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Mn and Co Levels in various Soil Types of Central Backa

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Abstract: A determination of pseudo-total contents of Mn and Co has been done within the framework of the soil fertility control system established at the production plots of the Agro-Industrial Combine "Becej" in central Backa. The production plots of AIC "Becej" cover 15,826.11 ha and they include eight soil types. Analyses were done on 348 samples gathered in the period 1990-1996.

The analyzed soils were found to contain high, very high and toxic levels of Mn. The toxic levels, which were very close to the upper limit of the category of very high level, were established at 347.68 ha or 2.2% of the total area. The plots with the toxic Mn levels belong to the following soil types: the calcareous chernozem soil, the gleying chernozem soil and the calcareous black meadow soil.

High Mn levels were found at only 90.28 ha or 0.57% of the total area. Very high Mn levels, which were characteristic for the production plots of the AIC "Becej", were found at 15,388.11 ha or 97.23% of the total area.

The AIC "Becej" has no plots with toxic levels of Co. Very high Co level, The maximum level of 5.92 mg/kg was found in a plot belonging to the category of very high Co provision. This category, however, covers only 10.13% of the total area analyzed. As the medium Co level was established at only 4.72% of the total area, it means that the remaining acreage may be classified in the category of high Co level. High Co level was found at 13,475.43 ha or 85.14% of the total area.

Key words: Mn, Co, level, chernozem, hydromorphic black soil, black meadow soil.

Introduction

The level of soil provision with Mn depends on its amount present in the native substrate from which this soil had developed. A study of (Jakovljevic et al., 1997) showed that various soil types differed in total Mn content. The content is highest in alluvial soils and lowest in smonitza soils. A study of Sekulic et al., (1997) indicated that different varieties of the chernozem soil did not differ much in the Mn level, which ranged from 224.93 mg/kg in the gleyed chernozem soil to 299.34 mg/kg in the calcareous gleyed chernozem soil. Sekulic has found a significantly higher Mn level, 730.9 mg/kg, in pseudogley soils of the Sabac-Loznica region; however, there existed a variation in Mn levels which depended on the method of land use - the highest Mn level was found in meadows, the lowest in orchards. Plants take up Mn in the form of Mn^{2+} while its availability depends largely on the presence of H^+ ions (Kastori, 1997). Mn becomes toxic in soils formed on acid volcano and metamorphic rocks, especially if such soil are exposed to prolonged waterlogging. Agricultural soils of the region of Backa have high or very high Mn levels. A study of (Hadzic et al., 1996) showed that of about 15,000 ha of land in the municipality of Backi Petrovac, several hundred hectares had toxic Mn levels with the highest value of 432.70 mg/kg. Several studies have shown that various soil types also differ in the level of available forms of Mn. Milovac et al., (1997) reported that the humogley soil of central Banat has a significantly higher Mn level than the chernozem soil.

The importance of Co as a soil constituent is in its role of an essential element for ruminants and microorganisms. The level of soil provision with Co depends on its amount present in the native substrate from which this soil had developed. Its total content varies largely, from 0.05 to 300 mg/kg, but its average content is 10-15 mg/kg (Aubert and Pinta, 1977). Co availability decreases in proportion with pH increase. Co level is low in soils with a high content of organic matter and in soils with a high portion of clay, especially the clays with a high capacity to distend its lamellas (Saciragic, 1988). Co deficiency occurs in sandy soils, which had developed from acid rocks, calcareous and peat soils. According to the study conducted in the municipality of Backi Petrovac, the soils in the region of Backa have medium to high Co levels (Hadzic et al., 1997). Analyzing the Co level in different soil types, (Jakovljevic et al., 1997) found highest contents in alluvial soils and lowest in brown forest soils. A study of the pseudogley soils of the Sabac-Loznica region showed that they invariably had high Co levels, regardless of the method of land use (Sekulic et al., 1997).

