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EFFECT OF THE RADICULAR AND FOLIAR FERTILIZER ON FRUIT QUALITY IN THE PEACH ORCHARD

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Abstract

Nutrient management is a determining element of the technology in fruit quality. Significance of foliar fertilization has been increased continuously over the last years, as it can directly improve the vegetative and generative performance of the trees. In this study we aimed to evaluate the effect of the radicular (NPK+S) and foliar (Cropmax) fertilizer on fruit quality parameters in a peach orchard during 2019 -2021 period. According to our results, the weight of the fruits increased by 40% in the b1 treatment and 64% in the b2 treatment at Filip cultivar and by 27% in the b1 treatment and 49% in the b2 treatment at Catherine sel. 1 cultivar in the three years of study compared to the control treatment. In conclusion, the fruit quality can be improved in peach orchard using radicular and foliar fertilizers.

Key words*: climate conditions, fertilization, peach, weight.*

INTRODUCTION

Fertilization of fruit trees is an essential element of the technology due to its significant influence on the quality and yield. Nowadays foliar fertilization has become a basic management tool in intensive orchards. Foliar fertilizers have an interesting potential to improve fruit quality, with relatively low costs and low environmental impact (Csihon et al., 2021). Application of sprays supplies nutrients to plants more rapidly than the soil fertilization (Tagliavini et al., 2002; Nagy et al., 2012, 2019). The use of biostimulators is increasing all over the world. They can be considered as natural growth regulators. Beneficial effect of the biostimulators on the fruit quality is confirmed by several studies (Hudina et al., 2003; Basak & Mikos-Bielak, 2008; Nagy et al., 2019; Csihon et al., 2013, 2021).
The aim of this work was to provide data on the effect of 'Cropmax' foliar biostimulator on the fruit quality in a peach orchard.

MATERIALS AND METHODS

Experimental site. The studied orchard is located in Valu lui Traian commune, district Constanta, Dobrogea region, Romania. This is a semi-arid region with a climatic water deficit (WD), calculated as a difference between annual precipitation (P) and Penman-Monteith reference evapotranspiration (PM-ETo), ranging from about -400 mm on the Black Sea coastal area to -320 mm (Paltineanu et al., 2007). The soil is a calcareous chernozem with a loamy texture and alkaline pH in topsoil which has a good soil structure (0-60 cm depth, with 27-32% g/g clay content, 1.6-2.8% g/g humus content, 1.5-6.8% g/g carbonate content), while in the non-structured subsoil, the humus content is lower than 1% g/g and the carbonates from 9 to 14% g/g; land slope is between 2.0 and 2.5% (Paltineanu et al., 2011).
The peach orchard was planted in spring of 2011. Trees were grafted on Tomis 1 rootstock and designed with spacing of 4 x 2.5 meter with north-south row orientation. The canopy shape was a classic vase with the height of 2.5 m. The experiment design was based on the split-plot method with three treatments: b1) radicular fertilizer with NPK+S, 15:15:15+ 12.8; b2) radicular and foliar fertilizer (Cropmax); b3) control, each one containing four replicates. The soil management system is represented by clean cultivation both between tree rows and in the row. Plant protection refers to the principles of integrated pest management.

The climatic data: solar radiation, air temperature, relative humidity, wind speed at the height of 2 m, precipitation (P) and Penman-Monteith reference evapotranspiration have been recorded by an automatic weather station (iMetos, IMT 300, Pessl Instruments, Austria) by a 1-h step. These data have been periodically transferred to a laptop and processed as diurnal means and used in calculations.

Applied treatments. The main objective of this study was to evaluate the effect of radicular and foliar fertilizer on the fruit quality in a peach orchard. The trial was consisted of three treatments (control, radicular fertilizer and radicular + foliar fertilizer). The first treatment with foliar fertilizer was applied in full bloom in 2019 and 2020, then the treatments were repeated 3 times. In 2021, the first treatment with foliar fertilizer was applied later, 11.05, followed by two replicas (Table 1). Biostimulant treatment was applied to peach orchard in the vegetation phases with 0.5 l/ha dosage (Figure 1).
Every spring, in the peach orchard was applied to the soil the complex NPK fertilizer enriched with easily absorbable S (15: 15: 15+ 12.8), 500 kg/ha respectively. Each treatment was consisted of 16 trees.

