.0	24.7
6	HS	0-20	5.11	0.08	0.47	0.27	0.74	1.8	8.8	2.7	27.9
		20-40	4.90	0.10	0.70	0.78	1.48	1.5	7.8	3.4	27.9
	GS	0-20	4.84	0.04	0.31	0.40	0.71	1.3	7.7	2.9	22.4
		20-40	4.85	0.05	0.36	0.43	0.78	1.1	6.4	2.7	22.6
$LSD_{0.05}$ for:			pH_{H2O}	EC	N-NH_4	N-NO_3	Σ $N_{min.}$	P	K	Mg	Ca
Orchard			0.28	0.26	n.s.	0.26	0.44	0.72	1.62	0.52	5.95
Place			n.s.	0.21	0.19	n.s.	0.25	n.s.	0.93	n.s.	3.44
Soil layer			0.11	n.s.	n.s.	n.s.	n.s.	0.41	0.93	0.30	3.44

Table 4. Comparison of soil method results for P, K and Mg for herbicide strip in layer 0-20 cm

Nut-rient	Or-chard	Universal method				Egnera-Riehma/Schachtschabel methods		
		mg dm^{-3}	mg 100 g^{-1}	Interpretation soil test according to Nowosielski	Fertilizer recommenda-tions (kg ha^{-1}*)	mg 100 g^{-1}	Interpretation soil test	Fertilizer recommenda-tions (kg ha^{-1}**)
P	1	51.5	3.5	optimal	-	10.2	high	-
	2	59.4	4.5	optimal	-	6.9		
	3	32.4	2.6	medium	20	5.0		
	4	26.6	2.0	medium	20	6.5		
	5	38.3	2.8	medium	20	9.1		
	6	23.6	1.8	low	40	6.6		
K	1	74.4	5.0	low	200	11.6	low	80-120
	2	45.0	3.4	low	200	10.7	low	80-120
	3	99.5	7.9	medium	100	17.8	medium	50-80
	4	122.9	9.2	medium	100	26.4	high	-
	5	154.8	11.7	medium	100	29.3	high	-
	6	115.9	8.8	medium	100	24.7	high	-
Mg	1	49.9	3.4	low	20	7.0	high	-
	2	41.5	3.1		20	5.2	medium	60
	3	68.2	5.3		20	10.5	high	-
	4	48.2	3.6		20	11.4	high	-
	5	50.9	3.8		20	8.4	high	-
	6	35.2	2.7		20	6.6	high	-

* - value expressed in K, P and Mg
** - value expressed in P_2O_5, K_2O and MgO

The guide values for K (5.0-8.0 mg 100 g^{-1}) and Mg (3.0-6.0 mg) proposed by Komosa and Stafecka (2002) were calculated for the light and medium soils. These authors report that the test calibration with the very weak extraction solution is universal and irrespective of the soil properties, including soil texture. If the range of potassium content in the present investigations can be assumed as the optimum, only in the case of treatment No. 2 is the increase of the level of this compound necessary (Table 4). According to proposal of Nowosielski (1988) for the heavy soils, in two orchards (No. 1 and 2) the poor potassium content was observed while in four (No. 3, 4, 5 and 6) the medium one was found (Table 4). The nutrient needs determined by the universal method were 200 and 100 kg K ha^{-1} for the low and medium potassium abundance, respectively.

The level of magnesium extracted with 0.03 M CH_3COOH in soil samples of the herbicide strips was low both in 0-20 cm (2.7-5.3 mg Mg 100 g^{-1}) and in 20-40 cm (2.1-4.2 mg Mg 100 g^{-1}) layers (Table 3). According to Nowosielski (1988) in all six soil treatments fertilization with this compound was necessary at the rate 20 kg Mg ha $^{-1}$, while according to Komosa and Stafecka (2002) only in the orchard No. 6 (Mg content lower than 3.0 mg Mg 100 g^{-1}) (Table 4). Calcium level, detected by the universal method ranged between 22.4-58.0 mg 100 g^{-1} (Table 3). The higher Ca concentration was found in the extract of the 0-20 cm layer than in that of 20-40 cm one, and in the herbicide strips than in the grass strips.

