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NUTRITION LEVEL OF MOTHER PLANTATIONS OF VEGETATIVE APPLE-TREE ROOTSTOCKS M.9 AND M.26

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Abstract. Achievement of high productivity of mother plantations of rootstocks requires that the mother plants are provided with optimum supply of nutrients. So far that branch of production has not seen an estimation of the level of nutrition and of fertilisation requirements. In the years 1998–2002 a study was conducted at two production nursery farms of vegetative apple-tree rootstocks situated in the Lublin region. The experiment comprised model mother plantations of two apple-tree rootstocks with the greatest economic importance – M.9 T337 and M.26. In the course of the experiment chemical analyses of the soil (humus, potassium, phosphorus, magnesium, calcium) were conducted in four soil horizons: I – 0–25 cm, II – 25–50 cm, III – 50–75 cm, IV – 75–100 cm, as well as analyses of the chemical composition (nitrogen, potassium, phosphorus, magnesium, calcium) of leaves, shoots, adventitious roots and root stumps. The soil analyses revealed that changes in the chemical composition within the soil profile were similar: with increase in depth there was a decrease in the levels of humus, potassium, phosphorus and calcium, and an increase in that of magnesium. The chemical composition of leaves and shoots of both rootstock clones did not differ significantly, only the level of calcium in the leaves of rootstock M.9 was significantly higher than that in M.26. The organs of the mother plants (leaves, shoots, roots, root stumps) were characterised by the highest uptake of nitrogen, followed by that of potassium, calcium and magnesium.

Key words: chemical composition, leaves, shoots, roots, crowns, soil

INTRODUCTION

One of the conditions of achieving high productivity of mother plantations is to provide the mother plants with optimum supply of nutrients. Every year a large number of shoots with developed roots are removed from a mother plantation. This greatly increases the requirement for nutrients, thus rapidly reducing the fertility of the soil [Czynczyk 1997, 1998, Rejman et al. 2002].

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A few studies concerning this issue were conducted in the nineteen seventies. Since that time the technology of rootstock production has changed: the productivity of mother plantations has increased, new materials for ridging have come into use, multiplication of dwarf rootstocks has grown in scale, and therefore the fertilisation requirements of the plants have grown too.

The primary source of nutrients necessary for plants is the soil [Neilsen 1983, Clarkson 1985, Nurzyński 2003]. As a result of a variety of physicochemical and biological processes, soil components are activated in forms available for plants [Skłodowski and Bielska 2009]. Plant nutrition depends not only on the natural resources of soil and on the amount of nutrients supplied in the form of fertilisers, but also on genetic properties of plants, determining their capacity to uptake specific components [Lipecki 1996, Lewko et al. 2004]. Plant nutrition with macro- and microelements are determined by a number of various factors. This is of special importance in the case of fruit trees which are usually built of two different organs – the rootstock and the cultivated variety [Pieniążek 2000].

At present, estimation of the status of fruit tree supply with mineral components is performed on the basis of chemical analysis of the composition of leaves and soil, and on visual assessment of the condition of plants [Kłossowski 1972, Sadowski et al. 1990, Pieniążek 2000, Nurzyński 2003]. According to Blasing [1990], analysis of leaves and soil does not, however, fully define the nutrition status of trees, as the information acquired in that manner is static, while the situation in the plant and in the soil is dynamic. The results of analyses can be compared if samples are collected every year on the same dates, from the same part of plant, separately for the varieties and for the rootstocks. Correct interpretation of the results obtained requires knowledge of the limit values of the content of mineral components in leaves and in soil [Sadowski et al. 1990].

