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THE IMPACT OF THE FOLIAR FERTILIZATION ON THE SWEET CHERRY TREE PRODUCTIVITY

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ABSTRACT

This study aims to determine the impact of the nanotechnology-based foliar Pistachio Mix Plus NPA fertilizer on the yield and quality of sweet cherries. The research has been conducted using the 'Kordia' sweet cherry variety grafted on the Gisela 6 rootstock and planted at a distance of 4x1 m. Between 2023 and 2024, the foliar fertilizer was used during four phenophases of flower bud development in a dose of 2.5 l/ha. The fruit yield increased by 14.9-30.1%, when the Pistachio Mix Plus NPA was used 2.5 l/ha three times, in comparison with the yield of the sweet cherry trees which were not treated with the fertiliser. The foliar fertilization with microelements has increased the number of fruits with a diameter larger than 30 mm by 64.6-65.4%. Thus, the fruit yield and quality can be improved in sweet cherry orchards using nanotechnology-based foliar fertilizers during three fruiting phenophases, namely pink-white bud + petal shedding + the beginning of ripening.

INTRODUCTION

The foliar fertilization of sweet cherry trees is of crucial importance, since macro- and microelements have a significant impact on the quality and quantity of fruit. Nowadays, it is very important to manage the amount of nutrients through the use of chemical fertilizers on a global level (Bălan et al. 2001; Bălan 2009; Zulfiqar et al. 2019; Csihon et al. 2021). Soluble fertilizers, which are combinations of N, P, K, Ca, Mg, S and micronutrients in different ratios, are used in drip irrigation and foliar spray systems (Klein 2002; Stampar et al. 2003; Nagy et al. 2012). They allow the rapid compensation of deficient elements, reduce nutrient losses and increase the harvest through the correct management of water and nutrients (Babuc 2012; Gogos et al. 2012; Robinson & Lopez 2012; Malhotra 2016). The maximum concentration of Fe, Mn, Cu, Zn, B and Mo microelements in plants does not exceed 0.01% of the dry substance, but they play an essential role in the development of the physiological and biochemical processes. The objective of this paper was to determine the impact of the use of the nanotechnology-based fertilizer, which contains microelements (B - 0.3; Cu - 0.5; Fe - 2.0; Mn - 0.5; Zn - 1.0), on the yield and quality of sweet cherries.

MATERIAL AND METHODS

The studies were carried out between 2023 and 2024, in the northern fruit-growing area of the Republic of Moldova, namely in the sweet cherry orchard planted

in 2018 with the 'Kordia' and 'Regina' varieties, which were grafted on the 'Gisela 6' and planted at a distance of 4x1 m. The trees were protected with anti-hail netting and drip irrigated (the droppers were fixed at a height of 40 cm from the ground in the direction of the row).

The effect of the microelements-based foliar fertilizer (Pistachio Mix Plus NPA), used during four phenophases of sweet cherry flower bud development in a dose of 2.5 l/ha using 1000 l/ha of low pH (PH 6.5) water, was studied. The first treatment was carried out when the generative buds' scales cracked and the light-green bracts appeared(G2); when the flower buds were visible and separate, green and slightly open, and the tail (peduncle) of the flowers were elongated (G3); when the floral buds in most flowers took the shape of a white-pink ball, the petals were well developed and the buds were ready to bloom. The first flower was open (G4) and the most petals had shed (G5). Afterwards, the treatments were carried out in groups G2, G3 and G4, when all the petals had shed, and at the beginning of ripening, when the fruit had changed colour from green to white-pink and greenish-yellow. The experiments were presented linearly and included 3 groups of 8 trees each. In each experiment and group, two trees were not fertilized for differentiation purposes. In each group, 10 l of solution was used for 24 trees. The fruit yield in each group was determined by weighing all the sweet cherries (kg/tree). The fruit quality parameters were determined according to the fruit diameter (mm) and weight (g). The fruit diameter and weight were estimated using 100 fruit during the harvest period, using a recommended fruit grading template (Voen).

The statistical processing of the data was carried out using the method of monofactorial dispersion analysis and the correlation and regression method (Dospehov, 1985). The comparison of the sample averages was performed using the one-way analysis of variance (ANOVA) and the Tukey's test; the P-value of the test was less than 0.05 ($P \leq 0.05$).

RESULTS AND DISCUSSIONS

Sustainable fruit growing requires the development of new methods of using mineral fertilizers at each stage of vegetation in order to efficiently use nutrients and obtain high-quality fruit yields (Babuc, 2012; Asănică, 2012). Over the years of research, the yield of the 'Kordia' variety was average (Table 1). The lowest yield was obtained in the trees in G1 (the control group) each year (3.33-6.22 kg/tree). The yield of the trees treated with microelements was 6.62-7.24 kg/tree in 2023, and 3.45-4.33 kg/tree in 2024. The yield was higher in G4, when the trees were fertilized three times: during the phenophase of white-pink buds, when all the petals had shed and when the fruit began to ripen.

