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IMPACT OF PREPLANTING FERTILIZATION ON THE LEAF NUTRIENT CONTENT OF YOUNG SOUR CHERRY TREES

Krishkov E.

Institute of Agriculture, 2500 Kyustendil, Bulgaria; e-mail: efrbg@yahoo.com

Abstract. The objective of the present study was to determine the impact of seven variants of organic and mineral preplanting fertilization on the content of the main macronutrients (N, P, K, Ca, Mg) in the leaves of sour cherry trees, Erdi Bötermö cv., grafted on two types of rootstocks - seedling forms of Mahaleb (IK-M9) and Droganyellow bigarreau. The investigation was carried out during the period 2001-2003 in an experimental orchard at the Institute of Agriculture, Kyustendil. There was no significant effect of the different preplanting fertilization variants on leaf nitrogen content. The trees on rootstock Droganyellow bigarreau responded more pronouncedly to phosphorous and potassium fertilization, which corresponded to the higher leaf phosphorous and potassium content, compared to those on IK-M9. In all variants, there was a trend for a higher calcium concentration in the leaves of the trees on Droganyellow bigarreau. Leaf magnesium level decreased over experimental years, which was more strongly manifested by the trees on Droganyellow bigarreau, whereas in the variants on the Mahaleb rootstock it was of higher values.

Key words: sour cherry, nutrients, leaf analysis, preplanting fertilization, rootstocks

INTRODUCTION

Numerous studies have proven the interdependence between leaf nutrient concentration, growth and reproductive manifestations of fruit trees. Therefore, the results from the leaf chemical analysis can be used for the control of the fruit tree nutritional regime and the avoidance of soil pollution. This issue is of a great importance, taking into account the serious damage on the environment, caused by some agricultural systems and the society concern about human health, related to some cultivation practices (Borovinova, 2006; Borovinova and Sredkov, 2006; Radomirska and Krishkov, 2006).

There is evidence that sour cherry responds insignificantly to potassium and phosphorous fertilization (Sadowski et al., 1995). Other authors confirm that there is no effect of the application of phosphorous fertilizers even in cases of low soil phosphorous content (Obuhov, 1975; Vang-Petersen, 1984). It is presumed that sour cherry trees have the ability to retain sufficient reserves of this nutrient in their tissues long after soil phosphorous content has decreased.

The cultivar and rootstock influence sour cherry leaf nutrient content (Georgiev and Milenkov, 1989; Dencker and Toldam-Andersen, 2005; Vang-Petersen, 1984). The results obtained by Jadczuk et al. (1997) show that genetically determined characteristics and form of rootstock root system determining its penetration depth in soil are among the most crucial factors for sour cherry trees nutritional regime.

The objective of the present study was to determine the impact of seven variants of preplanting organic and mineral fertilization on the content of the main macronutrients (N, P, K, Ca, Mg) in the leaves of the sour cherry trees, cv. Erdi Bötermö, grafted on two types of rootstocks – seedling forms of Mahaleb (IK-M9) and Droganyellow bigarreau.

MATERIAL AND METHODS

The study was carried out during the period 2001-2003 in an experimental plantation at the Institute of Agriculture, Kyustendil, established in the spring of 1999 with trees from the cultivar Erdi Bötermö, grafted on two seedling rootstocks - Mahaleb (IK-M9) and Droganyellow bigarreau, spaced 5.7 x 4.0 m and shaped in freely growing crown. The soil was leached cinnamonic forest - Chromic Luvisols according to the classification of FAO (2002), correlation with WRBSR by Teoharov (2004), sandy-loam, with low humus (by Turin), total (by Kjeldahl) and alkaline-hydrolysable nitrogen (by Cornfield) and mobile phosphorous (by Egner-Riem) content, well supplied with available potassium (by Milcheva). The pH was slightly acidic - 4.76 (in 1n KCl). There were four replications with 3 experimental trees in a variant.

The following preplanting fertilization variants were examined:

1. P_0K_0 (standard);
2. 8 t farmyard manure – on the whole area of the variant;
3. $P_{80}K_{55}$ + 8 t farmyard manure – on the whole area of the variant;
4. $P_{80}K_{55}$ – on the whole area of the variant;
5. (P_0K_0 + 15 kg farmyard manure) – on the whole area of the variant + (300 g triple superphosphate + 200 g potassium sulphate) – in the planting holes;
6. ($P_{80}K_{55}$ + 8 t farmyard manure) – on the whole area of the variant + (15 kg farmyard manure + 300 g triple superphosphate + 200 g potassium sulphate) – in the planting holes;
7. $P_{80}K_{55}$ – on the whole area of the variant + (15 kg farmyard manure + 300 g triple superphosphate + 200 g potassium sulphate) – in the planting holes.

