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EFFECT OF SOIL LOCALITY ON THE GROWTH AND CONTENT OF MINERAL COMPONENTS IN M.9 ROOTSTOCK

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Abstract. Studies were carried out in the Department of Pomology on the area of the Agricultural and Pomological Experimental Farm in Przybroda belonging to the Agricultural University in Poznań. In the years 2005–2006, apple-tree rootstocks M9 were planted into rhizoboxes with soil taken from different orchard localities. It was found that the previous method of soil use had an essential effect on the growth and the chemical composition of the planted rootstocks. Cultivation of rootstocks in rhizoboxes showed that the growing for many years of the same species deteriorates the growth. On the other hand, a change in the grown species decreases the risk of soil fatigue.

Key words: rhizoboxes, rootstock, growth, plant vegetative parts, component content

INTRODUCTION

The establishing of an orchard is an expensive investment. Outlays for orchard establishment must be quickly returned and this depends on how early high yields will be obtained and this depends on several factors. One of the most important factors is the soil locality on which the new orchard is estabiuished and the quality of the applied nursery material. Very frequently it happens that we are forced to use replantation, i.e. we have to plant new orchard in the place of a previous existing one [Mika 1996; Szczygieł 1991]. It happens too often that the growing of the same species after the previous one leads to „soil fatigue" and this, in turn, contributes to the deterioration of growth and to poorer plant yielding [Pacholak et al. 1995; Sobiczewski 2000].

Replantation disease refers to many orchard species. Peach-trees, apple-trees, sour-cherry-trees and raspberry bushes are regarded as the most sensitive ones [Rebandel 1987]. There exists also a high genetic differentiation of the susceptability within a species. It is visible among others in apple-tree rootstocks of East Malling series,

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among which M.7 rootstocks is regarded as being less sensitive in comparison with M.9 rootstock the most popular one in our orchards and regarded as a moderately sensitive one.

The objective of studies carried out in the years 2005–2006 was the estimation of the effect of differentiated soil localities on the growth and mineral composition of M.9 rootstocks grown in rhizoboxes.

MATERIAL AND METHODS

Studies were carried out in Pomicultural Department of Agricultural University in Poznań in two vegetation periods, in 2005 and 2006. The studied object was the M.9 rootstock which was planted in rhizoboxes of 70 × 37 × 25 cm dimensions. Eight plants of each combination were planted on April 23, 2005 and they were grown until April 25, 2006 and on April 28, 2006 and grown till November 20, 2006.

In the experiment, soil from a replanted apple orchard was used. The soil was taken from five different localities:

– locality 1 – soil from virgin soil (earlier, only agricultural plants were grown in it),
– locality 2 – soil taken from an old sour-cherry orchard,
– locality 3 – soil taken from herbicide fallow belts in an old apple orchard,
– locality 4 – soil taken from sward belts in an old sour-cherry orchard,
– locality 5 – soil taken from apple orchard after 3 replantations.

In October, all leaves were collected from the rootstocks and they were scanned in order to calculate the leaf blade surface area and an analysis was carried out referring to the content of mineral components. On the other hand, during the liquidation of the experiment, the following measurements were made: main shoot diameter, length and mass of shoots, roots and root-necks. After material preparation, chemical analyses were carried out to check mineral components in the particular organs of M.9 rootstock. The obtained results were statistically analysed to determine the significance of differences on the probability level of $\alpha = 0.05$.

RESULTS AND DISCUSSION

Vegetative rootstock M.9 is the basic rootstock in nursing production and it constitutes the root system of trees planted in orchard which is the most endangered by the replantation disease.