The yield per hectare in 2023 was higher (15.55-18.11 t/ha) compared to 2024 (11.93-14.46 t/ha), as heavy rains in June (112 mm) during the fruit ripening period had a great impact on the yield. The lowest yield was produced by the untreated trees (8.32-15.55 t/ha), while the trees treated with microelements showed yields that ranged from 8.62 to 18.11 t/ha. In 2023, the highest harvest (17.67-18.11 t/ha) was produced by the trees in G3 and G4, while the yield of the trees in the control group was lower by 14.9-16.5% (8.32-15.55 t/ha). In 2024, the harvest in G3 and G4 (10.3-10.82 t/ha) also exceeded the harvest produced by the trees in the control group by 23.8-30.1% (8.32 t/ha).

Table 1

The impact of the foliar fertilizer Pistachio Mix Plus NPA on the sweet cherry harvest

Group	Yield (kg/tree)			Yield (t/ha)		
	Year 2023	Year 2024	Average indices	Year 2023	Year 2024	Average indices
G1	6.22	3.33	4.77	15.55	8.32	11.93
G2	6.62	3.45	5.03	16.55	8.62	12.58
G3	7.15*	4.12*	5.63	17.87*	10.30*	14.08
G4	7.24*	4.33*	5.78	18.11*	10.82*	14.46
G5	6.68	3.50	5.09	16.71	8.75	12.72
LSD 0,05%	0.54	0.35	-	1.012	1.55	-

*the difference between the treated and control groups was statistically significant (P<0.05); 'Gisela 6' rootstock, 'Kordia' variety, planting distance 4x1 m, slender spindle-shaped crown, the age of the trees – 6-7 years

In conclusion, it should be noted that the treatment of trees with microelements during the phenophases of green bud (G3) and white-pink bud (G4) significantly increased the yield of the 'Kordia' variety grafted onto the 'Gisela 6' rootstock.

The size of the sweet cherries was between 26.7 and 29.6 mm (Table 2, Figure 1, 2). It is obvious that the fertilization of the sweet cherry trees with microelements during the fruiting phenophase contributed to an increase in the weight of the fruit. Thus, on average over two years, the weight of the fruit in the groups, in which the trees were fertilized, increased by 2.1-16.5%, being greater in G3 (10.8 g), G4 (11.25 g) and G5 (10.65 g) as compared to the weight of the fruit from the untreated trees in the control group.

Table 2

The impact of the foliar fertilizer Pistachio Mix Plus NPA on the size of the sweet cherries*

Group	Fruit diameter (mm)			Fruit weight (g)		
	Year 2023	Year 2024	Average indices	Year 2023	Year 2024	Average indices
G1	28.3	26.7	27.5	10.1	9.2	9.65
G2	27.7	27.8	27.75	9.8	9.9	9.85
G3	29.5	27.6	28.55	11.5	10.1	10.8
G4	29.6	27.9	28.75	11.9	10.6	11.25
G5	28.8	27.8	28.3	11.2	10.1	10.65
Average indices	28.78	27.56	28.17	10.9	9.98	10.44

*'Gisela 6' rootstock, 'Kordia' variety, planting distance – 4x1 m, slender spindle-shaped crown, the age of the trees – 6-7 years)

It should be mentioned that, in the year 2024, the size of the fruit of the 'Kordia' variety, grafted on 'Gisela 6' rootstock, decreased as compared to the year 2023, because the high temperatures during their development accelerated their ripening. The indices of the size and weight of the sweet cherries, per year, increased by 2.1-16.5% in the groups in which the fertilizer had been used as compared to the control group.

The studies conducted showed that the relationship between the diameter and weight of fruit during the harvest period was significant (Figure 1, 2). The data are presented linearly, and the reliability index (R^2=0.9378; R^2=0.8034) around R^2>0.95 is a good argument, which confirms its linear nature at a high level. Thus, the correlation

between the diameter and weight of ripe fruit is linear and allows one to determine the diameter of fruit when knowing their weight, which has also been confirmed by other authors (Bălan et al. 2017; 2023).