Mother plantations of vegetative rootstocks are of a specific character and in many aspects differ from other stages of nursery production. They remain at the same place for even close to twenty years, and every year rooted shoots are taken off the mother plants for use in further production. Together with the rooted offshoots (rootstocks) considerable amounts of mineral components are removed from the soil, and from 1 hectare of mother plantation even 200 thousand rootstocks can be acquired [Kozłowski et al. 1991, Czynczyk 1997, Rejman et al. 2002]. The loss of nutrients is, therefore, significant, even though the leaves remain at the mother plantation and their components undergo gradual redistribution. As a result, it is recommended to fertilise mother plantations with large doses of mineral fertilisers [Rusnak 1976, Czynczyk 1997, Rejman et al. 2002]. The recommendations are based on research, but so far no limit values for mother plantations have been established.

Another specific feature of mother plantations is the use, for root establishment by the shoots, of sawdust of various origin that, due to its physical properties, create favourable conditions for the development of adventitious roots by rootstock is off-shoots [Kopytowski 2001]. The application of sawdust and bark in successive years of mother plantation use has an effect not only on the physical properties but also on the chemical composition of the soil. In orchards, the use of sawdust or other organic materials as mulch may lead to temporary deficit of nitrogen, detrimental especially for young plants. Therefore it is frequently recommended to apply additional nitrogen fertilisation in orchards where organic mulches are used [Mika and Krzewińska 1996, Bielińska 2001].

So far in Poland there is a lack of fertilisation studies related with rootstock mother plantations, and transfer of research results concerning rootstocks and maiden budded trees in a nursery onto mother plants is a simplification and requires verification. Therefore, it appears worthwhile to undertake an attempt at determination of the nutrition of mother plants of apple-tree rootstocks of economic importance.

MATERIAL AND METHODS

The study was conducted in the years 1998–2002, at two production nursery farms situated in the province of Lublin (N: 51°17'.08'' E: 22°39'2.9''). The experiment comprised model mother plantations of two apple-tree rootstocks with the greatest economic importance – M.9 T337 and M.26. The study was performed in the period of full use of the mother plantations (4th–9th year of use). On both mother plantations the rootstocks were multiplied via vertical off-shoots and the sawdust from coniferous trees to throw were used. The particle size distribution of the soils of the mother plantations studied qualifies them among silty clay formations.

The experiment included the following analyses:

– content of nutrients in the soil; soil samples were taken from four horizons: I – 0–25 cm, II – 25–50 cm, III – 50–75 cm, IV –75–100 cm on two dates in spring, prior to the spreading of sawdust, and in autumn, before taking off the rootstocks. Humus content in the soil was determined with the Tiurin method, content of available potassium and phosphorus with the Egner-Riehm method, content of available magnesium with the Schachtschabel method, and content of calcium – in extract of 0.03 M acetic acid at the soil-solution ratio of 1 to 10.

– content of mineral components in the leaves, shoots, adventitious roots and root stumps of mother plants. After drying and incineration of plant material at temperature of 500°C, the content of total nitrogen was determined with the Kiejdahl method, content of potassium, magnesium and calcium with the ASA method with an atomic absorption spectrometer, and the content of phosphorus with the vanadium-molybdenum method, colorimetrically. The samples for the determination of the content of nutrients in leaves and shoots was taken on the 20th August of each year of the study. A sample of 100 leaves was taken from the central part of 30 shoots. Each year, in autumn, analysis of the chemical composition of roots formed on the rootstocks was made, taking roots from 30 rootstocks and root stumps of mother plants (small parts of a mother plant were taken from 30 places). The analysis of the roots could be made in autumn as the root formation on rootstocks takes place in late summer and autumn.

The results were processed with analysis of variance. The significance of the results was estimated with the Tukey test at confidence level of $\alpha = 0.05\%$.

RESULTS AND DISCUSSION

Elements in soil undergo numerous transformations and migrations, the directions and scope of which largely depend on the grain size distribution and mineral composition of the soil. In the experiment, analyses of the soil revealed that in both mother plantations, in spite of quantitative differences, similar regularities appeared in most cases. The soil of the mother plantation of rootstock M.26 had almost twice as much humus as that in the M.9 plantation, the greatest difference being noted in the arable horizon of the soils, and gradually decreased down the depth of the profile (tab. 1). The decrease in the percentage content of humus in the deeper layers of the soil was statistically significant. That phenomenon is known from literature [Lityński and Jurkowska 1982, Chodoń et al. 1994, Baghdadi 1991, Bielińska 1997, 2001]. Factors affecting changes in the content of organic carbon include, apart from the processes of soil formation, crop rotations and mineral fertilisation, also proper air-water relations that in the mother plantations are notably modified by sawdust used as mulch [Lipa 2010]. Sawdust applied every year could have caused an increase of humus level in the surface horizons of the soil [Lipa et al. 2004].