Material and methods

In the period 1990-1996, soil sampling to the depth of 30 cm was done within the framework of the soil fertility and fertilizer use control system established in the location of Becej. The collected samples were analyzed for basic chemical properties and the contents of Mn and Co. Mn and Co were

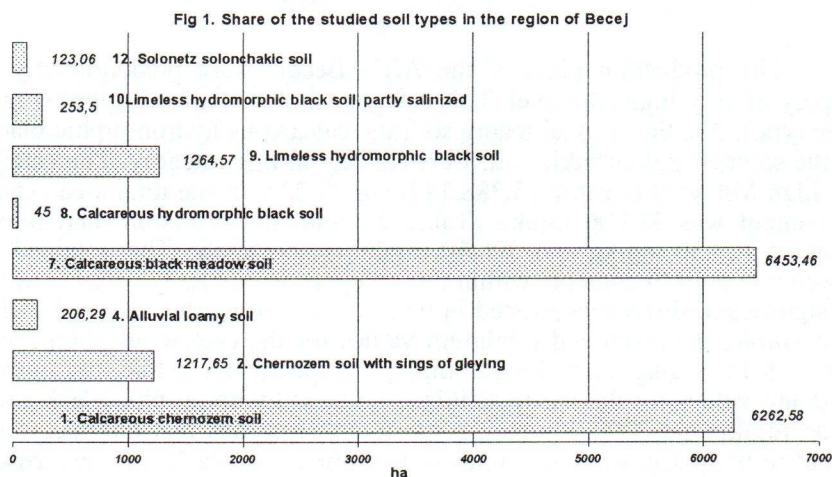
determined after extraction with 1M HCl and measurements on a Varian 600 atomic absorption spectrophotometer. The samples were classified for the Mn and Co level according to Durman (1989). Each category was analyzed for the proportion of the various soil types present in it. Data processing was done with the Excel program package.

Tab. 1 - Soil classification for Mn and Co level according to Durman (1989) following the extraction with 1M HCl

Supply level	Mn (mg/kg)	Co (mg/kg)
Very low	< 5,0	<0.2
Low	5-10,0	0.2-1.0
Medium	10-50,0	1-3.0
High	50-100,0	3-5.0
Very high	100-400,0	5-20.0
Toxic	> 400,0	> 20,0

Results and discussion

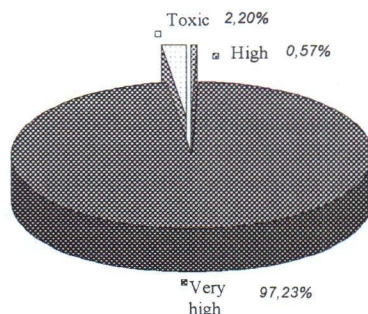
The analysis of soil properties of the production plots of the AIC "Becej" included the area of 15,826.11 ha. Eight soil types were distinguished in that area (Figure 1). The calcareous chernozem soil and the chernozem variety with signs of gleying were the most widespread soil types. The second largest soil type, the calcareous black meadow soil, covered 6,453.46 ha. The third type was the limeless hydromorphic black soil. The remaining five soil types covered less than 300 ha each and they are not discussed in this paper.



The analysis of the Mn categories in the soils of the production plots of the AIC "Becej" showed that high and very high Mn levels predominated while toxic levels were encountered on a limited acreage (Figure 2). High Mn levels

were found in two plots with the total area of 90.2 ha. The mean Mn content for these plots was 95.44 mg/kg, which is close to the upper limit of this category (Table 2). Very high Mn levels were found in 97.23% of the analyzed area. It is an indication that plants are well supplied with this element. Toxic Mn levels, over 400 mg/kg, were found in ten samples, *i.e.*, at the area of 347,68 ha or 2.20% of the total area. The toxic levels were detected in three samples of the calcareous chernozem soil, three samples of the chernozem with signs of gleying and four samples of the limeless black meadow soil. The mean values for these soil types were 422.57 mg/kg, 417.33 mg/kg and 405.1 mg/kg, respectively. The highest Mn level of 454.7 mg/kg was found in a sample of the calcareous chernozem soil (Table 2). The above values show that the actual toxic levels of Mn do not exceed the toxicity limit, when Mn becomes detrimental for plant growth and development, by more than 10%. Here it should be mentioned that some authors claim that Mn levels up to 1,000 mg/kg should not be qualified as toxic but as harmless for plant growth and development.