Correlations of the compared methods

The significant correlation between the compared methods of analyses was found. The highest correlation coefficient was calculated in the case of potassium (r = 0.83 at significance level 0.05; y = 0.533 + 0.348 x, where y – result of detection in 0.03 M CH_3COOH in mg 100 g^{-1}, x – result of detection by Egner-Riehm method in mg 100 g^{-1}), for phosphorus and magnesium this value was 0.65 (y = -0.5272 + 0.392 x) and 0.45 (y = 2.0959 + 0.142 x) respectively. By the universal method 44.1% P and 35.4% K (on average) extracted from the soil by calcium lactate (Egner-Riehm method) and 40.3% Mg soluble in Schachtschabel's extract were estimated. In the Egner-Riehm method the strong extracting solution, well buffered against H^+ and Ca^{+2} concentration, being decisive in the soluble phosphorus forms solubility, extracts partially also the storage forms of it, e.g. P absorbed specifically on the hydrated Al and Fe oxides as well as on calcium carbonate molecules (Egner et al. 1960, Fotyma et al. 1987).

In Schaschabel's method extraction is carried out with 0.025 M $CaCl_2$, because of the reversibility of exchange between the calcium ions of extractant and Mg ions absorbed, only part of exchanchable magnesium and the whole content of soil solution Mg is determined by this method. The diluted weak organic acid, applied in the universal method, extracts from the soil only easily available for the plants, active forms of nutrients (Nowosielski 1974).

Plant nutrition

The total nitrogen content determined in the leaves of apple tree grown in the investigated six orchards was ranged between from the low (1.8-2% N) to the optimum (2.1-2.4%) (Table 5). In the investigated plant material the optimum phosphorus level was observed (0.16-0.25% P) and the optimum (1-1.5% K in orchard No. 2) and high level of potassium (>1.5% in orchards No. 1, 3, 4, 5 and 6). The highest variability was found in the case of magnesium: the deficit content (<0.18% Mg) was estimated in orchards No. 5 and 6, the low in No. 4 and the optimum in No. 1 and 3, while the high (>0.32%) level of this element was detected in orchard No. 2. The deficit and low magnesium content found in orchards No. 4, 5 and 6 was probably due to the elevated content of potassium (Table 2). Because of the competition between cations of rhisosphere the high potassium concentration in the soil solution can cause insufficient supply of plants in magnesium (Zydlik and Pacholak 1998). Calcium content in the plant material ranged between 0.7-2.4% Ca, considered as the normal level (Kenworthy, after Sadowski 1967).

Table 5. Nutrient contents (% d.m.) in the apple leaves

Orchard	N	P	K	Mg	Ca
1	1.97 c	0.21 a	1.58 a	0.25 bc	1.76 b
2	2.48 ab	0.26 b	1.19 d	0.42 d	2.09 c
3	2.29 a	0.19 a	1.68 ab	0.30 c	1.63 b
4	2.44 ab	0.26 b	1.72 abc	0.20 ab	0.84 a
5	2.55 ab	0.22 ab	2.06 c	0.13 a	0.90 a
6	2.60 b	0.19 a	2.01 bc	0.14 a	0.99 a

