CHEMICAL SOIL PROPERTIES IN APPLE ROOTSTOCK STOOL-BEDS WITH SPECIAL EMPHASIS TO THE CONTENT OF COPPER
AUGSNES ĶĪMISKĀS ĪPAŠĪBAS ĀBEĻU POTCELMU MĀTESAUGU STĀDĪJUMĀ ĪPAŠI AKCENTĒJOT VARU

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Kopsavilkums

Ābeļu potcelmu mātesaugu rindās augsne saturēja vairāk organiskās vielas, fosfora, kālija, magnēzija un kopējo slāpekli, nekā blakus esošā starprindu augsne (kontroles variants). Šīs atšķirības tika konstatētas augsnes virskārtā un bija nozīmīgas tikai dažos gadījumos. Vairāk pētīto elementu (izņemot magnēziju) tika atrasti starprindu augsnē mātesaugu stādījumā nekā rindās. Vara satura palielinājums saistāms ar varu saturošo defoliantu lietošanu. Tomēr šis vara satura palielinājums mātesaugu stādījumā kopumā nav būtisks un tika konstatēts 0 – 25 cm dziļumā. Būtiski augstāks tas ir potcelmu mātesaugu rindu augsnē.

Abstract

Soil in apple rootstock stool-beds contained more organic matter, phosphorus, potassium, magnesium and total nitrogen than that in the nearby bare land (control field). These differences were evident mainly in the superficial soil layers and were significant only in some cases. Similarly, more of the examined elements (except for magnesium) were found in the soil between the rows of plants within the stool-beds than in the rows of rootstocks. The increase in total copper level in the soil used in stool-beds was observed over some consecutive years as a result of the use of rootstock defoliation compounds containing copper. Yet this Cu increase was not significant and it occurred in the soil layer 0 – 25 cm. deep. Significantly more copper was found in the soil taken from between the plant rows in stool-bed than from the stool beds.

Key words: stool-bed, soil, chemical properties, copper

Introduction

The number of rooted layers in the apple rootstock stool-bed varies between 30000 and 320000 per ha yearly, depending on the age of plants and type of rootstock (Rejman and Makosz, 1994). For effective rooting, shoots should have optimal conditions concerning chemical and physical soil properties. To improve these conditions and to control weed growth, sawdust is often used to mound the low parts of shoots. The volume of sawdust may reach 3000 m^3 per hectare. Layers are defoliated by hand and/or chemically and leaves remain in the plantation. We did not find in the literature any data dealing with the effect of sawdust on the chemical properties of the soil in stool-beds and on the impact of defoliants use (copper sulphate as Miedzian 50 WP and copper chelate as Insol 240 SL) on the copper content in the soil. The last problem is important because of the threat of possible environment pollution.

Materials and Methods

These studies were carried out in two stool-beds of the apple rootstock M.9 and M.26 situated in the Lublin area, Poland, on Haplic Luvisol type of soil. The chemical analyses of the soil (pH, organic matter, P_2O_5, K_2O, MgO, total N and total Cu) were done in 1999, 2000 and 2002 in soil from 0-25, 25-50, 50-75 and 75-100 cm level. Similar analyses were done in summer 2002 using soil taken from control plots situated close to the stool-beds, which was never used for nurseries or orchards. At the same time, soil samples were taken from stool-bed interrows and rows of rootstocks and then analysed. The following analytical methods for: pH in 1M KCl, organic matter by Tiurin, N by Kjeldahl, K and P by Egner-Riehm, Mg by Schachtschabel and Cu by ASA were used for all examined samples. The soil samples were taken from randomly selected plots in three replications separately from plant rows and interrows. The data was subjected to analysis of variance, and the mean separation of Duncan's multiple range tests was used at P 0.05. Similar tendencies were found in

both stool-beds, so the results are presented as means for both of them. Since 2000 chemical defoliation of layers was done every year according to Basak's (1999) recommendations.

The data were subjected to analysis of variance, and mean separation of Duncan's multiple range tests was used at $P<0.05$.

Results and Discussion

Organic matter. Soil in the total profile (0 – 100 cm) in the stool-beds contained more organic matter than in the control plots. This was true only in two superficial layers, whereas in the deeper ones (50 – 75 and 75 – 100 cm) more organic matter was found in the soil from the control fields. The tendency towards the higher content of organic matter in the soil in alleyways was observed, especially in the layer 0 – 25 cm deep. These differences were, however, not significant.

Phosphorus. The content of this element was significantly higher in the whole soil profile in stool-beds in comparison with control plots. Differences were significant also in the layer 0 – 25 cm. deep. Also, soil in two superficial layers in the stool-bed interrows contained more P_2O_5 than in the rows (significantly in the level 25 – 50 cm)

Potassium. Soil in the stool-beds contained more potassium than in control fields, especially in the superficial levels. However, these differences were not significant. There was more potassium in the soil in the alleyways than in the rows of rootstocks, with the exception for the layer 75 – 100 cm. deep.

Magnesium. Differences of magnesium between the soil in stool-beds and control plots were small and not significant, but somewhat pronounced in stool-beds in both deep layers only (50 – 100 cm). In all soil layers there was a tendency toward a higher content of magnesium in the rows of rootstocks than between them.

Total nitrogen. The level of nitrogen was higher in all levels of the soil in stool-beds in comparison with control plots, but these differences were not significant. In the soil in the alleyways there was more nitrogen than in the rows, except the layer 50 – 75 cm deep.

Soil pH. In all layers studied, soil in the stool-beds was generally less acid than in control fields. Soil in the rows and between them did not differ significantly in this respect, although the tendency towards more acid soil in the rows in the layers 25 – 100 cm could be seen when compared with the soil from between the rows.

