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The influence of three fertilizers and preparation Gibrescol used as the foliage spraying on the growth and nutritional status of maiden apple trees in a nursery

Wpływ trzech nawozów i preparatu Gibrescol stosowanych dolistnie na wzrost i stan odżywienia okulantów jabłoni w szkółce

Summary. The influence of three fertilizers and Gibrescol preparation used as the foliage spraying on the growth and state of nourishment of two cultivars of maiden apple trees in a nursery was compared. Foliar fertilizers did not have any significant influence on the growth of maiden trees, except the number of dwarf shoots of 'Delikates' cultivar. However, they considerably increased the number of formed flower buds. Gibrescol preparation significantly increased the height and number of long shoots of maiden trees of 'Jonica' and the dwarf shoots of 'Delikates' cultivar, compared to the control. At the same time it did not initiate the formation of flower buds. The effect of chemical agents, applied as the foliage spraying on the content of mineral elements in the leaves of maiden apple trees, cultivated in a nursery, was diverse. Only a significantly higher amount of nitrogen in the leaves of two apple tree cultivars after foliar use of urea was noticed. A significantly lower value of calcium was observed in the leaves of the two cultivars in the control combination, compared with the others considered in the experiment.

Key words: maiden apple trees, Gibrescol, fertilizers, foliar fertilization, growth, branching, nutritional status

INTRODUCTION

Nowadays apple orchards are established by planting mainly trees on dwarf rootstocks. Usually maiden apple trees on such rootstocks branch worse [Jaumień *et al.* 1993, Bootsma 1995, Słowiński and Sadowski 1996]. The superiority of branched maiden trees over unbranched ones, was confirmed by many researchers [Van Oosten 1978, Vittrup 1978, Shepherd 1979, Bootsma and Baart 1990, Poniedziałek *et al.* 1993, 1996, Czyn-czyk 1998]. Apple trees which were well-branched tend to develop more blossoms and set fruits better after being planted and therefore give a higher yield in the early years in the orchard [Quinlan 1978, Jaumień *et al.* 1993].

The yield of trees in the orchard is affected by the quality of nursery material. The most important traits of the nursery material are the trunk diameter, height of the tree, and the number and length of lateral shoots of maiden trees. Unfortunately, maiden trees of many cultivars form a small number of lateral shoots or do not form them at all. So far, many researches have used different kinds of chemicals (Off-shoot-O, NC 9634, M&B 25-105, Paturyl, Promalin) for branching maiden apple trees [Cody *et al.* 1985, Unrath 1985, Quinlan and Tobutt 1990, Poniedziałek and Porębski 1992, Jaumień *et al.* 1993, Basak *at al*. 1993, Wertheim and Estabrooks 1994, Jaumień and Dziuban 1998]. Many of these chemicals stimulating fruit trees branching were promising.

There are different opinions on foliar fertilization. The best results were obtained when urea was applied [Kłossowski 1972, Nowosielski 1988]. Good ones were noted for 'Wangenheim's Prune' seedling with the foliar use of Florovit [Grzyb *et al.* 1985]. Fertilization with magnesium as the foliage spraying was suggested by Byszewski and Sadowska [1974]. It gives effects after a few weeks and only after a year, when introduced into the soil. Foliar fertilization is more effective, the use of fertilizers is four times smaller compared with fertilization into the soil. It is very useful, especially during dry weather, when the assimilation of nutrients from the soil is limited. This assimilation can also be disturbed by other factors such as: pH, humidity, physical properties of the soil [Leszczyńska 1989]. However, Kohler [1989] claims, that it is better to use soil fertilization leaving the foliar one, when shortage of nutritive ingredient is observed. Fertilization as the foliage spraying is much more expensive than through the soil, as well as the technique of foliar fertilization compared with sowing fertilizers into the soil [Olszewski 1990].

In the experiment, the effects of Gibrescol and three fertilizers used as the foliage spraying on the growth and state of nourishment of maiden apple trees in a nursery were compared.