With the exception of the examined variants, the trees were grown under equal cultivation conditions. No irrigation was applied. Nitrogen fertilizers were not used during the period of investigation.

For determination of leaf macronutrients content mean samples for laboratory analysis were taken yearly (in August) by replications and analyzed according to the following methods - total N - by Keldahl; P_2O_5 – photoelectrocolorimetrically; K_2O – by flame photometry; Ca and Mg - complexonometrically.

RESULTS AND DISCUSSION

The average leaf nitrogen content in the examined variants varied between 2.26 % and 3.26 % of dry matter content and no clearly demonstrated trend for the impact of the preplanting fertilization variant on this index was established (Table 1). The samples from variant 3 on rootstock Droganyellow bigarreau had the highest average for the period value - 2.67%, followed by variant 5. The lowest leaf nitrogen content was fond in the leaves from variant 2 – 2.52%, of the variants on the aforementioned rootstock. The highest leaf nitrogen concentration in the trees on IK-M9 was observed in the samples from variant 5 – 2.69%, followed by variant 1 – 2.68% and variant 7 - 2.63%.

No considerable differences were found regarding the influence of the rootstock used on nitrogen provision to the trees in the farmyard manure variants. This could be due to the fact that organic matter decomposition is most intensive in the upper soil layers, whereas the root systems of the rootstocks used are located at a greater depth, although there is evidence of the impact of root system characteristics on nitrogen uptake and its leaf content (Georgiev and Milenkov, 1989; Jadczuk et al., 1997). Other authors have also reported little or no effect of the application of easily soluble and fast acting mineral nitrogen fertilizers on leaf nitrogen concentration in the first years after tree planting (Sadowski and Jadczuk, 2001; Szücs, 1996) and alternatives for nitrogen fertilization are sought (Georgiev et al., 2003).

Table 1

Leaf nitrogen content, % d.m.

Variant	Droganyellow bigarreau				IK-M9			
	2001	2002	2003	Mean	2001	2002	2003	Mean
1	2.48	3.04	2.26	2.59	2.54	3.14	2.37	2.68
2	2.43	2.76	2.37	2.52	2.46	3.09	2.29	2.61
3	2.65	2.97	2.39	2.67	2.40	2.90	2.44	2.58
4	2.44	2.80	2.61	2.62	2.31	2.83	2.37	2.50
5	2.48	3.11	2.35	2.65	2.50	3.26	2.32	2.69
6	2.46	2.44	2.62	2.27	2.27	2.82	2.37	2.49
7	2.43	2.82	2.53	2.59	2.38	2.90	2.62	2.63
GD 5%	NS	0.213	0.111		0.221	0.133	0.140	
GD 1%		0.181	0.151			0.181	0.190	
GD 0.1%			0.203			0.244		

The average for the experimental period values of the leaf phosphorous content of the trees on rootstock Droganyellow bigarreau are similar, being a little higher in variants 3, 4, 6, and 7 – 0.37%, followed by variant 5 (0.36%), and variants 1 and 2 – 0.34% (Table 2).

Table 2

Leaf phosphorous content, % d.m.

Variant	Droganyellow bigarreau				IK-M9			
	2001	2002	2003	Mean	2001	2002	2003	Mean
1	0.24	0.38	0.41	0.34	0.27	0.38	0.38	0.34
2	0.27	0.38	0.38	0.34	0.27	0.37	0.37	0.34
3	0.31	0.42	0.37	0.37	0.31	0.39	0.35	0.35
4	0.31	0.40	0.39	0.37	0.29	0.37	0.37	0.34
5	0.27	0.37	0.43	0.36	0.29	0.37	0.35	0.34
6	0.30	0.42	0.38	0.37	0.29	0.37	0.34	0.33
7	0.29	0.39	0.42	0.37	0.28	0.38	0.37	0.34
GD 5%	0.032	0.023	NS		0.030	NS	0.037	
GD 1%	0.044	0.031						
GD 0.1%	0.059							

The samples from the trees on IK-M9 showed the highest leaf phosphorus concentration in variant 3 (0.35%), and lowest – in variant 6 (0.33%). With the exception of variants 1 and 2, where values are equal for trees on both rootstocks, there is a trend for a little higher phosphorous concentration in the leaves of the trees grafted on Droganyellow bigarreau. This variation is caused probably by the different uptake ability of the rootstock root system, which has been confirmed by the results obtained by Georgiev and Milenkov (1989) on other rootstocks. The trees on Droganyellow bigarreau in the variants, including the application of the mineral phosphorous fertilizer (in the preplanting holes and on the whole area of the variant), had higher leaf phosphorous content. Such a trend was not observed in the variants with IK-M9.