Table 1. Foliar fertilizer application times (2019-2021)

2019	2020	2021
12.04.2019	24.04.2020	11.05.2021
13.05.2019	15.05.2020	09.06.2021
31.05.2019	29.05.2020	02.07.2021
18.06.2019	17.06.2020	

Figure 1. Foliar fertilizer applied at peach orchard

Applied materials. The peach tree (*Prunus persica* L. Batsch) has been selected for this study as it is one of the most cultivated fruit tree species worldwide, especially in the warm temperate climate regions. Filip is the first peach cultivar with flat fruit "sandwich" and white pulp, registered in Romania, in 2002 at Research Station for Fruit Growing (RSFG) Constanța (Figure 2). Catherine sel. 1 is the first clingstone peach cultivar registered in Romania, in 2001 at RSFG Constanta (Figure 3).

Figure 2. Filip cultivar

Figure 3. Catherine sel. 1 cultivar

NPK complex fertilizers, with a balanced formula in the content of Nitrogen (N), Phosphorus (P), Potassium (K), guarantee a fertilization rich in nutrients with direct results on increases in the quality and quantity of fruit products.
Cropmax is a complex super concentrate nutrient for foliar fertilization, which is 100% natural, produced by Farming Holland BV. Cropmax fertilizer presents the following chemical composition: growth plant stimulator (auxines, citochinine, gibberellines), organic amino acids, vegetal vitamins, vegetal enzymes, macro-elements: N0 - 2%, P - 0.4% , K - 0.02%, Fe - 220 mg, Mg - 180 mg, Zn - 40 mg, Mn - 45 mg, Cu - 5 mg, other elements: B, Ca, Mo, Co, Ni - 10 mg. Being a natural product, Cropmax is well absorbed by leaves and stems. Influence on photosynthesis leads to the increase of carbohydrates amount. Also are reduced metabolic deficiencies.

Assessed parameters. Each year average samples of 15 fruits/treatment were tested. Fruit growth was monitored by measuring longitudinal and transversal fruit diameter and fruit height after harvest. The measurements were performed using a metric digital caliper (Insize Co., Ltd. China). The average weight of a fruit was determined by weighing 10 fruits/treatment and dividing by the number of weighed fruits. The weighing of the fruit was performed with a precision balance (Kern & Sohn GmbH, Germany). Fruits of Filip cultivar were harvested between the 11th to the 12th of July in 2019, from 15th to the 16th of July in 2020 and 26th to the 27th of July in 2021. Fruits of Catherine sel. 1 cultivar were harvested between the 23rd to the 24th of July in 2019, from 27th to the 28th of July in 2020 and 2nd to the 3rd of August in 2021.

Data analyses. SPSS 14.0 software and Microsoft Office Excel were used for the analysis of variance and various calculations for fruit quality properties. Different letters in the graphs indicate significant differences for the probability (P) ≤ 0.05 according to Duncan's multiple range test.

RESULTS AND DISCUSSIONS

Climate conditions. During the growing season in the experimental period the mean yearly maximum and minimum air temperatures were 26.4 and 12.7°C, respectively, versus the long-term yearly means of 25.8 and 13.3°C.

The mean annual air temperature was 19.5°C, versus 19.7°C for long-term. In the growing season, the mean annual precipitation amount was 213.8 mm, versus 270.7 mm for long-term, almost similar, and mean annual reference evapotranspiration was 714.0 mm, versus 722.7 mm for long-term, indicating a normal period, both in terms of rainfall and evapotranspiration. ETo values were on average 134.0, 150.3 and 134.7 mm month-1 during June, July and August, respectively.

The average value of climatic water deficit (WD) in the growing season of the study period was -500.2 mm, versus -452.0 for long-term. The mean value of yearly and monthly climate data during the growing season in the experimental period is shown in the Tables 2 and 3.