On the basis of the experiments, it was found that the locality and particularly the previous method of soil use exerted an essential effect on the growth of M.9 rootstock. Independent of the vegetation season, rootstock planted on soil on which previously sour-cherry was grown and on virgin soil (earlier, agricultural plants were grown on it) were characterized by a definitely longer and better developed root system in comparison with the rootstocks planted on replanted soil on which apple-trees were grown before (tab. 2; photo 1). The mean length of roots was 79.2 cm in the locality after an old sour-cherry orchard. and 74.9 cm on virgin soil. A similar dependence was found in

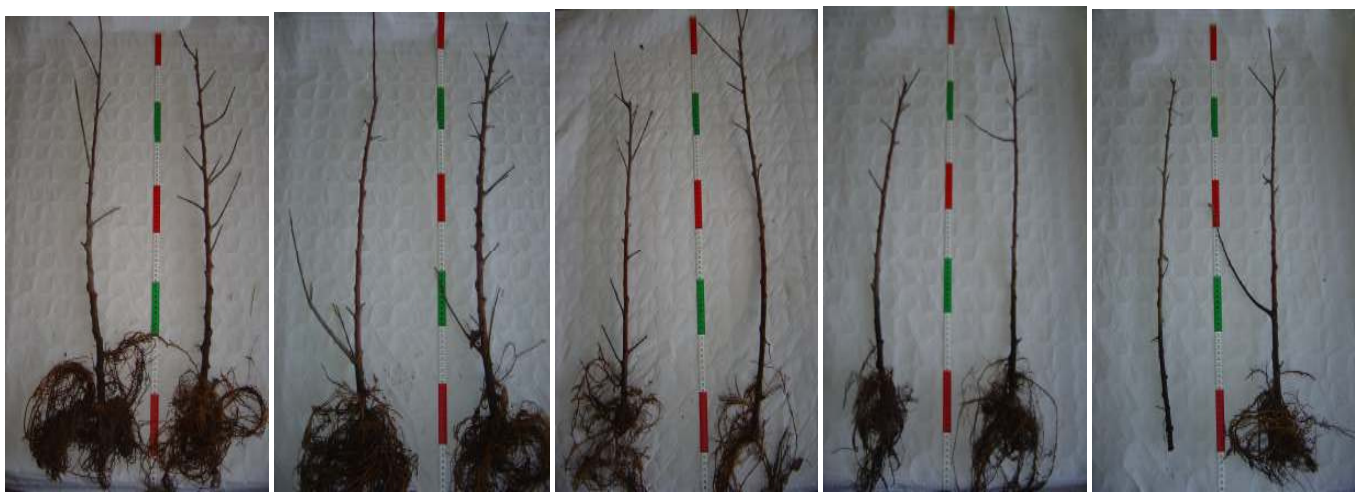
Table 1. Effect of differentiated soil locality on the growth of the vegetative apple-tree rootstock M.9 (mean values for two seasons)
Tabela 1. Wpływ zróżnicowanego stanowiska glebowego na wzrost wegetatywny podkładki wegetatywnej jabłoni M.9 (średnie dla dwóch sezonów)

Combinations Kombinacje	Roots – Korzenie		Shoots – Pędy				Root neck mass Szyjka korzeniowa masa g	f.s.c.s. p.p.p.p. cm^2	Total leaf surface area Sumaryczna powierzchnia liści cm^2
			lider – główny		side – boczne				
	length długość cm	mass masa g	length długość cm	mass masa g	length długość cm	mass masa g			
Virgin soil. Gleba z nowiny	74.9 c*	31.3 b	76.9 b	48.3 a	30.8 b	7.6 b	29.4 ab	11.2 a	314 c
Soil from old sour-cherry tree orchard. Gleba ze starego sadu wiśniowego	79.2 c	49.7 c	76.1 b	59.9 b	41.1 c	9.9 c	36.5 b	14.8 b	346 c
Soil from herbicide fallow belts in old apple-tree orchard. Gleba z pasów ugoru herbicydowego starego sadu jabłoniowego	38.4 a	24.2 a	58.4 a	41.7 a	12.3 a	2.9 a	28.5 ab	10.7 a	198 a
Soil from sward belts of old apple-tree orchard. Gleba z pasów murawy starego sadu jabłoniowego	50.8 b	29.7 a	68.4 ab	42.1 a	14.3 a	3.5 ab	25.4 a	11.6 a	262 b
Soil from apple-tree orchard after 3 replantations. Gleba z sadu jabłoniowego po 3 replantacji	37.9 a	30.2 ab	56.9 a	39.2 a	13.5 a	3.8 ab	22.5 a	10.9 a	182 a

* Mean values marked with the same letters do not differ significantly among each other at probability level of $\alpha = 0.05$.
Średnie oznaczone tymi samymi literami nie różnią się istotnie między sobą na poziomie prawdopodobieństwa $\alpha = 0{,}05$.