Table 1. Content of humus (%) in dependence on kind of rootstock and the depth of collecting soil samples (1998–2002)
Tabela 1. Zawartość próchnicy w glebie (%) w zależności od podkładki i głębokości pobierania prób (1998–2002)

Soil horizon (cm) (A) Warstwa (cm) (A)	Rootstock (B) – Podkładka (B)		
	M.9	M.26	mean (A) średnio (A)
0–25	1.51 g*	3.20 h	2.35 D
25–50	0.85 e	1.44 f	1.15 C
50–75	0.35 c	0.61 d	0.48 B
75–100	0.18 a	0.28 b	0.23 A
Mean (B) – Średnio (B)	0.72 A	1.38 B	

* Means followed by the same letter not significantly different at $\alpha = 0.05$
*Średnie oznaczone taką samą literą nie różnią się istotnie przy $\alpha = 0,05$

The content of available phosphorus varied within the range of high values in the surface horizon of the soil (0–25 cm) relative to the limit values for orchard soils [Sadowski et al. 1990], at an average of 15.4 mg K in 100 g of soil. The content decreased with increasing depth of soil sampling, and the differences between the particular horizons were significant both for the rootstocks and when averaged for both mother plantations (tab. 2). The soil in the mother plantation of rootstock M.26, in all horizons except for the deepest one (75–100 cm), had a higher level of potassium than the soil in the mother plantation of M.9. This may, perhaps, be attributed to a higher level of potassium in that soil even before the mother plantation was established, and also to its stronger sorptive complex. Such a possibility is indicated by, among others, Neilsen and Stevenson [1983].

Table 2. Content of potassium and phosphorus in soil (mg 100 g^{-1}) in dependence on kind of rootstock and the depth of collecting soil samples (1998–2002)
Tabela 2. Zawartość potasu i fosforu w glebie (mg 100 g^{-1}) w zależności od podkładki i głębokości pobierania prób (1998–2002)

Soil horizon (cm) (A) Warstwa (cm) (A)	Potassium			Phosphorus		
	M.9	M.26	mean (A) średnio (A)	M.9	M.26	mean (A) średnio (A)
0–25	11.4 e*	19.5 g	15.4 D	7.6 h	6.7 g	7.2 C
25–50	8.1 d	12.9 f	10.5 C	4.8 f	3.6 d	4.2 B
50–75	7.1 b	7.5 c	7.3 B	4.2 e	2.1 a	3.2 A
75–100	6.4 a	6.1 a	6.3 A	3.3 c	2.3 b	2.8 A
Mean (B) – Średnio (B)	8.3 A	11.5 B		5.0 B	3.7 A	

*Means 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 w obrębie składników nie różnią się istotnie między sobą $\alpha = 0,05$

Long-term fertilisation with phosphorus caused its accumulation, especially in the surface horizon of the soil (tab. 2), where its level was considerably higher than the optimum content of that component for orchards. Pacholak and Komosa [1993] and Treder [2003] found a significant increase in the level of phosphates in a soil regularly fertilised with that element. It is a common phenomenon, as phosphorus is an element with low mobility in soil [Lityński and Jurkowska 1982, Chodoń et al. 1994, Bielińska 2001, Chełpiński et al. 2001], and even the irrigation applied in the experiment conducted by Pacholak et al. [1998] had no significant effect on the migration of that element down the soil profile. The reduction of the level of phosphorus with increasing depth of the successive soil horizons supports the above opinions.