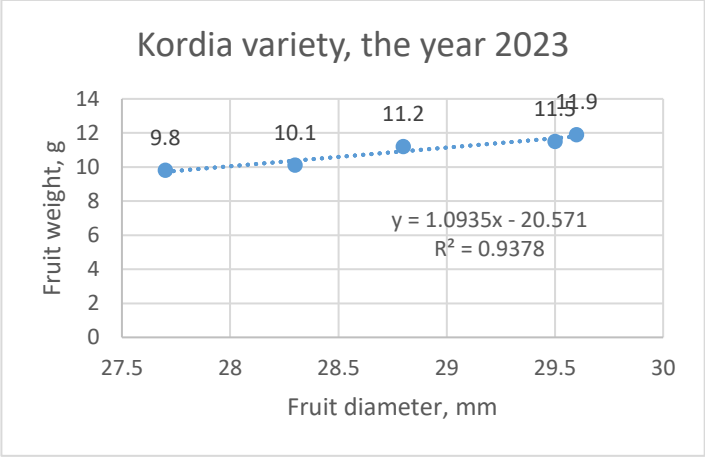

Figure 1. The impact of the foliar fertilizer Pistachio Mix Plus NPA on the size of sweet cherries *(Gisela 6 rootstock, Kordia variety, planting distance – 4x1 m, slender spindle-shaped crown, the age of the trees – 6 years)*

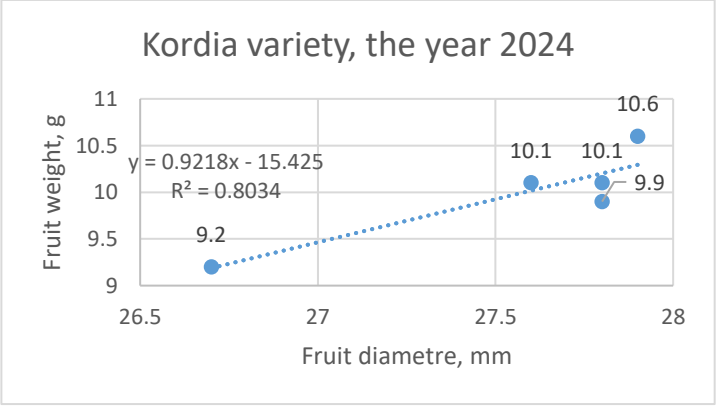

Figure 2. The impact of the foliar fertilizer Pistachio Mix Plus NPA on the size of sweet cherries *(Gisela 6 rootstock, Kordia variety, planting distance – 4x1 m, slender spindle-shaped crown, the age of the trees – 7 years)*

The most impressive changes can be observed in the redistribution of sweet cherries by diameter (Table 3) – the trees in G3 and G4 produced larger crops, since the foliar treatments with the Pistachio Mix Plus NPA fertilizer was used. In the untreated group (G1), the proportion of fruit with a diameter of 22-26 mm amounted to 20.9%, with a diameter of 26-30 mm – 35.6%, and with a diameter greater than 30 mm – 43.5%. Consequently, 56.5% of the fruit had a diameter smaller than 30 mm. In the treated varieties, the proportion of fruit with a diameter larger than 30 mm increased significantly and amounted to 52.1-57.9%; it was greater in G3 (57.2%)

and G4 (57.9%). Thus, the foliar fertilization based on nanotechnology increased the proportion of sweet cherries with a diameter larger than 30 mm.

Table 4

The impact of the foliar fertilizer Pistachio Mix Plus NPA on the redistribution of sweet cherries by diameter

Group	Proportion of sweet cherries (%) depending on their diameter		
	22-26 mm	26-30 mm	>30 mm
G1	20.9	35.6	43.5
G2	19.7	28.0	52.3
G3	15.9	26.9	57.2
G4	18.0	24.1	57.9
G5	20.7	27.2	52.1

*'Gisela 6' rootstock, 'Kordia' variety, planting distance – 4x1 m, slender spindle shaped crown, the age of the trees – 6 years

It should be noted that the greatest number of high-quality fruit was obtained when the fertilization process was carried out during the green bud (G3) and white-pink bud phenophase of the generative buds (G4).

CONCLUSIONS

The sweet cherry yield and quality can be effectively improved using a nanotechnology-based foliar fertilizer. The utilization of the microelement solution of B – 0.3%, Cu – 0.5%, Fe – 2.0%, Mn – 0.5% and Zn – 1.0% in the dose of 2.5 l/ha, three times during the sweet cherry growth period, contributed to the increase of the harvest of the 'Kordia' variety by 14.9-16.5% in 2023 and by 23.8-30.1% in 2024. The untreated trees produced 43.5% of fruit with a diameter larger than 30 mm, while the foliar fertilization with microelements in the green bud (G3) and white-pink bud phenophase of generative buds (V4) increased the proportion of fruit with a diameter larger than 30 mm up to 57.2-57.9% in the 'Kordia' variety.

The first fertilization must be carried out when the floral bud in most flowers takes the shape of a white-pink ball, the petals are well developed and the first flower is open, the second fertilization – when all the petals have shed, and the third fertilization – when the fruit turn from green to white-pink and greenish-yellow.

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