Table 2. The mean value of annual climate data during the growing season in the 2019÷2021 experimental period versus the long-term, 1980 ÷ 2015, Valu lui Traian, Romania

Climatic data	Growing season	
	2019÷2021	1980÷2015
Mean air temperature, T_{med} (°C)	19.5	19.7
Mean maximum air temperature, T_{max} (°C)	26.4	25.8
Mean minimum air temperature, T_{min} (°C)	12.7	13.3
Precipitation, P (mm)	213.8	270.7
Reference evapotranspiration, PM-ET_0 (mm)	714.0	722.7
Water Deficit/Water Excess, WD/WE (mm)	-500.2	-452.0

Table 3. The mean value of monthly climate data during the growing season in the experimental period 2019÷2021, Valu lui Traian, Romania

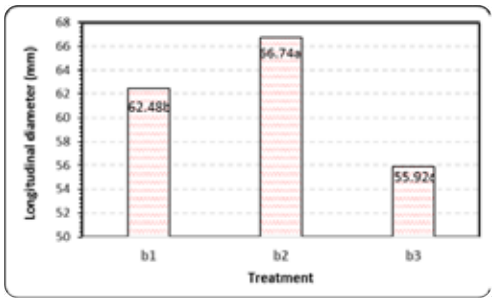
Climatic data	Growing season					
	April	May	June	July	August	September
Mean air temperature, T_{med} (°C)	10.0	16.6	22.3	24.0	23.9	19.4
Mean maximum air temperature, T_{max} (°C)	16.7	23.0	29.3	31.4	31.7	26.5
Mean minimum air temperature, T_{min} (°C)	3.6	10.6	16.0	16.5	16.7	12.6
Precipitation, P (mm)	34.5	41.2	55.0	26.0	9.7	47.4
Reference evapotranspiration, PM-ET_0 (mm)	86.0	123.0	134.0	150.3	134.7	86.0
Water Deficit/Water Excess, WD/WE (mm)	-51.5	-81.8	-79.0	-124.3	-125.0	-38.6

The period of experiment (2019÷2021) was considered as a relatively normal period, with monthly temperature means of 22.3°C in June, 24.0°C in July and 23.9°C in August, respectively.

Biometrical measurements and weight to peach fruits. After harvesting, the fruits of experience have been subjected to biometrical measurements and fruits weighing. The values presented represent average values of the three years of study.

Thus, peach fruits on Filip cultivar had a longitudinal diameter of 55.92 mm to 66.74 mm. The smallest longitudinal diameter was found in b3 treatment. Figure 4a shows that there were significant differences between the treatments studied on fruit's longitudinal diameter, as indicated by different letters according to the probability (P) ≤ 0.05 according to Duncan's multiple range test. As with fruit longitudinal diameter, the transversal diameter determined on the fruits of the studied treatments had the same trend. The highest value was obtained in b2 treatment, 63.24 mm and the lowest value in b3 treatment, 53.27 mm, respectively. Figure 4b shows significant differences, written with different letters, between the treatments studied regarding the fruits transversal diameter. The height of the fruits determined by the studied treatments had the same trend. The peach fruits had a height of 30.54 mm to 36.96 mm. Figure 4c shows significant differences between the treatments studied regarding the fruits height. As with fruit biometrical characteristics, the fruit weight determined on the fruits of the studied treatments had the same trend. The highest value was obtained in b2 treatment, 85.15 g and the lowest value in b3 treatment, 51.95 g, respectively. Figure 4d shows significant differences between the treatments studied regarding the fruits weight.

The peach fruits of the Catherine sel. I cultivar had a longitudinal diameter of 53.8 mm to 69.7 mm. The smallest longitudinal diameter was found in b3 treatment. Figure 5a shows that there were significant differences between the treatments studied on fruit's longitudinal diameter, as indicated by different letters according to the probability (P) ≤ 0.05 according to Duncan's multiple range test.



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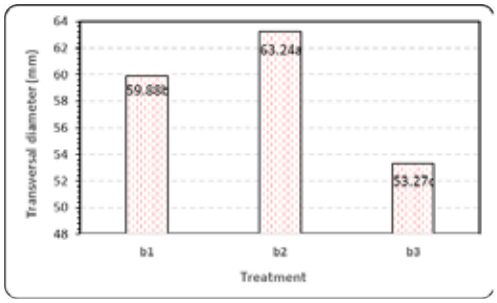