Leaf potassium content varied over investigation years. The highest average concentration of the nutrient for the trees on the two rootstocks, in all variants, was that of variant 6 on Droganyellow bigarreau (2.26%), followed by variants 7 and 4 on the same rootstock (Table 3). Among the variants on IK-M9, variant 4 (1.98%) had the highest concentration, followed by variants 3 and 7 (1.87%). The positive long-standing effect of the mineral potassium fertilizer applied before tree planting, as well as farmyard manure can be observed, as the potassium level in the leaves of those variants is obvious. These results contravene the data obtained by other researchers regarding the little or no effect of the application of potassium fertilizers in sour cherry cultivation (Obuhov, 1975), although some authors have established positive effects (Vang-Petersen, 1984). The lowest potassium concentration of the variants on Droganyellow bigarreau was found in the leaf samples from variant 1 (1.75%), while on IK-M9 the trees had the lowest potassium rate in variant 5 (1.75%). As a whole, the trees on Droganyellow bigarreau responded more tangibly to the applied potassium fertilization and in variants 3, 4, 5, 6 and 7, where potassium sulfate was used, the samples were characterized by higher leaf potassium level compared to that of the trees in all variants on rootstock IK-M9.

Table 3

Leaf potassium content, % d.m. (2001-2003)

Variant	Droganyellow bigarreau				IK-M9			
	2001	2002	2003	Mean	2001	2002	2003	Mean
1	1.86	1.82	1.58	1.75	1.69	1.78	1.96	1.81
2	1.56	1.65	2.23	1.81	1.59	1.76	2.18	1.84
3	1.76	1.94	2.51	2.07	1.46	1.67	2.49	1.87
4	1.81	1.57	3.14	2.17	1.51	1.71	2.71	1.98
5	2.82	1.96	1.64	2.14	1.87	1.79	1.60	1.75
6	1.77	1.86	3.15	2.26	1.43	1.72	2.42	1.86
7	1.70	1.80	3.12	2.21	1.47	1.72	2.74	1.87
GD 5%	0.336	0.220	0.37		0.188	NS	0.41	
GD 1%	0.460		0.50		0.258		0.56	
GD 0.1%	0.627		0.68				0.76	

The leaf calcium concentration of the experimental trees varied between 2.12 and 3.11% over the years of the study. Its highest average value was established in variant 7 on Droganyellow bigarreau, and lowest in variant 7 on IK-M9 - 2.43% (Table 4).

Table 4

Leaf calcium content, % d.m. (2001-2003)

Variant	Droganyellow bigarreau				IK-M9			
	2001	2002	2003	Mean	2001	2002	2003	Mean
1	3.08	2.59	2.55	2.74	3.00	2.46	2.57	2.68
2	2.92	2.71	2.72	2.78	2.92	2.31	2.56	2.60
3	2.94	2.94	2.37	2.75	3.03	2.82	2.27	2.71
4	3.02	2.96	2.60	2.86	3.05	2.43	2.36	2.61
5	3.11	2.78	2.83	2.91	3.01	2.50	2.87	2.79
6	3.01	2.59	2.65	2.75	2.97	2.72	2.45	2.71
7	3.10	2.87	2.95	2.97	2.72	2.46	2.12	2.43
GD 5%	0.131	0.322	0.234		0.151	0.319	0.417	
GD 1%			0.318		0.206			
GD 0.1%					0.278			

In all variants there was a trend, similar to that for leaf phosphorous content, in higher calcium content in the leaves of the trees grafted on Droganyellow bigarreau, compared to those on IK-M9.

A trend for a slight decrease of leaf magnesium levels was observed, which was more pronounced in the variants on Droganyellow bigarreau (Table 5). Except for variant 2, the average leaf magnesium values are higher in the variants on IK-M9 in comparison with those on Droganyellow bigarreau. Similar results have been obtained by Ugorik and Holubowicz (1990) in the assessment of the chemical composition of the sour cherry leaves on different types of rootstocks, as well as that of self-rooted trees. The authors conclude that leaf magnesium content of the sour cherry trees is determined predominantly by the rootstock and that Mahaleb rootstocks should be used when the soil magnesium level is insufficient.