CONCLUSIONS

1. Compared methods of the soil chemical analysis were significantly correlated.
2. By using the universal method 44.1% P and 35.4% K (on average) extracted from the soil by calcium lactate (Egner-Riehm method) and 40.3% Mg soluble in Schachtschabel's extract were estimated.
3. The place (herbicide/grass strips) as well as the depth of the soil samples taking (0-20 cm/20-40 cm) significantly affected the compound content detected by the universal method. In the soil of the herbicide strips higher EC, $N-NH_4$, K and Ca contents were found. The 0-20 cm layer was more abundant in $N-NO_3$, P, K, Mg and Ca.
4. In the leaves of apple trees taken from the investigated orchards the high level of potassium, optimum of phosphorus and calcium, deficit to optimum of nitrogen and deficit to high of magnesium was found. Only potassium content in the leaves was dependent on K concentration, extracted from the soil both with 0.03 M CH_3COOH and with calcium lactate.
5. According to the obtained results the universal method can be applied for estimation of the nutrient needs of the orchard plants, however, the temporary ranges of soil abundance in the available phosphorus, potassium and magnesium as well as the fertilizer doses proposed for them by Nowosielski should be verified.

REFERENCES

BEDNAREK W., LIPIŃSKI W., 1995. Rozpuszczalne formy fosforu w glebie poddanej oddziaływaniu następczemu zróżnicowanego nawożenia mineralnego. Zesz. Probl. Post. Nauk. Rol. 421: 15-20.

EGNER H., RIEHM H., DOMINGO W.R., 1960: Untersuchungen veber die chemische bodenanalyse als grundlage fur die bevrteilung des nahrstoffzustandes der boden. II. Chemische extraktionsmetoden zu phosphor – und kaliumbestimmung K. Lantbr. Hogsk. Annlr. 26: 199-215.

FOTYMA M., MERCIK ST., FABER A., 1987. Chemiczne podstawy żyzności gleby i nawożenia. PWRiL, Warszawa.

FOTYMA M., FOTYMA E., 1995. Współczesne metody badania żyzności gleby i możliwości ich wykorzystania w doradztwie nawozowym. Zesz. Probl. Post. Nauk Roln. 421: 95-104.

FOTYMA M., GOSEK S., SZEWCZYK M., 1996. Porównanie przydatności różnych metod określania odczynu gleby oraz zawartości przyswajalnych form fosforu, potasu i magnezu. Rocz. Gleb. 1-2: 65-78.

GOSEK S., 2000. Ocena metod oznaczania przyswajalnego fosforu w glebie. Fertilizers and fertilization 4(5): 144-152.

JADCZUK E., 1990. Transport of mineral elements from grassed alleyways to herbicide strips as a results of grass mowing. Acta Hort. 274: 201-205.

KOMOSA A., 2000. In: Nowoczesne diagnozowanie potrzeb nawozowych roślin sadowniczych. VIII Konf. Nauk. „Efektywność stosowania nawozów w uprawach ogrodniczych”. Warszawa: 11-16.

KOMOSA A., STAFECKA A., 2002. Zawartości wskaźnikowe składników pokarmowych dla gleb sadowniczych analizowanych metodą uniwersalną. Roczn. AR w Poznaniu CCCXLI Ogrod. 35: 105-117.

KOZANECKA T., 1995. Zawartość mineralnych form N-NH_4 i N-NO_3 w glebie sadu jabłoniowego. Roczn. Gleb. XLVI 1/2: 105-117.

LITYŃSKI T., JURKOWSKA H., GROCHALA E., 1976. Analiza chemiczno–rolna. PWN, Warszawa.

MIKA A., 1998. In: Uwagi o nawożeniu sadów. I Ogólnopolskie Sympozjum Mineralnego Odżywiania Roślin Sadowniczych. Skierniewice: 3-10.

NOWOSIELSKI O., 1974: Metody oznaczania potrzeb nawożenia. PWRiL Warszawa.

NOWOSIELSKI O., ELLIS E., CZERNIEWSKA W., STRAHL A., TOKARZ A., 1984. Common exstraction of trace elements from horticultural soil and substrates. Acta Hort. 145: 296-296.

NOWOSIELSKI O., 1988. Zasady opracowywania zaleceń nawozowych w ogrodnictwie. PWRiL, Warszawa.