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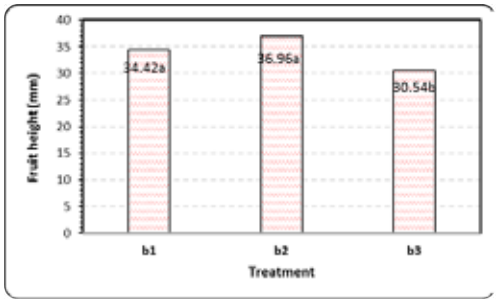

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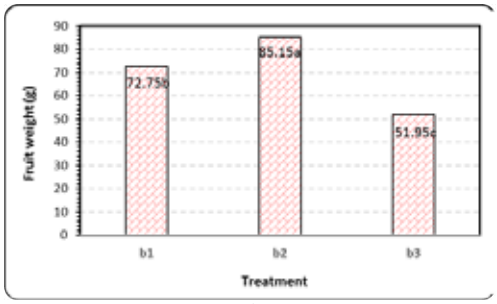
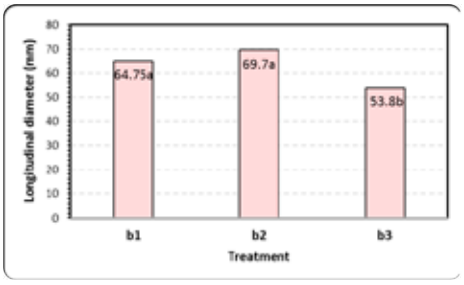


d

Figure 4. Longitudinal diameter (a), transversal diameter (b), fruit height (c) and fruit weight (d) of the fruits to Filip cultivar, 2019-2021

As with fruit longitudinal diameter, the transversal diameter determined on the fruits of the studied treatments had the same trend. The highest value was obtained in b2 treatment,

64.0 mm and the lowest value in b3 treatment, 50.3 mm, respectively. Figure 5b shows significant differences, written with different letters, between the treatments studied regarding the fruits transversal diameter. The height of the fruits determined by the studied treatments had the same trend. The peach fruits of the Catherine sel I cultivar had a height of 45.1 mm to 56.6 mm. Figure 5c shows significant differences between the treatments studied regarding the fruits height. As with fruit biometrical characteristics, the fruit weight determined on the fruits of the studied treatments had the same trend. The highest value was obtained in b2 treatment, 172.4 g and the lowest value in b3 treatment, 115.4 g, respectively. Figure 5d shows significant differences between the studied treatments regarding the fruits weight.



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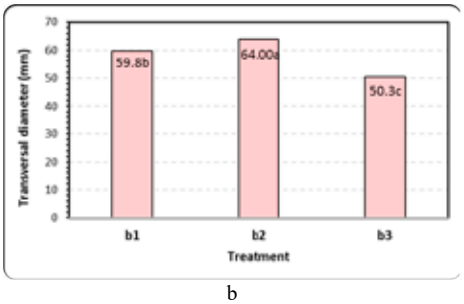

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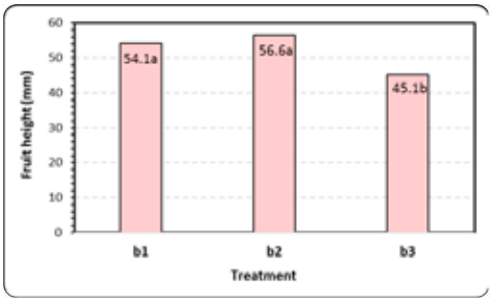

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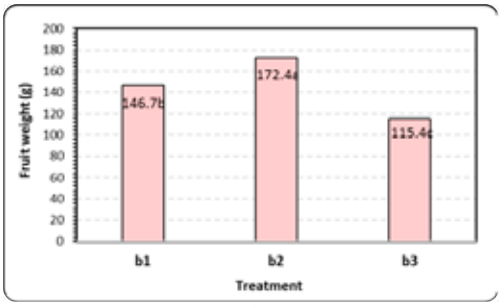

d

Figure 5. Longitudinal diameter (a), transversal diameter (b), fruit height (c) and fruit weight (d) of the fruits to Catherine sel. 1 cultivar, 2019-2021

CONCLUSIONS

The study found that both radicular and foliar fertilization help to improve the quality of the fruits of the two studied cultivars.
Radicular and foliar fertilization with Cropmax has led to a higher increase in fruit weight in Filip and Catherine sel. 1 cultivars compared to radicular fertilization.

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