Table 3. Content of magnesium and calcium in soil (mg 100 g^{-1}) in dependence on kind of rootstock and the depth of collecting soil samples (1998–2002)
Tabela 3. Zawartość magnezu i wapnia w glebie (mg 100 g^{-1}) w zależności od podkładki i głębokości pobierania prób (1998–2002)

Siol horizon (cm) (A) Warstwa (cm)	Magnesium			Calcium		
	M.9	M.26	mean (A) średnio (A)	M.9	M.26	mean (A) średnio (A)
0–25	6.2 a	7.9 d	7.1 A	50.5 f	37.2 d	43.9 D
25–50	7.5 c	7.0 b	7.2 A	42.0 e	32.6 c	37.3 C
50–75	11.6 f	8.0 d	9.8 B	36.7 d	30.6 b	33.6 B
75–100	12.6 g	9.9 e	11.2 C	29.8 ab	29.4 a	29.6 A
Mean (B) – Średnio (B)	9.5 B	8.2 A		39.8 B	32.5 A	

For explantions, see Table 2 – Objaśnienie jak w tabeli 2

The content of magnesium in the soil increased with increasing depth of sampling (tab. 3). This is a phenomenon known from literature [Lityński and Jurkowska 1982, Chodoń et al. 1994, Bielińska 2001, Nurzyński 2003, Pacholak et al.1998]. In the soil of the mother plantation of rootstock M.9 level was higher than in that under M.26, with the exception of the surface horizon which could have resulted from the higher humus content in that horizon in the mother plantation of M.26 [Lityński and Jurkowska 1982]. It should be emphasised that in the 0–25 cm soil horizon a higher content of magnesium was found in the soil in the mother plantation of rootstock M.9, with a lower humus content.

The content of calcium in the soil decreased with increasing depth, which is also supported in literature [Baghdadi 1991]. The soil in the mother plantation of rootstock M.9 contained significantly more calcium in the three surface horizons than the soil in the mother plantation of M.26 (tab. 3).

In all soil horizons the ratio of potassium to magnesium was correct in accordance with the opinion of Sadowski et al. [1990]. The values of the ratio decreased with increasing depth of soil sampling (tab. 4), which was also observed by Baghdadi [1991], Bielińska [2001] and Treder [2003].

Table 4. The ratio of K:Mg in soil in dependence on kind of rootstock and the depth of collecting soil samples (1998–2002)
Tabela 4. Stosunek K:Mg w glebie w zależności od podkładki i głębokości pobierania prób (1998–2002)

Soil horizon (cm) (A) Warstwa (cm) (A)	Rootstock (B) – Podkładka (B)		
	M.9	M.26	mean (A) – średnio (A)
0–25	1.8 e	2.5 f	2.2 D
25–50	1.1 d	1.8 e	1.5 C
50–75	0.6 b	0.9 c	0.8 B
75–100	0.5 a	0.6 b	0.6 A
Mean (B) – Średnio (B)	1.0 A	1.5 B	

For explantions, see Table 1 – Objaśnienie jak w tabeli 1

The most frequently used and a sensitive indicator of the current status of plant supply with mineral components is the analysis of chemical composition of plant material. In the case of orchard plants, the most frequently applied is the chemical analysis of leaves [Treder and Olszewski 2004].

The results of analyses of the chemical composition of plant material revealed a large differentiation in the concentrations of nitrogen, phosphorus, potassium, calcium and magnesium in the various organs of the mother plants (leaves, shoots, roots and the perennial underground part – the root stumps). Comparison of the results obtained with literature data is difficult because no publications were found that would present analyses of various organs of mother plants. In the discussion of the content of nutrients in leaves and the levels of macro-elements in the soil we based on the limit values for apple trees, taking into account that mother plants remain at one place for several years, as do trees in an orchard, but they never flower and bear fruit. Comparison with numerous experiments involving plants of fruit tree nurseries is also difficult. Rootstocks planted in a nursery are annual plants, with shallow root systems that do not permit uptake of nutrients from deeper layers of soil. Perennial mother plants have that capability, as their roots reach rather deep into the soil [Lipa 2010].