Locality 1 Stanowisko 1	Locality 2 Stanowisko 2	Locality 3 Stanowisko 3	Locality 4 Stanowisko 4	Locality 5 Stanowisko 5

Photo 1. Effect of soil locality on the growth of the root system of M.9 rootstock grown in rhizoboxes (view after rinsing)
Fot. 1. Wpływ stanowiska glebowego na wzrost systemu korzeniowego podkładki M.9 uprawianej w skrzyniach korzeniowych (widok po wypłukaniu)



Locality 1 Stanowisko 1	Locality 2 Stanowisko 2	Locality 3 Stanowisko 3	Locality 4 Stanowisko 4	Locality 5 Stanowisko 5

Photo 2. Effect of soil locality on the growth of the overground part of M.9 rootstock grown in rhizoboxes
Fot. 2. Wpływ stanowiska glebowego na wzrost części nadziemnej podkładki M.9 uprawianej w skrzyniach korzeniowych

relation to root mass which was the highest in rootstocks planted in the locality after an old sour-cherry orchard, and its weight was on the average 49.7 g, while on the virgin soil, the mean mass of roots reached 31.2 g. It must be stressed that rootstocks planted on replanted soil originating from sward belt of an old apple-tree orchard were characterized by a longer root system reaching on the average 50.8 cm in comparison with the rootstocks planted in soil from the rows of old trees whose length did not exceed 39 cm. This confirms the results obtained by Akophyne and Antisyan [1990] and by Domżał et al. [1993], who showed that the system of soil cultivation in orchards has an effect on the condition of soil environment and thereby on the growth of plants because higher content of humus in sward belts is better than in the belts of herbicide fallow.

Similarly as in case of the growth of the underground part, also the growth of the overground part of rootstocks expressed by the length of the main shoot and the side shoots was the best on virgin soil and in the locality after old sour-cherry orchard.

The mean length of main shoots was 76.1 cm in the locality after old sour-cherry orchard. Measurements of the length of side shoots showed still greater differences between the localities on which rootstocks were planted. On the average, the longest rootstocks grew in those planted in the locality after old sour-cherry orchard and their length was 41.1 cm, while on the virgin soil, it was 30.8 cm. The length of side shoots in rootstocks planted on replanted soil did not differ significantly and did not exceed 15 cm (tab. 1, photo 2).

Also summary measurements of the leaf blade surface area showed high differentiation between soil localities. The greatest surface area of leaves was shown by rootstocks planted in the locality after old sour-cherry orchard (mean value 346 cm^2). In replanted localities, the mean leaf blade surface area was significantly lower (tab. 1).

Independent of the analysed parameter of the growth of the underground and the overground parts, it must be stated that the best plant growth was found on the soil after old sour-cherry orchard and on the virgin soil, while the poorest growth of rootstock was found in the locality on which three apple-tree replantations were previously applied.

Analysis of mineral component content in the vegetative organs of M.9 rootstock showed a significant differentiation depending on the place of sampling on the plant (table 2, 3).

In the underground part, a higher content of the analysed components was shown by the root system, while the lowest content was found in the root neck (tab. 2).