MATERIAL AND METHODS

The experiment was conducted in the experimental station of University of Life Sciences in Poznań. Experimental plant material consisted of one-year maiden apple trees of 'Delikates' and 'Jonica' cultivars on M.9 rootstock. The nursery trial was set up in four replications, with 25 plants per plot. During the vegetative season 2006 and 2007 the plants were treated with Gibrescol and fertilized as the foliage spraying with 0.5–1.0 % concentrated urea (in the procedure – in two later terms a higher concentration was applied), 0.5 % Florovit and 1.0 % lime and magnesium nitrate. Spraying with Gibrescol at a rate of 500 mg 1 dm^{-3} of water was conducted once in the third decade of June, when the maiden trees were about 60 cm high. The maiden trees were treated with foliar fertilizers five times in two-week intervals, from mid-June to mid-August. For chemical analyses of the macroelements content in the second decade of August leaves from the middle part of long shoots, were collected. All the observations and measurements were performed for 15 maiden apple trees in each replicate. The height and the thickness of the trunk (30 cm above the ground) were measured. The numbers of long shoots, dwarf shoots and formed flower buds were counted. The statistical analysis of the data obtained was carried out using a two-factor variance analysis, using Duncan test, at the significance level $\alpha = 0.05$. The results presented in tables are the mean values collected in two years.

RESULTS AND DISCUSSION

Spraying treatment of the trees, with the three above mentioned fertilizers, did not significantly affect their height. The exception were 'Jonica' maiden trees cultivar treated with Gibrescol. They were significantly higher, than these ones untreated, with any chemical agent. For 'Delikates' maiden trees, the results of their height did not differ depending on combination (tab. 1). Grzyb *et al.* [1985] found a positive influence of spraying with Florovit on the height of 'Wangenheim's Prune' seedling, which was not observed in the considered experiment.

Table 1. Height and thickness of maiden apple trees
Tabela 1. Wysokość i grubość okulantów jabłoni

Combinations Kombinacje	Cultivar – Odmiana			
	height – wysokość (cm)		thickness – grubość (mm)	
	Jonica	Delikates	Jonica	Delikates
Gibrescol	155.9 c	120.8 a	12.9 bc	11.3 ab
Urea Mocznik	150.3 bc	119.4 a	13.1 bc	12.2 ab
Florovit	144.4 bc	118.6 a	12.6 bc	12.3 ab
Lime and magnesium nitrate Saletra wapniowo-magnezowa	143.2 bc	119.5 a	13.9 c	12.3 ab
Control – Kontrola	137.5 b	115.0 a	12.5 bc	10.9 a

Means, followed by the same letters within the characteristic, do not differ significantly at $\alpha = 0.05$
Średnie oznaczone tymi samymi literami w obrębie cech nie różnią się istotnie przy $\alpha = 0,05$

Genetical features of growth between cultivars affected the obtained results. 'Jonica' maiden trees were significantly higher than 'Delikates' ones. Strongly growing 'Jonica' gave significantly higher maiden apple trees, than a weaker growing 'Delikates' cultivar (tab. 1).

Also the thickness of maiden trees, depended mainly on the budded apple cultivar than on different fertilizers, applied as the foliage spraying. The results of the thickness of maiden apple trees of the 'Jonica' and 'Delikates' cultivars were not significantly differentiated, depending on their treatment with Gibrescol and other fertilizers applied via the foliage, as compared to the control. Only 'Jonica' maiden apple trees sprayed with lime and magnesium nitrate were significantly thicker, than all 'Delikates' maiden trees (tab. 1). Grzyb *et al.* [1985] obtained not only higher, but also thicker 'Wangenheim's Prune' seedlings, after spraying them with Florovit as the foliage spraying. Such a difference was not observed in the considered experiment.

After spraying with the Gibrescol, maiden trees of 'Jonica' cultivar produced a significantly greater number of long shoots than the control. The result of the control combination did not significantly differ from the one obtained for trees treated with urea and Florovit and lime and magnesium saltpetre. The number of long shoots of 'Delikates' cultivar trees did not differ significantly, depending on spraying maiden trees, or its lack (tab. 2). Popenoe and Barritt [1988] did not discover any effect of spraying with Gibrescol on the branching of maiden apple trees in a nursery. In the present experiment

Gibrescol gave significantly better results of the number of side shoots for one cultivar, not for the other one. The cultivar significantly affected the number of long shoots. Also Jaumień *et al.* [1993] observed that cultivars differ with their ability to natural creation of side shoots. In the experiment they obtained on average 0.4 to 1.2 side shoots for 'Jonagold' maiden trees in a control combination not treated with any chemical agent, depending on a year. Observations of this cultivar was also conducted on M.9 rootstock. In the considered experiment, however, much more long shoots were found for 'Jonica' cultivar, than the above mentioned authors noted for 'Jonagold' cultivar. Of course, the differences could have been influenced by climatic and soil conditions.