Fig.2. Mn categories in the production plots of the AIC Becej

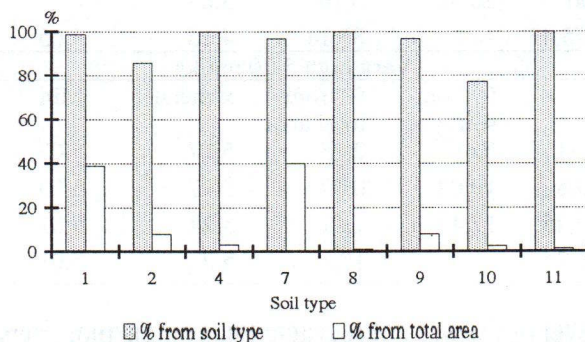


The production plots of the AIC "Becej" were predominantly in the category of very high Mn level. This category included all soil types (Figure 3). Some types, like the alluvial loamy soil, the calcareous hydromorphic black soil, and the solonetz solonchakic soil, were entirely in this category. The category of very high Mn level covered 15,388.14 ha or 97.23% of the total area. The mean Mn content was 315.06 mg/kg (Table 2), with the minimum and maximum values of 103.30 mg/kg and 396.50 mg/kg, respectively. The obtained results showed that the Mn contents within this category were highly variable as well as that significant differences existed in that respect among the analyzed soil types. For example, the mean and minimum values for the calcareous chernozem soil were 338.15 mg/kg and 264.90 mg/kg, respectively, while the mean and maximum values for the partly salinized limeless hydromorphic black soil were 151.56 mg/kg and 200.20 mg/kg, respectively. It means that the maximum Mn content in the partly salinized limeless hydromorphic black soil was lower than the minimum Mn content in the calcareous chernozem soil.

Tab. 2. Mn levels according to categories

High 50-100,0 mg/kg						
Type	ha	%from soil type	%from total area	x-mean	Min	Max
9	34,33	2,71	0,22	95,94		
10	55,96	22,07	0,35	95,44		
Total	90,29		0,57	95,69		
Very high 100-400,0 mg/kg						
Type	ha	% from soil type	% from total area	x-mean	Min	Max
1	6217,29	99,28	39,28	338,15	264,90	396,50
2	1074,65	88,26	6,79	337,58	289,80	391,40
4	206,29	100,0	1,30	251,77	169,10	373,30
7	6294,07	97,53	39,77	334,34	263,80	392,90
8	45,00	100,0	0,28	172,60	-	-
9	1230,24	97,28	7,77	183,55	103,30	353,10
10	197,54	77,92	1,25	151,46	106,6	200,20
11	123,06	100,0	0,78	189,94	163,11	229,40
Total	15388,14		97,23	315,06	103,3	396,50
Toxic > 400,0 mg/kg						
Type	ha	% from soil type	% from total area.	x-mean	Min	Max
1	45,29	0,72	0,29	422,57	404,70	454,70
2	143,00	11,74	0,90	417,33	406,10	437,5
7	159,39	2,47	1,01	405,10	402,40	410,20
Total	347,68		2,20	414,01	402,40	454,70

Fig. 3. Land area in the category of very high Mn level



The production plots of the AIC "Becej" were found to belong to three categories of Co provision. The largest portion of the plots was in the category of high Co level (3.0-5 mg/kg). The areas belonging to the categories of very high

and medium Co level (5-20.0 mg/kg and 1-3.0 mg/kg, respectively) were similar in size.

Six soil types were found in the category of medium Co level. The mean Co content for the area of 747.4 ha was 2.54 mg/kg. The entire acreage of the calcareous hydromorphic black soil and 79.68% of the solonetz solonchakic soil were in this category (Table 3). In the soil types from this category, the Co content ranged between 1.21 and 3.00 mg/kg.