Table 5

Leaf magnesium content, % d.m. (2001-2003)

Variant	Droganyellow bigarreau				IK-M9			
	2001	2002	2003	Mean	2001	2002	2003	Mean
1	0.58	0.47	0.46	0.50	0.67	0.64	0.52	0.61
2	0.59	0.62	0.55	0.59	0.57	0.62	0.58	0.59
3	0.54	0.52	0.47	0.51	0.56	0.61	0.50	0.56
4	0.58	0.51	0.41	0.50	0.56	0.58	0.49	0.54
5	0.60	0.50	0.44	0.51	0.68	0.65	0.60	0.64
6	0.51	0.49	0.48	0.49	0.62	0.66	0.50	0.59
7	0.57	0.45	0.42	0.48	0.50	0.60	0.47	0.52
GD 5%	0.058	0.068	0.072		0.085	NS	NS	
GD 1%		0.093			0.115			
GD 0.1%		0.125			0.156			

Another factor causing this effect could be the more intensive accumulation of calcium by the trees on Droganyellow bigarreau, as well as the antagonistic interrelations during the uptake of potassium, calcium and magnesium by root system. In variants 4, 6 and 7, where higher quantities of mineral potassium fertilizer and farmyard manure were incorporated into the soil, the lower leaf calcium content could be due to the higher potassium uptake rate from the soil. This corresponds to its relatively higher concentration in the leaves from the variants on the two rootstocks, and the competitive relations of these two nutrients. Manifestations of nutrient uptake antagonism were also revealed in variant 5 on IK-M9, which demonstrated the highest average for the period leaf nitrogen content and lowest leaf potassium levels, whereas the samples from the trees in the same variant did not exhibit such a trend. Similar results have been obtained by Vang–Petersen (1975), showing that the increased nitrogen concentration leads to a reduction in the content of phosphorous and potassium, while it enhances that of calcium and magnesium. The author concludes that the higher potassium content causes a decrease of calcium and magnesium, while the augmented leaf magnesium rate leads to a decrease of the potassium concentration in the leaves of sour cherry trees. For the period of the experiment, antagonism concerning the uptake of nitrogen and phosphorous was not observed.

CONCLUSIONS

For the period of the experiment, there was no significant effect of the different preplanting fertilization variants on leaf nitrogen content. The trees on rootstock Droganyellow bigarreau responded more pronouncedly to phosphorous and potassium fertilization, which corresponded to the higher leaf phosphorous and potassium content compared to those on IK-M9. In all variants, there was a trend for a higher calcium concentration in the leaves of the trees on Droganyellow bigarreau. Leaf magnesium levels decreased over experimental years, more strongly manifested by the trees on Droganyellow bigarreau. However, in the variants on the Mahaleb rootstock it had higher values. The nutrient requirements of the young sour cherry trees are lower; the root system is undeveloped, which could lead to the insignificant response to fertilization. The rootstock used had a considerable impact on leaf nutrient content.

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REZUMAT

IMPACTUL FERTILIZĂRII ÎNAINTE DE PLANTARE ASUPRA CONȚINUTULUI ÎN NUTRIENȚI A FRUNZELOR LA POMII TINERI DE VIŞIN

Lucrarea prezintă impactul fertilizării organice şi minerale, efectuată înainte de plantarea pomilor de vişin, asupra conținutului frunzelor în principalele macronutriente (N, P, K, Ca, Mg). S-au urmărit şapte variante de fertilizare, la soiul Erdi Bötermö, altoit pe două tipuri de portaltoi generativi, respectiv Mahaleb (IK-M9) şi Droganyellow bigarreau. Investigațiile s-au efectuat în perioada 2001-2003, în livada experimentală a Institutului de Agricultură Kyustendil, Bulgaria. Efectul fertilizării asupra conținutului frunzelor în nitrogen a fost nesemnificativ. Pomii altoiți pe Droganyellow bigarreau au reacționat mai pronunțat la fertilizarea cu fosfor şi potasiu, printr-un conținut mai mare a frunzelor în P şi K, comparativ cu cei altoiți pe Mahaleb IK-M9. La toate variantele, concentrația frunzelor în calciu a fost mai mare la pomii altoiți pe Droganyellow bigarreau. Nivelul magneziului în frunze a scăzut în anii de experimentare, în special la pomii altoiți pe Droganyellow bigarreau; față de aceştia, cei altoiți pe mahaleb au avut frunze cu un conținut mai mare de magneziu.