Nitrogen content in the leaves of the rootstocks studied was generally high, somewhat higher levels being recorded in the leaves of rootstock M.26 than M.9 (tab. 5). Similar results were obtained by Ugolik [1993] who found significantly more nitrogen in leaves of rootstock M.26 compared to those of M.9 T337, and by Aguirre et al. [2001] who compared rootstock M.26 with several clones of rootstock M.9. Different results were obtained by Kurlus and Ugolik [1999] and Kurlus [2003]: rootstock M.9 stimulated nitrogen uptake by oculants of cv. 'Šampion'. Treder and Olszewski [2004] demonstrated that a weaker-growing cultivar ('Gala') had higher nitrogen content that a cultivar characterised by stronger growth ('Jonagold').

Table 5. Content of nitrogen (N % d.m.) in the individual part of mother plants in dependence on kind of rootstock (1998–2002)
Tabela 5. Zawartość azotu ogółem (N % s.m.) w różnych organach mateczników w zależności od podkładki (1998–2002)

Part of mother plants Organ rośliny	Rootstock – Podkładka		
	M.9	M.26	mean – średnio
Leaves – Liście	2.52 a*	2.58 a	2.55 C**
Shoots – Pędy	0.74 a	0.66 a	0.70 A
Roots – Korzenie	1.14 b	1.02 a	1.80 B
Crowns – Karpy	0.80 a	0.72 a	0.76 A

* Means in the row followed by the same letter are not significantly different at α = 0.05
* Średnie w wierszach oznaczone taką samą literą nie różnią się istotnie przy α = 0,05
** Means in the column in the row followed by the same letter are not significantly different at α = 0.05
** Średnie w kolumnach oznaczone taką samą literą nie różnią się istotnie α = 0,05

The shoots of rootstock M.9 had only slightly higher levels of nitrogen than those of rootstock M.26. Comparison of the results with literature data is difficult as there is a lack of reports on analyses of the chemical composition of rootstock shoots. Zydlik and Pacholak [2007] studied the effect of soil on the levels of mineral components in rootstock M.9 and demonstrated a lower level of nitrogen in the shoots than that obtained in the present experiment. It should be noted, however, that the rootstocks in the experiment cited above were nursery plants, while those in the present experiment are rootstocks from mother plants.

The highest levels of nitrogen were found in the leaves, followed by the roots, and the lowest in the shoots and the root stumps (tab. 5). Similar results were obtained by Zydlik and Pacholak [2007] in the case of rootstock M.9.

The levels of potassium in the particular organs of the mother plants were comparable for both rootstocks, and only in the case of the adventitious roots a significantly higher content of potassium was noted for rootstock M.9. Skrzyński et al. [2004], in a study of the root systems of trees grown on various rootstocks, also demonstrated higher levels of potassium in the roots of rootstock M.9 than of M.26. The highest levels of potassium were found in the leaves, followed by the roots, shoots, and notably lower in the root stumps (tab. 6). In a study by Zydlik and Pacholak [2007] estimation was made of the mineral composition of leaves, main and lateral shoots, roots and the root neck of rootstock M.9 and somewhat lower levels of potassium were noted in all of those parts of the rootstock than in the study presented here, though the levels determined were also the highest in the leaves, followed by the roots, shoots, and the root neck.

Table 6. Content of potassium (K % d.m.) in the individual part of mother plants in dependence on kind of rootstock (1998–2002)
Tabela 6. Zawartość potasu (K % s.m.) w różnych organach mateczników w zależności od podkładki (1998–2002)

Part of mother plants Organ rośliny	Rootstock – Podkładka		
	M.9	M.26	mean – średnio
Leaves – Liście	1.51 a	1.44 a	1.48 D
Shoots – Pędy	0.63 a	0.69 a	0.66 B
Roots – Korzenie	1.22 b	0.80 a	1.01 C
Crowns – Karpy	0.21 a	0.19 a	0.20 A