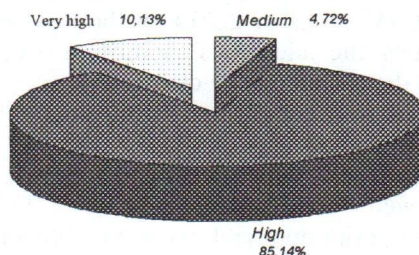
Tab. 3. Co level according to categories

Medium 1-3,0 mg/kg						
Type	ha	% from soil type	% from total area	x-mean	Min	Max
1	-	-	-	2,89	-	-
7	-	-	-	3,00	-	-
8	45,00	100,00	0,28	2,88	-	-
9	474,30	37,51	3,00	2,66	1,87	2,98
10	130,08	51,31	0,82	2,62	2,23	2,86
11	98,06	79,68	0,62	1,89	1,21	2,85
Total	747,44		4,72	2,54	1,21	3,00
High 3-5 mg/kg						
Type	ha	% from soil type	% from total area	x-mean	Min	Max
1	5906,87	94,32	37,32	4,11	3,08	4,98
2	1015,57	89,97	6,92	4,16	3,42	4,97
4	206,29	100,00	1,30	3,72	3,45	4,82
7	5328,01	82,56	33,67	4,37	3,11	4,97
9	790,27	62,49	4,99	3,56	3,05	4,55
10	123,42	48,69	0,78	3,64	3,31	3,94
11	25,00	20,31	0,16	3,87	-	-
Total	13475,43	-	85,14	4,16	3,05	4,98
Very high 5-20 mg/kg						
Type	ha	% from soil type	% from total area	x-mean	Min	Max
1	355,71	5,68	2,25	5,17	5,03	5,40
2	122,08	10,03	0,77	5,17	5,03	5,32
7	1125,45	17,44	7,11	5,24	5,01	5,92
Total	1603,24	-	10,13	5,22	5,01	5,92

Toxic level of Co was not registered in a single plot. Very high Co levels were found at the area of 1,603.24 ha which included three soil types. The calcareous black meadow soil had the highest relative portion of its area in this category - 17.44% (Table 3). The areas of the other two soil types were below 10%. The mean, minimum and maximum Co values within this category were

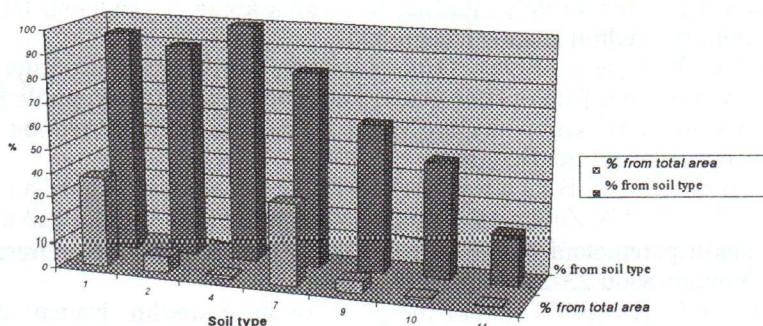
5.22 mg/kg, 5.01 mg/kg and 5.92 mg/kg, respectively. The obtained values indicate that the maximum Co value is not significantly above the lower limit value of the category, *i.e.*, it is not close to the upper limit value which, for this category, is 20.0 mg/kg.

Fig. 4. Co categories in the production plots of the AIC Becej



The production plots of the AIC "Becej" were predominantly in the category of high Co level (3-5.0 mg/kg). This category was found in 287 samples that covered 13,475.43 ha or 85.14% of the total area (Table 3). The category included seven soil types. It was the predominant category with the alluvial loamy soil, while 94.32% of the calcareous chernozem soil were also within the limits of 3 and 5.0 mg/kg (Figure 4). Furthermore, 89.97% of the area under the chernozem soil with signs of gleying was in this category. So, it can be concluded that this category of Co provision was characteristic for the different chernozem varieties and the alluvial loamy soil at the AIC "Becej". High Co levels were characteristic for the calcareous black meadow soil - they were found at 82.56% of the area under this soil type or at 33.67% of the total area (Figure 4). A similar percentage, 62.49%, was established for the limeless hydromorphic black soil. Within this category, the minimum, maximum and mean Co values were 3.05 mg/kg, 4.98 mg/kg and 4.163 mg/kg, respectively.