OSTROWSKA A., GAWLIŃSKI S., SZCZUBIAŁKA Z., 1991. Metody analizy i oceny właściwości gleb i roślin. Instytut Ochrony Środowiska, Warszawa.

SADOWSKI A., 1967. Zawartość składników pokarmowych w liściach a wzrost jabłoni. Zesz. Nauk. SGGW, 4: 43-54.

SADOWSKI A., HOŁUBOWICZ T., NURZYŃSKI J., PACHOLAK E., 1983. Określenie potrzeb nawożenia roślin sadowniczych. Instrukcje upowszechnieniowe. Ser. F, 25: 1-18.

SADOWSKI A., NURZYŃSKI J., PACHOLAK E., SMOLARZ K., 1990. Określenie potrzeb nawożenia roślin sadowniczych. II. Zasady, liczby graniczne i dawki nawożenia. Instrukcja upowszechnieniowa 3, Warszawa: 6-9.

SADY W., DOMAGAŁA I., KOWALSKA I., LIS – KRZYŚCIN A., OSTROWSKA J., 1994. Przewodnik do ćwiczeń z uprawy roli i nawożenia roślin ogrodniczych. AR Kraków.

STAFECKA A., KOMOSA A., 1998. Wspólny wyciąg do analizy gleb sadowniczych. I Ogólnopolskie sympozjum mineralnego odżywiania roślin sadowniczych, Skierniewice: 21-27.

TRĘBSKI L., SORCZYŃSKI W., SZOT A., WITKOWSKA H., 1971. Wstępne badania nad przydatnością metod: Egnera-Riehma, Gohlera oraz zmodyfikowanej metody Spurwaya do ustalenia potrzeb nawożenia roślin warzywnych. Pamiętnik Puławski 50: 137-152.

WRONA D., SADOWSKI A., 1998. In: Efekty nawożenia jabłoni azotem w pierwszych czterech latach po posadzeniu. I Ogólnopolskie sympozjum mineralnego odżywiania roślin sadowniczych. Skierniewice: 113-128.

ZYDLIK Z., PACHOLAK E., 1998. In: Wpływ wieloletniego zróżnicowanego nawożenia N, P, K i Mg na wzrost i plonowanie jabłoni odmiany Cortland oraz zawartość składników w glebie i liściach. I Ogólnopolskie sympozjum mineralnego odżywiania roślin sadowniczych. Skierniewice: 100-111.

ZASTOSOWANIE METODY WSPÓLNEJ EKSTRAKCJI Z 0,03 M CH_2COOH W ANALIZIE GLEB W SADOWNICTWIE

Streszczenie: Badania prowadzono w latach 2002–2003 w sześciu sadach jabłoniowych założonych na glebach ciężkich. Ocenę zasobności gleb w składniki pokarmowe prowadzono metodą Egnera-Riehma (P i K) i Schachtschabela (Mg) oraz z wykorzystaniem testu uniwersalnego z ekstrakcją 0,03 M CH_3COOH. Wartość współczynników korelacji była najwyższa dla potasu (r = 0,83, istotne dla p = 0,05), a dla fosforu i magnezu wynosiła odpowiednio r = 0,65 i r = 0,45. Wykazano istotną korelację pomiędzy porównywanymi metodami analiz gleby. Metodą uniwersalną oznaczano średnio 44,1% P i 35,4% K ekstrahowanego z gleby mleczanem wapnia (metoda Egnera-Riehma) oraz 40,3% Mg przechodzącego do wyciągu Schachtschabela. Uzyskane wyniki badań wskazują, że metoda uniwersalna może być stosowana do oceny potrzeb nawożenia roślin sadowniczych, ale uściślenia wymagają tymczasowe przedziały zasobności w przyswajalny fosfor, potas i magnez oraz dawki nawozów zaproponowane dla tych przedziałów przez Nowosielskiego (1988).

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