For explantions, see Table 5 – Objaśnienie jak w tabeli 5

Table 7. Content of phosphorus (P % d.m.) in the individual part of mother plants in dependence on kind of rootstock (1998–2002)
Tabela 7. Zawartość fosforu (P % s.m.) w różnych organach mateczników w zależności od podkładki (1998–2002)

Part of mother plants Organ rośliny	Rootstock – Podkładka		
	M.9	M.26	mean – średnio
Laeves – liście	0.18 a	0.19 a	0.19 C
Shoots – pędy	0.12 a	0.09 a	0.10 B
Roots – korzenie	0.14 b	0.11 a	0.13 B
Crowns – karpy	0.06 a	0.05 a	0.06 A

For explantions, see Table 5 – Objaśnienie jak w tabeli 5

The levels of phosphorus in plant organs from both mother plantations were similar. Statistical analysis revealed significant differences between the plantations studied only in the case of the roots (to the advantage of rootstock M.9), which is in agreement with the results obtained by Skrzyński et al. [2004]. The concentration of the element in the leaves (tab. 7) was at a high level compared to the limit values for apple trees [Sadowski et al. 1990, Szűse 2005]. The highest levels of phosphorus were recorded in the leaves, the lowest in the root stumps, while the shoots and the roots had similar levels of that element. Zydlik and Pacholak [2007] obtained somewhat higher concentrations of phosphorus in the leaves of rootstock M.9, while in other parts of the rootstock the level of phosphorus was similar to that obtained in the experiment presented here.

Table 8. Content of magnesium (Mg % d.m.) in the individual part of mother plants in dependence on kind of rootstock (1998–2002)
Tabela 8. Zawartość magnezu (Mg % s.m.) w różnych organach mateczników w zależności od podkładki (1998–2002)

Part of mother plants Organ rośliny	Rootstock – Podkładka		
	M.9	M.26	mean – średnio
Leaves – Liście	0.20 a	0.25 a	0.23 C
Shoots – Pędy	0.07 a	0.08 a	0.08 B
Roots – Korzenie	0.11 b	0.09 a	0.10 B
Crowns – Karpy	0.04 a	0.04 a	0.04 A

For explantions, see Table 5 – Objaśnienie jak w tabeli 5

Table 9. Content of calcium (Ca % d.m.) in the individual part of mother plants in dependence on kind of rootstock (1998–2002)
Tabela 9. Zawartość wapnia (Ca % s.m.) w różnych organach mateczników w zależności od podkładki (1998–2002)

Part of mother plants Organ rośliny	Rootstock – Podkładka		
	M.9	M.26	mean – średnio
Leaves – Liście	1.13 b	0.88 a	1.01 C
Shoots – Pędy	0.55 a	0.38 a	0.10 A
Roots – Korzenie	0.16 a	0.21 b	0.19 A
Crowns – Karpy	0.38 a	0.35 a	0.36 B

For explantions, see Table 5 – Objaśnienie jak w tabeli 5

Numerous authors [Lord et al. 1985, Villeneuve and Boulay 1988, Tragliavini et al. 1992, Duarte 1993, Gruca 2003] indicate better magnesium nutrition of rootstock M.26 than M.9. In this experiment also higher levels of that element were observed in the leaves and shoots of rootstock M.26 as compared to M.9, but the differences were not statistically proven (tab. 8). Whereas, the statistical analysis revealed such differences in the case of the roots, in which higher levels of magnesium were noted for rootstock M.9. Similar levels of nutrition with magnesium were observed for rootstock M.9 by Zydlik and Pacholak [2007]. In the present experiment, the leaves of the rootstocks under examination had medium levels of that element, even though the soil had a high content of available magnesium and the value of the K:Mg ratio was favourable for its uptake. The poor uptake of the element by the plants in the mother plantations could be attributed to the relatively low pH of the soil. Sas [1998] and Mercik [2002] reports that plants growing under acid soil conditions uptake lower amounts of magnesium, calcium, phosphorus and molybdenum.

