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THE EFFECT OF FOLIAR FERTILIZATION ON GROWTH AND YIELD OF SOUR CHERRY (*Prunus cerasus* L.) cv. Łutówka

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Abstract

The present study, carried out in the period 2007-2009 in the Sandomierz Upland, did not show a significant effect of foliar fertilization on trunk thickness and canopy volume in the cultivar Łutówka. However, under the influence of urea applied three times in combination with Florovit at a concentration of 0.5%, a clear increasing trend was observed in the above mentioned parameters used to assess the strength of growth. In years of abundant fruiting, this study showed a significant increase, or on the verge of significance, in yield after threefold application of urea and Florovit in combination. A small insignificant effect of fertilization on fruit weight shows that the growth in yield after the application of fertilization was produced as a consequential effect of a significant increase in the length of one-year shoots and thereby in flowering intensity of the 'Łutówka' cherry trees. In the case of the sour cherry cultivar Łutówka bearing fruit on one-year shoots, foliar feeding after flowering using multi-nutrient fertilizers and urea can be recommended as a technological treatment, in particular in years of abundant fruiting.

Key words: sour cherries, foliar fertilization, growth, yield, fruit quality

INTRODUCTION

In the opinion of Nurzyński (1996) and Sadowski (1996), soil fertilization is and will remain the basic method of supplying mineral nutrients in fruit farming. The above-mentioned authors treat extra-root fertilization as supplementary nutrition that is applied when nutrient deficient symptoms occur or in stress situations that impede nutrient uptake by roots.

Over the recent years, foliar fertilization of trees at different growth stages during the growing season has been recommended more and more frequently (Aleksander and Lapin, 1996; Pacholak, 2001; Wójcik, 2002, 2009; Morgaś, 2004; Guak et al. 2005; Kurlus and Łysiak, 2008; Jarociński, 2008; Grzyb and Rozpara, 2009; Tomala and Jeziorek, 2010).

Foliar feeding with calcium compounds is a commonly used treatment that prevents bitter pit in apples (Aleksander and Lapin, 1996; Nurzyński, 1996; Pacholak, 2001; Wójcik, 2009) and reduces sour and sweet cherry fruit cracking during the ripening period (Wójcik, 2002; Wermund et al. 2005; Chełpiński et al. 2007; Jarociński, 2008).

In the case of sour cherry, foliar application of multi-nutrient fertilizers after flowering had a positive effect on fruit size and quality (Kurlus and Łysiak, 2008). A number of authors (Wójcik, 2002, 2009; Morgaś, 2004; Guak et al. 2005; Jarociński, 2008) recommend foliar fertilization with urea during the period of intensive growth of primordia and shoots, but also at higher concentrations during the autumn period. These authors are of opinion that this treatment, when performed right after blooming, produces better fruit set and growth, whereas the autumn treatment increases flowering intensity in the next year and reduces the occurrence of some pathogens overwintering on fallen leaves. Jarociński (2008) and Wójcik (2009) recommend foliar feeding with boron-containing fertilizers in autumn or during flowering as a treatment that improves sour cherry fruit set and formation. Tomala and Jeziorek (2010) think that foliar supplements containing phosphorus and potassium, when applied 4 and 2 weeks before harvest, improve apple fruit colouration.

The effects of fertilization depend on many factors: cropping method and tree age (Sadowski and Jadczuk, 2001); biological material (Wociór, 2008); the time of treatment, nutrients applied and the

occurrence of stress factors – drought, excess water, root damage (W ó j c i k , 2009).

The aim of the present study was to evaluate the effect of foliar fertilization with nitrogen and a multi-nutrient fertilizer, Florovit, on growth and yield of the cultivar Łutówka. This cultivar bears fruit on one-year shoots and after anthesis it is characterized by a large predominance of the number of primordia compared to the number of leaves. This predominance increases with tree age. For this reason, the study was conducted during the period between year 9 and 11 after the establishment of the orchard.

MATERIALS AND METHODS

This study was carried out in the period 2007-2009 in a commercial orchard located in the Sandomierz Upland. The experimental material consisted of sour cherry trees cv. Łutówka grafted on sweet cherry and planted in autumn 1998 at a spacing of 5 x 3 m on grey-brown podzolic soil belonging to soil class III b. In the orchard, turf was maintained in the interrows and herbicide fallow in the tree rows. Nitrogen fertilization was applied each year in the orchard at a rate of 100 kg×ha^{-1} (70% in the spring and 30% at the end of May). Phosphorus fertilization at a rate of 50kg×ha^{-1} and potassium fertilization at a rate of 200kg/ha were introduced in the autumn. The trees selected for investigation were in good health.