Fig. 5. Land area in the category of high Co level



Conclusion

The analysis of Mn and Co levels in 348 soil samples from the production plots of the Agro-Industrial Combine "Becej" which cover 15,826.11 ha indicated the following.

With regard to the established Mn level, the analyzed soils belonged to three categories: high, very high and toxic.

Toxic Mn levels, but hardly above the upper limit of very high Mn levels, were found at 347.68 ha or 2.20% of the total area. This area was under the following soil types: the calcareous chernozem soil, the chernozem soil with signs of gleying, and the calcareous black meadow soil.

High Mn levels were established for the area of 90.28 ha or 0.57% of the total area.

Very high Mn levels, which were characteristic for the production plots of the AIC "Becej", were found at 15,388.11 ha or 97.23% of the total area. In this category, the mean, minimum and maximum Mn values were 315.06 mg/kg, 103.30 mg/kg and 396.50 mg/kg, respectively.

Toxic level of Co was not registered in a single plot of the AIC "Becej". The highest level, found in the category of very high Co level, was 5.92 mg/kg. This category occupied only 10.13% of the total analyzed area.

As the medium Co level was established at only 4.72% of the total area, it means that the remaining acreage may be classified in the category of high Co level.

Very high Co levels were found in 85.14% of the samples tested or at the area of 13,475.43 ha. The mean, minimum and maximum Co values within this category were 4.16 mg/kg, 3.05 mg/kg and 4.98 mg/kg, respectively.

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OBEZBEĐENOST Mn i Co RAZLICITIH TIPOVA ZEMLJIŠTA U CENTRALNOJ BAČKOJ

- originalni naučni rad -

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Rezime

Na području centralne Bačke, odnosno na proizvodnim površinama PIK-a Becej na 15.826,11 ha koji su svrstani u osam tipova zemljišta u okviru programa sistema kontrole plodnosti zemljišta izvršeno je I određivanje sadržaja pseudoukupnog sadržaja Mn i Co. Istraživanje je sprovedeno iz uzoraka iz perioda 1990-1996 godine na 348 uzoraka.

U pogledu obezbeđenosti zemljišta Mn ona pripadaju trima klasama, visokoj, vrlo visokoj i toksičnoj klasi obezbeđenosti Mn. Toksičan sadržaj Mn, ali veoma blizak gornjoj granici vrlo visoke obezbeđenosti Mn utvrđen je na 347,68 ha ili 2,20% ispitivane površine, na parcelama koje pripadaju sledećim tipovima zemljišta: cernozem karbonatni, cernozemu sa znacima oglejavanja i livadska crnica karbonatna.

Visok sadržaj Mn utvrđen je tek na površini od 90,28 ha ili 0,57% ispitivane površine. Vrlo visok sadržaj Mn karakteristican je za proizvodno područje PIK-a Becej i utvrđen je 97,23% ispitivanih površina ili 15388,11 ha.

Područje PIK-a Becej nema parcela sa toksičnim sadržajem Co. Najviši utvrđeni sadržaj je u klasi vrlo visoke obezbeđenosti i iznosi 5,92 mg/kg, a ova klasa zauzima tek 10,13% ispitivane površine. Srednji nivo Co utvrđen je na 4,72% površine, te na osnovu toga možemo zaključiti da ova zemljišta pripadaju visokom nivou obezbeđenosti Co. Visok nivo obezbeđenosti Co utvrđen je na 85,14% ispitivanih uzoraka ili površini od 13475,43 ha.