Strongly growing maiden trees of 'Jonica' were more branched (tab. 2). Stronger growth of a given cultivar is positively correlated with the branching of maiden trees. The correlation mentioned is stricter for a strongly branching cultivar, in this case for 'Jonica' than for a cultivar developing less side branches, i.e. 'Delikates'. A similar conclusions, based on earlier researches were drawn by Słowiński and Sadowski [1996] and Lipecki and Janisz [1999].

Table 2. Average number of flower buds and long and dwarf shoots of maiden apple trees
Tabela 2. Średnia liczba pąków kwiatowych oraz długo- i krótkopędów okulantów jabłoni

Combinations Kombinacje	Cultivar – Odmiana					
	long shoots długopędy		dwarf shoots krótkopędy		flower buds pąki kwiatowe	
	Jonica	Delikates	Jonica	Delikates	Jonica	Delikates
Gibrescol	6,8 c	2.4 a	12.1 c	5.0 b	0.0 a	0.1 a
Urea Mocznik	5,6 bc	2.2 a	11.5 c	4.4 b	3.5 c	1.7 bc
Florovit	5.3 bc	1.8 a	11.2 c	4.3 b	3.2 c	2.4 c
Lime and magnesium nitrate Saletra wapniowo--magnezowa	5.6 bc	2.0 a	11.8 c	4.8 b	2.6 c	2.4 c
Control Kontrola	4.5 b	1.5 a	10.6 c	2,8 a	0.9 ab	0.3 a

Means, followed by the same letters within the characteristic, do not differ significantly at $\alpha = 0.05$
Średnie oznaczone tymi samymi literami w obrębie cech nie różnią się istotnie przy $\alpha = 0,05$

Maiden trees treatment with different agents applied as the foliage spraying, did not affect the number of dwarf shoots of 'Jonica' cultivar, comparing with the control. However, the number of dwarf shoots of 'Delikates' cultivar of the control, was significantly lower, than for the remaining combinations. It testifies a positive influence of all foliar fertilizers on the number of dwarf shoots of 'Delikates' cultivar. Significantly more dwarf shoots were obtained for 'Jonica' maiden trees than for 'Delikates' (tab. 2). According to the results it could be concluded that maiden apple trees that branch much harder form more dwarf shoot after treatments stimulating the process, than the ones with the tendency of forming these shoots in a natural way.

The control 'Jonica' maiden trees and these treated with Gibrescol, produced significantly less flower buds, than the remaining combinations, which results did not differ. A similar relation was observed in 'Delikates' maiden trees. The number of flower buds

did not differ, depending on a cultivar within, the same combination. Foliar fertilization of maiden trees beneficially affected the number of formed flower buds (tab. 2). One could assume that trees, fertilized as the foliage spraying in a nursery, planted in an orchard, begin fructification earlier. This is a basic requirement of establishing nowadays intensive orchards. At the same time, the use of fertilizers stimulating the branching process of maiden apple trees in an orchard, such as Gibrescol, impedes the initiation of flower buds on the trees.

Taking into consideration the cost of spraying and the cost of agents used, it must be noticed that their application can be justified in the light of the obtained results. These treatments can be important only for cultivars, that branch very hard and in years with low atmospheric falls in the period of very intensive growth of maiden trees. In the years whers the experiment was conducted, the number of atmospheric falls in the vegetative period was quite high, which could have directly influenced the obtained experimental results of foliar nourishment of the maiden trees.

On the basis of the performed chemical analyses of the content of macroelements in leaves no clear impact of spraying maiden trees with Gibrescol and foliar fertilizers was observed. Significantly higher content of nitrogen was only noted for maiden trees of both cultivars treated with urea as compared to the remaining combinations. The lowest content of calcium was observed for maiden trees coming from the control (tab. 3 and 4). The content of mineral elements in the leaves of maiden trees was also dependant, in some degree, on the budded apple tree cultivar. A higher amount of nitrogen and phosphorous, was noted for 'Delikates' cultivar maiden trees in comparison with 'Jonica'. A higher content of potassium, was observed for 'Jonica' cultivar, however, it was not a rule for all combinations. No differences, in the content of magnesium and calcium in the leaves of maiden apple trees were observed (tab. 3 and 4).