The content of nutritive elements in the overground parts also depended on the analysed organ (tab. 3). The highest content of all components was found in leaves, significantly lower content was in side shoots and the lowest one was found in the main shoot. Similarly as the vegetative growth depended on the soil locality, also the component content was closely correlated with the growth intensity. The highest content in all vegetative parts of the rootstock was found in samples taken from a locality where pomicultural plants were never grown before (tab. 2, 3). It is worth noticing that M.9 showed a higher content of components when grown on soil taken from the old sour-cherry orchard. This fact confirms the opinion that change of species on a soil showing soil fatigue can decrease the effects of it [Hoestra 1994; Olszewski and Mika 1991; Pacholak and Zydlik 2003; Szczygieł 1997; Szajdak 2003; Utkhede and Smith 1994], as

Table 2. Effect of differentiated soil locality on the content of mineral components in the underground part of M.9 rootstock

Tabela 2. Wpływ zróżnicowanego stanowiska glebowego na zawartość składników mineralnych z części podziemnej podkładki M.9

	Combinations Kombinacje	Mineral components in % d.m. Składniki mineralne w % s.m.				
		N	P	K	Mg	Ca
Root Korzeń	Virgin soil. Gleba z nowiny	0.91*	0.21 f	0.94 g	0.18 c	0.65 d
	Soil from old sour-cherry tree orchard. Gleba ze starego sadu wiśniowego	0.90	0.20 ef	0.95 g	0.17 c	0.59 c
	Soil from herbicide fallow belts in old apple-tree orchard. Gleba z pasów ugoru herbicydowego starego sadu jabłoniowego	0.86	0.15 d	0.69 e	0.17 c	0.56 b
	Soil from sward belts of old apple-tree orchard. Gleba z pasów murawy starego sadu jabłoniowego	1.04	0.18 e	0.73 f	0.17 c	0.59 c
	Soil from apple-tree orchard after 3 replantations. Gleba z sadu jabłoniowego po 3 replantacji	0.89	0.16 de	0.64 d	0.17 c	0.48 a
Mean Średnio		0.92 b	0.18 b	0.79 b	0.17 b	0.57 a
Root neck Szyjka korzeniowa	Virgin soil. Gleba z nowiny	0.63	0.14 c	0.50 a	0.07 a	0.76 f
	Soil from old sour-cherry tree orchard. Gleba ze starego sadu wiśniowego	0.53	0.11 ab	0.42 a	0.09 ab	0.68 e
	Soil from herbicide fallow belts in old apple-tree orchard. Gleba z pasów ugoru herbicydowego starego sadu jabłoniowego	0.51	0.09 a	0.45 b	0.08 ab	0.70 e
	Soil from sward belts of old apple-tree orchard. Gleba z pasów murawy starego sadu jabłoniowego	0.65	0.12 b	0.47 b	0.10 b	0.87 g
	Soil from apple-tree orchard after 3 replantations. Gleba z sadu jabłoniowego po 3 replantacji	0.54	0.10 a	0.41 a	0.10 b	0.064 d
Mean Średnio		0.57 a	0.11 a	0.45 a	0.09 a	0.73 b

* Mean values marked with the same letters do not differ significantly among each other at probability level of α = 0.05. Średnie oznaczone tymi samymi literami w obrębie składników nie różnią się istotnie między sobą na poziomie prawdopodobieństwa α = 0,05.

Table 3. Effect of soil locality on mineral components content in overground parts of M.9 rootstock
Tabela 3. Wpływ zróżnicowanego stanowiska glebowego na zawartość składników mineralnych w częściach nadziemnych podkładki M.9