Crown thinning was done in March, at the same time reducing the crowns down to about 2.8m. With the loose spacing of the trees, their crowns were maintained in a natural way.

The experiment was set up in a randomized block design. It comprised 4 treatment combinations in five replicates. The plots with 3 trees growing in each of them were the replicates.

The following treatment combinations were used in the experiment:

1. Control
2. Foliar fertilization with 0.5% urea
3. Foliar fertilization with 0.5% urea combined with 0.5% Florovit
4. Foliar fertilization with 0.5% Florovit

Foliar fertilization was applied three times at ten-day intervals; the first treatment was performed 7-10 days after flowering.

In the experiment, trunk diameter was measured at a height of 30 cm as well as canopy height and width. Based on these measurements, trunk cross-sectional area and canopy volume were calculated, treating the crown as a sphere ($V=4/3\pi R^3$). Five axial shoots were measured on each tree in the years 2007 and 2009. Yield from each tree was weighed during harvest; 100 fruits were also weighed to estimate fruit size.

The results were statistically analysed using the analysis of variance and Tukey's confidence intervals at p=0.05.

RESULTS AND DISCUSSION

Over the three-year study period, foliar fertilization did not affect significantly the trunk thickness in the cultivar Łutówka. When urea and Florovit were applied together, each year a clear increasing trend in trunk cross-sectional area was observed compared to the control treatment (Table 1).

A tendency towards the formation of larger canopy volume by the foliar-fertilized trees was demonstrated. The combined application of urea and Florovit gave the best results, producing a 16% increase in canopy volume compared to the control treatment. However, the differences between the treatments in individual years were insignificant.

The measurements of the length of axial shoots, performed in the years 2007 and 2009, showed a significant increase in shoot increment in 2007 after spraying the trees with urea as well as urea with Florovit compared to the control (Table 2). In 2009 a similar correlation was observed, while the differences between the above-mentioned treatments were on the verge of significance.

In the opinion of N u r z y ń s k i (1996), P a c h o l a k (2001), and W ó j c i k (2009), foliar feeding during the intensive growth of primordia and shoots stimulates the growth and development of additional leaves as well as it mitigates competition between fruit and shoots for nutritional compounds. It can be presumed that a similar phenomenon occurred in the present study, causing a growth in shoot length and an increase of the crown under the influence of the treatments applied.

Foliar fertilization increased yield of the cultivar Łutówka (Table 3). The combined application of urea and Florovit was the most effective, producing on average a ca. 14% increase in yield compared to the control treatment. In 2008 the differences between the above-mentioned treatments were significant, while in the next year they were on the verge of significance. In the year 2007, in which the flowers were significantly damaged by spring ground frost, a significantly lower yield was harvested relative to the other years. A smaller effect of fertilization on yield was also found in the above-mentioned year.

The applied foliar fertilization treatments did not change significantly fruit weight in the cultivar Łutówka (Table 3). Yield had a significant effect on fruit weight. In 2007, the year with the lowest yield, fruit weight was significantly higher relative to the other years.

Wójcik (2009) reports that urea application can improve the penetration of other foliar fertilizers into orchard plants. In the present study, better effects of spraying with urea and Florovit in combination were observed in both the growth and yield parameters compared to those when the same concentrations of these fertilizers were applied separately. This would confirm the above-mentioned author's view.

A number of authors (Nurzyński, 1996; Wójcik, 2002, 2009; Jarociński, 2008; Grzyb and Rozpara, 2009) think it is justified to apply foliar feeding of sour cherry trees under stress conditions impeding adequate nutrient uptake by roots. During the study period in the Sandomierz Upland, rainfall in April, May and June 2007 was 105 mm, in 2008 it was 162 mm, 169 mm in 2009, while the long-term average for this period was 179 mm. The presented data show that water deficit could be a stress factor impeding nutrient uptake only in 2007 during the period of the most intensive growth of shoots and primordia. In the remaining years, however, there was found a higher effect of foliar feeding on yield of the cultivar Łutówka. This indicates the need to apply foliar fertilization of this cultivar in years of abundant fruiting in order to stimulate in the trees the increase in assimilation area during the period of the most intensive growth of fruit and shoots. Positive effects of this treatment were obtained in the aging sour cherry orchard even with high NPK fertilization rates of, respectively, 100, 50 and 200 kg×ha^{-1} per year. In the case of this cultivar, abundant fruiting should be considered to be a stress factor, resulting in an increased requirement of the tree for nutrients.