Total copper. The content of Cu steadily increased in all soil layers in stool-beds in the years 1999 – 2002, with the exception for the level 25 – 50 cm. This phenomenon was observed also when the whole soil profile was examined, i.e. the content of copper was 6.61; 7.10 and 7.49 mg kg^{-1} of dry soil for the years 1999, 2000 and 2002, respectively. Clearly a higher level of copper was found in two superficial layers of soil from alleyways when compared with the rows of rootstocks. However, this was contrary to the situation in the deeper layers. The layers of soil 0 – 25 and 75 – 100 cm deep in the stool-beds contained more copper than in control soil.

It is possible to point out tendencies in the changes of chemical properties in the soil between stool-beds and control fields as well as between the soil in rows and between them, inside stool-beds. However, significant differences were observed in a few cases only, mostly in the superficial layers of the soil (0 – 25 and 25 – 50 cm. deep). It could be concluded, that the soil in the stool-beds was richer in macroelements and organic matter than that in control plots, which has resulted from both fertilizing and use of sawdust. As compared with the rows of rootstocks, the soil in the alleyways contained more of almost all elements studied (except for magnesium). However, this was mainly in the superficial layers. In the layers deeper than 50 cm. all these differences were small. This phenomenon could be explained by the fact that the soil surface between the rows is lower that that in the rows as a effect of mounding the plants. So all the leaves as well as fertilizers tended to accumulate between rows. This would also explain the fact that more copper was found in the soil of the alleyways. The content of copper in this layer increased steadily in consecutive years. The highest content of this element was observed in two deep layers (50 – 100 cm.), but its concentration was far less than considered by Siuta (1995) as medium for Polish soils (15 mg) and recently found in the orchard soil near Szczecin (Ostrowska *et al*., 2004).

Table 1. Some chemical properties of soil in stool-beds and in control field

Chemical properties	Position in stool-bed		Stool-bed	Control field
	rows	alleyways		
Organic matter %				
Whole profile	0.86 a	1.03 a	0.95 a	0.73 a
Soil layers: 0 – 25	1.74 a	2.75 a	2.25 a	1.47 a
25 – 50	1.15 a	0.83 a	0.99 b	0.38 a
50 – 75	0.37 a	0.19 a	0.28 a	0.60 a
75 – 100	0.19 a	0.35 a	0.27 a	0.48 b
P_2O_5 mg · 100 g^{-1}				
Whole profile	9.81 a	12.47 a	11.14 b	8.20 a
Soil layers: 0 – 25	16.55 a	23.10 a	19.82 b	8.55 a
25 – 50	6.98 a	12.98 b	9.97 a	6.72 a
50 – 75	8.12 a	7.17 a	7.65 a	10.05 a
75 – 100	7.57 a	6.62 a	7.10 a	7.45 a
K_2O mg · 100 g^{-1}				
Whole profile	9.53 a	11.94 a	10.74 a	8.36 a
Soil layers: 0 – 25	14.25 a	21.00 b	17.62 a	13.10 a
25 – 50	9.67 a	13.25 a	11.46 a	8.05 a
50 – 75	7.42 a	8.20 a	7.81 a	6.72 a
75 – 100	6.75 a	5.27 a	6.01 a	5.57 a
MgO mg · 100 g^{-1}				
Whole profile	9.53 a	7.98 a	8.76 a	7.93 a
Soil layers: 0 – 25	7.35 a	6.50 a	6.93 a	6.78 a
25 – 50	7.68 a	6.60 a	7.14 a	7.10 a
50 – 75	11.28 a	9.80 a	10.54 a	8.95 a
75 – 100	11.80 a	9.02 a	10.41 a	8.95 a
N – total %				
Whole profile	0.061 a	0.070 a	0.066 a	0.058 a
Soil layers: 0 – 25	0.090 a	0.102 a	0.096 a	0.095 a
25 – 50	0.050 a	0.087 a	0.068 a	0.052 a
50 – 75	0.062 a	0.045 a	0.054 a	0.045 a
75 – 100	0.042 a	0.045 a	0.044 a	0.040 a
pH				
Whole profile	5.42 a	5.52 a	5.47 b	4.60 a
Soil layers: 0 – 25	5.81 a	5.45 a	5.63 b	4.48 a
25 – 50	5.50 a	6.01 a	5.76 b	4.52 a
50 – 75	5.33 a	5.49 a	5.41 b	4.73 a
75 – 100	5.03 a	5.11 a	5.07 b	4.66 a
Copper total, mg kg^{-1}				
Whole profile	6.51 a	7.49 a	7.00 a	7.43 a
Soil layers: 0 – 25	5.41 a	8.24 b	6.82 a	6.16 a
25 – 50	4.41 a	5.58 a	4.99 a	6.82 a
50 – 75	7.24 a	7.58 a	7.41 a	9.74 a
75 – 100	8.99 a	8.57 a	8.78 a	6.99 a

* in 2002

Table 2. Details concerning the content of copper in the soil, mg kg^{-1} dry soil

Soil layers	Position in stool-bed				Control field 2002
	rows	Alleyways			
	2002	1999	2000	2002	
Whole profile	6.51	6.61	7.10	7.49	7.43
0 – 25	5.41	6.33	7.49	8.24	6.16
25 – 50	4.41	6.99	5.25	5.58	6.82
50 – 75	7.24	6.41	7.00	7.58	9.74
75 - 100	8.99	6.71	8.66	8.57	6.99

Conclusions

Soil in stool-beds contained generally more macroelements and organic matter than in the control fields and it was less acid.

The content of copper in soil increased with years, but in the superficial layer (0 – 25 cm. deep) only. However it remained lower than quoted in the literature.

Reference

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