Combinations Kombinacje		Mineral components in % d.m. Składniki mineralne w % s.m.				
		N	P	K	Mg	Ca
Leaves Liście	Virgin soil. Gleba z nowiny	1.28 e	0.30 h	1.47 i	0.23 h	1.47 i
	Soil from old sour-cherry tree orchard. Gleba ze starego sadu wiśniowego	1.37 f	0.26 g	1.66 j	0.27 i	1.10 h
	Soil from herbicide fallow belts in old apple-tree orchard. Gleba z pasów ugoru herbicydowego starego sadu jabłoniowego	1.26 e	0.16 f	1.13 g	0.25 hi	1.06 g
	Soil from sward belts of old apple-tree orchard. Gleba z pasów murawy starego sadu jabłoniowego	1.33 f	0.25 g	1.29 h	0.26 hi	1.06 g
	Soil from apple-tree orchard after 3 replantations. Gleba z sadu jabłoniowego po 3 replantacji	1.30 e	0.23 g	0.89 f	0.32 j	1.09 h
Mean – Średnio		1.31 c	0.24 c	1,29 c	0.27 c	1.16 c
Lider shoots Pęd główny	Virgin soil. Gleba z nowiny	0.65 b	0.12 cd	0.52 b	0.06 a	0.61 b
	Soil from old sour-cherry tree orchard. Gleba ze starego sadu wiśniowego	0.61 b	0.11 bc	0.56 c	0.07 ab	0.56 a
	Soil from herbicide fallow belts in old apple-tree orchard. Gleba z pasów ugoru herbicydowego starego sadu jabłoniowego	0.53 a	0.08 a	0.46 a	0.08 bc	0.64 c
	Soil from sward belts of old apple-tree orchard. Gleba z pasów murawy starego sadu jabłoniowego	0.60 b	0.11 bc	0.52 b	0.07 ab	0.57 ab
	Soil from apple-tree orchard after 3 replantations. Gleba z sadu jabłoniowego po 3 replantacji	0.56 a	0.10 b	0.47 a	0.09 c	0.55 a
Mean – Średnio		0.59 a	0.10 a	0.51 a	0.07 a	0.59 b
Side shoots Pędy boczne	Virgin soil. Gleba z nowiny	0.83 d	0.16 f	0.59 de	0.09 cd	0.85 ef
	Soil from old sour-cherry tree orchard. Gleba ze starego sadu wiśniowego	0.78 c	0.14 ef	0.63 e	0.10 de	0.65 c
	Soil from herbicide fallow belts in old apple-tree orchard. Gleba z pasów ugoru herbicydowego starego sadu jabłoniowego	0.80 dc	0.13 de	0.56 c	0.12 f	0.89 f
	Soil from sward belts of old apple-tree orchard. Gleba z pasów murawy starego sadu jabłoniowego	0.86 d	0.14 ef	0.57 cd	0.11 ef	0.84 e
	Soil from apple-tree orchard after 3 replantations. Gleba z sadu jabłoniowego po 3 replantacji	0.86 d	0.15 f	0.55 bc	0.14 g	0.78 d
Mean – Średnio		0.83 b	0.14 b	0.58 b	0.11 b	0.80 a

* See note in table 2 . Patrz uwaga tab. 2.

confirmed by our studies, it may even intensify the growth. On the other hand, on soils taken from apple-tree orchard grown for many years, or taken from a replanted orchard, the content of components in the vegetative parts of M.9 rootstock was significantly lower (tab. 2, 3).

CONCLUSIONS

1. Rootstocks grown in rhizoboxes showed that apple-tree cultivation carried out for many years decreases the vegetative growth of M.9 rootstock.
2. Soil from sour-cherry orchard after 25 years of the same species cultivation had a positive effect on the growth of M.9 rootstock.
3. Component content in the vegetative parts, in spite of a significant differentiation between them depended on the place from which the soil was taken and on the course of climatic conditions.
4. Rootstock M.9 reacted quickly to soil fatigue, therefore, it is a good testing plant.

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WPŁYW STANOWISKA GLEBOWEGO NA WZROST I ZAWARTOŚĆ SKŁADNIKÓW MINERALNYCH PODKŁADKI M.9

Streszczenie. Badania były przeprowadzone w Katedrze Sadownictwa na terenie Rolniczo-Sadowniczego Gospodarstwa Doświadczalnego w Przybrodzie należącego do Akademii Rolniczej w Poznaniu. W latach 2005–2006 podkładki jabłoni M.9 wysadzono do rizoboksów (skrzyń korzeniowych) z glebą z różnych stanowisk sadowniczych, Stwierdzono, że wcześniejszy sposób użytkowania gleby miał istotny wpływ na wzrost i skład chemiczny wysadzonych podkładek. Uprawa podkładek w rizoboksach wykazała, że wieloletnia uprawa tego samego gatunku osłabia wzrost. Natomiast zmiana gatunku zmniejsza ryzyko zmęczenia gleby.

Słowa kluczowe: skrzynia korzeniowa, podkładka, wzrost, części wegetatywne rośliny, zawartość składników

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