Table 1

Growth of sour cherry trees cv. Łutówka in dependence on the type of foliar fertilization in 2007-2009

Treatment combinations	Trunk cross-sectional area in cm^2		
	2007	2008	2009
Control	87.2	90.6	96.1
Urea 0.5% x 3	86.7	89.3	95.1
Urea and Florovit 0.5% x 3	90.8	94.6	100.9
Florovit 0.5% x 3	85.5	89.1	94.9
LSD p=0.05	ns	ns	ns

Table 2

Canopy size and shoot length in sour cherry trees cv. Łutówka in dependence on the type of foliar fertilization in 2007-2009

Treatment combinations	Canopy volume in m^3				Shoot length in cm	
	2007	2008	2009	$\overline{\chi}$	2007	2009
Control	12 .8	12 .3	12 .6a	12 .6	48 .8b	43 .1a
Urea 0 .5% x 3	13 .9	13 .1	13 .9a	13 .6	56 .7a	54 .0a
Urea and Florovit 0 .5% x 3	14 .7	14 .0	15 .0a	14 .6	57 .5a	54 .5a
Florovit 0 .5% x 3	13 .0	13 .2	12 .8a	13 .0	53 .0ab	44 .0a
LSD p=0 .05	ns	ns	4 .5		6 .7	11 .7

Means followed by the same letters do not differ significantly at p=0.05

Table 3

Yield and fruit quality of sour cherry cv. Łutówka in dependence on the type of foliar fertilization in 2007-2009

Treatment combinations	Yield in kg/tree				Percentage in comparison to the control	Fruit weight in g		
	2007	2008	2009	$\overline{\chi}$	in %	2007	2008	2009
Control	15.1	27.1b	25.9a	22.7	100	5.8a	5.1	5.1
Urea 0.5% x 3	15.7	28.6ab	28.9a	24.4	107	6.4a	5.2	5.1
Urea and Florovit 0.5% x 3	16.8	31.5a	29.3a	25.9	114	6.2a	5.3	5.2
Florovit 0.5% x 3	15.5	28.7ab	26.9a	23.7	104	6.6a	5.2	5.2
LSD p=0.05	ns	4.3	3.7	-		0.8	ns	ns
Mean for years	15.8B	29.0A	27.5A			6.2A	5.2B	5.1B

Means followed by the same letters do not differ significantly at p=0.05

Differences between treatments are marked with small letters, differences between years with capital letters.

CONCLUSIONS

1. In the case of the sour cherry cultivar Łutówka bearing fruit on one-year shoots, foliar fertilization after flowering using Florovit and urea can be recommended as a technological treatment, in particular in years of abundant fruiting.
2. In years of abundant fruiting, this study showed a significant increase, or on the verge of significance, in yield after threefold application of urea and Florovit in combination.
3. A small insignificant effect of fertilization on fruit weight shows that the growth in yield after the application of fertilization was produced as a consequent effect of a significant increase in the length of one-year shoots and thereby in flowering intensity of 'Łutówka' cherry trees.
4. Foliar fertilization was not found to have a significant effect on trunk thickness and canopy volume in the cultivar Łutówka. However, under the influence of urea applied three times in combination with Florovit at a concentration of 0.5%, a clear increasing trend was observed in the above mentioned parameters used to assess the strength of growth.

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Wpływ dokarmiania dolistnego na wzrost i plonowanie wiśni (*Prunus cerasus* L) odmiany Łutówka

Streszczenie

Badania wykonane w latach 2007-2009 na Wyżynie Sandomierskiej nie wykazały istotnego wpływu dokarmiania dolistnego na grubość pni i objętość koron odmiany Łutówka. Zaobserwowano jednak wyraźną tendencję do zwiększania wymienionych parametrów oceny siły wzrostu pod wpływem trzykrotnego łącznego stosowania mocznika z Florovitem w stężeniu 0,5%. W latach obfitego owocowania wykazano istotne lub znajdujące się na pograniczu istotności zwiększenie plonu po trzykrotnym łącznym

zastosowaniu dokarmiania mocznikiem i Florovitem. Niewielki, nieistotny wpływ dokarmiania na masę owocu wskazuje na to, że wzrost wielkości plonu po zastosowaniu dokarmiania powstał jako efekt następczy istotnego zwiększenia długości pędów jednorocznych i tym samym intensywności kwitnienia drzew „Łutówki". W przypadku owocującej na pędach jednorocznych odmiany Łutówka dokarmianie dolistne po kwitnieniu przy użyciu Florovitu i mocznika można polecić jako zabieg technologiczny, szczególnie w latach obfitego owocowania.