Table 3. Content of mineral elements in the leaves of maiden apple trees of 'Jonica' cultivar (% dry matter)
Tabela 3. Zawartość składników mineralnych w liściach okulantów jabłoni odmiany 'Jonica' (% suchej masy)

Combinations Kombinacje	Nitrogen Azot	Phosphorus Fosfor	Potassium Potas	Magnesium Magnez	Calcium Wapń
Gibrescol	2.03 ab	0.42 a-c	1.93 cd	0.37 a-c	2.70 cd
Urea Mocznik	2.17 c	0.45 cd	2.05 e	0.36 a-c	2.63 b-d
Florovit	2.11 b	0.36 a	2,01 de	0.41 bc	2.59 bc
Lime and magnesium nitrate Saletra wapniowo-magnezowa	2.08 b	0.44 b-d	1.94 cd	0.46 c	2.72 cd
Control Kontrola	1.99 a	0.39 ab	1,99 de	0.27 a	2.38 a

Means, followed by the same letters within the characteristic, do not differ significantly at $\alpha = 0.05$
Średnie oznaczone tymi samymi literami w obrębie cech nie różnią się istotnie przy $\alpha = 0,05$

Table 4. Content of mineral elements in the leaves of maiden apple trees of 'Delikates' cultivar (% dry matter)
Tabela 4. Zawartość składników mineralnych w liściach okulantów jabłoni odmiany 'Delikates' (% suchej masy)

Combinations Kombinacje	Nitrogen Azot	Phosphorus Fosfor	Potassium Potas	Magnesium Magnez	Calcium Wapń
Gibrescol	2.34 d	0.50 e	1.87 bc	0.38 a-c	2.63 b-d
Urea – Mocznik	2.52 f	0.48 d	1.82 ab	0.38 a-c	2.64 b-d
Florovit	2.20 c	0.45 cd	1.82 ab	0.42 bc	2.52 b
Lime and magnesium nitrate Saletra wapniowo--magnezowa	2.40 e	0.51 e	1.88 bc	0.46 c	2.73 cd
Control – Kontrola	2.30 d	0.50 e	1.79 a	0.31 ab	2.34 a

Means followed by the same letters within the characteristic, do not differ significantly at $\alpha = 0.05$
Średnie oznaczone tymi samymi literami w obrębie cech nie różnią się istotnie przy $\alpha = 0,05$

The results of chemical analysis of the leaves of maiden apple trees presented in tables 3 and 4 did not confirm the results obtained earlier by Szwedo and Murawska [1999]. The authors mentioned noted a higher content of nitrogen (on average 2.5 % dry matter), lower content of phosphorus (0.15–0.20% dry matter) and magnesium (0.23–0.28 % dry matter) in the leaves of 'Jonagold' maiden trees, depending on the year and the time of collecting leaf samples. The most similar results were obtained in the case of the content of potassium (on average 2.0% dry matter). On the basis of the observation one can state that the foliar fertilization does not always exhibit direct impact on the mineral elements content in the leaves of maiden apple trees in a nursery. Many factors are involved, among others: the cultivar, time of leaf sampling and the climatic conditions in a given year.

CONCLUSIONS

1. Gibrescol caused the most intensive branching of maiden trees, but at the same time it greatly reduced to a greater extent the number of formed flower buds.
2. None of the applied foliar fertilizers affected significantly the growth and formation of side shoots, except a bigger number of dwarf shoots of 'Delikates' cultivar. However, all of them increased the number of formed flower buds comparing to the control.
3. The treatment of maiden trees with Gibrescol preparation and foliar fertilizers did not affect explicitly the content of macroelements in leaves.

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Streszczenie. W doświadczeniu porównano wpływ trzech nawozów i preparatu Gibrescol stosowanych dolistnie na wzrost i stan odżywienia okulantów dwóch odmian jabłoni w szkółce. Zastosowane nawozy nie miały istotnego wpływu na wzrost okulantów. Wyjątek stanowiła liczba krótkopędów odmiany ‘Delikates’. Jednakże okulanty zauważalnie zwiększyły liczbę założonych pąków kwiatowych. Preparat Gobrescol istotnie zwiększył wysokość i liczbę długopędów okulantów jabłoni odmiany ‘Jonica’ i krótkopędów odmiany ‘Delikates’ w porównaniu z kontrolą. Jednocześnie nie zainicjował formowania się pąków kwiatowych. Wpływ środków chemicznych stosowanych dolistnie na zawartość składników mineralnych w liściach okulantów jabłoni był zróżnicowany. Odnotowano jedynie po zastosowaniu dolistnie mocznika istotnie wyższą zawartość azotu w liściach okulantów dwóch odmian jabłoni w stosunku do kontroli. Istotnie niższa była zawartość wapnia w liściach obu odmian jabłoni w kombinacji kontrolnej w porównaniu z pozostałymi rozpatrywanymi w doświadczeniu.

Słowa kluczowe: okulanty jabłoni, Gibrescol, nawozy, dokarmianie dolistne, wzrost, rozgałęzianie się, stan odżywienia