Andziak et al. [2004], Simons and Swiader [1985], Duarte [1993], Rom et al. [1995] and Gruca [2003] observed that the weaker the growth of a rootstock, i.e. the more dwarfy it is, the higher levels of calcium can be expected in the leaves of plants grown on it. A similar regularity was noted by Ugolik [1993], Villeneuve and Boulay [1988] and by Sas and Mercik [2002] in leaves of various rootstocks, whereas Gąstoł and Poniedziałek [2004] did not demonstrate any differentiation in calcium levels in leaves attributable to the type of rootstock. In our own study (tab. 9), the leaves, shoots and root stumps of rootstock M.9 were characterised by higher calcium levels than those of rootstock M.26, which largely supports the opinions cited above. The lower level of the element in the mother plantation of rootstock M.26 could have been a result of the high level of potassium in the soil of the mother plantation, which had an antagonistic effect on calcium uptake of the plants of that rootstock type. Similar values for the leaves and main shoots of rootstock M.9 were obtained by Zydlik and Pacholak [2007], and only in the case of the lateral shoots the level of calcium was notably higher, at 0.80% of dry matter.

CONCLUSIONS

1. Changes in chemical composition in the soil profile in both mother plantations were similar: with increasing depth there was a decrease in the levels of humus, potassium, phosphorus and calcium, and an increase in the content of magnesium.

2. There were no significant differences in the chemical composition of the leaves and shoots of the two rootstock clones, only the content of calcium in the leaves of rootstock M.9 was significantly higher than in those of M.26.

3. The chemical composition of the roots of the two rootstock clones was varied: rootstock M.9 had significantly higher levels of nitrogen, potassium, phosphorus and magnesium, and lower content of calcium than rootstock M.26.

4. All the organs (leaves, shoots, roots and root stumps) of both rootstocks were characterised by the highest uptake of nitrogen. Only the rots of rootstock M.9 had a slightly higher content of potassium than of nitrogen. The next element in terms of its share in the dry matter was potassium. The remaining elements were taken up in considerably smaller amounts.

5. The results obtained may be helpful for the development of up-to-date fertilisation recommendations and of limit values for that branch of nursery production.

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POZIOM ODŻYWIENIA MATECZNIKÓW PODKŁADEK WEGETATYWNYCH JABŁONI M.9 I M.26

Streszczenie. Uzyskanie dużej wydajności mateczników wymaga zapewnienia roślinom matecznym optymalnego zaopatrzenia w składniki pokarmowe. Do tej pory ten dział produkcji nie doczekał się oceny poziomu odżywienia oraz wymagań nawozowych. W latach 1998–2002 przeprowadzono badania w produkcyjnych matecznikach podkładek wegetatywnych jabłoni na terenie Lubelszczyzny. Doświadczenie obejmowało wzorowo prowadzone mateczniki dwóch najważniejszych gospodarczo podkładek jabłoni M.9 T337 i M.26. W czasie doświadczenia przeprowadzono analizy chemiczne gleby (próchnica, potas, fosfor, magnez, wapń) w czterech warstwach gleby: I – 0–25 cm, II – 25–50 cm, III – 50–75 cm, IV – 75–100 cm oraz analizy składu chemicznego (azot, potas, fosfor, magnez, wapń) liści, pędów, korzeni przybyszowych i karp. Analizy gleby wykazały, że zmiany składu chemicznego w profilu glebowym w obu matecznikach były zbliżone: wraz z głębokością spadała zawartość próchnicy, potasu, fosforu i wapnia, a rosła magnezu. Skład chemiczny liści i pędów obu klonów podkładek nie różnił się istotnie, jedynie poziom wapnia w liściach podkładki M.9 był istotnie wyższy niż w M.26. Organy roślin matecznych (liście, pędy, korzenie, karpy) najwięcej pobierały azotu, następnie potasu wapnia i magnezu.

Słowa kluczowe: skład chemiczny, liście, pędy, korzenie, karpy, gleba

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