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EFECTUL UNOR PRODUSE ORGANICE ASUPRA COMPOZIȚIEI CHIMICE A FRUCTELOR ȘI A PIGMENTILOR FOTOSINTETICI DIN FRUNZE LA SOIUL DE PIERSIC 'LASKAVA'

EFFECT OF SOME ORGANIC PRODUCTS ON THE CHEMICAL COMPOSITION OF FRUIT AND PHOTOSYNTHETIC PIGMENTS OF LEAVES ON 'LASKAVA' PEACH CULTIVAR

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Abstract

The study was carried out in the period 2020-2021 in a fruit-bearing peach plantation on the territory of the Fruit Growing Institute Plovdiv. The object of the study was 'Laskava' cultivar, grafted on peach seedling rootstock. The aim of the present study was to investigate the effect of the organic products Agriful, Humustim and Lumbreco on the chemical composition of the fruit and on the content of photosynthetic pigments in the leaves, under the conditions of integrated fruit production. The following fertilization variants were tested: soil fertilization with Agriful applied as an aqueous solution at three rates (1.3 L/da, 2.0 L/da and 2.70 L/da); foliar nutrition with Humustim at three rates (230 ml, 280 ml and 350 ml/da); fertilization with Lumbreco – foliar application (1 L/da), soil application (2 L/da), combined – foliar (1 L/da) + soil (2 L/da) and control – untreated. The best values for the soluble solids content by Brix were reported in the variants with foliar nutrition with Lumbreco – 15.9°Brix (2020) and 16.3°Brix (2021), fertilization with Humustim at the rate of 280 ml/da – 14.2°Brix (2020) and 16.2°Brix (2021) and fertilization with Agriful at the rate of 2.7 L/da – 14.8°Brix (2020) and 16°Brix (2021). The sugar content varied from 7.36% in the control to 14.74% in the variant with the application of 2.7 L/da Agriful. Sucrose values were about 2 times higher on average than the inverted sugar values. The best values for sucrose 10.30% and 9.16% were found in the variant of Agriful application at the rate of 2.70 L/da and Humustim at the rate of 280 ml/da. The bioproducts used had a positive effect on the accumulation of chlorophyll. The variants with the foliar application of Lumbreco, treatment with Humustim at the rate of 350 ml and with Agriful 2.0 L/da showed the best results. The application of the selected bioproducts had a favourable effect on the content of photosynthetic pigments in the leaves, which in its turn is a prerequisite for the good physiological status of the peach plants.

Cuvinte cheie: fertilizare, produse biologice, calitatea fructelor, compozitie frunze
Key words: fertilization, bioproduct, fruit quality, composition of leaves

1. Introduction

Organic fertilization has been especially relevant in recent years. Biofertilizers, which have an organic origin, play a key role, as they are produced entirely from natural materials, without polluting the environment and fruit production. The market for organically produced fruits is growing and attracting, more and more customers who choose a product of the desired quality, promoting the idea that organic fruit production is a promising economic model. There are many factors influencing the quality of fruits – the cultivar, age of the trees, pruning, fruit thinning, soil and climatic conditions, agricultural techniques (Génard et al., 1991). The organoleptic qualities of the fruit are largely determined by the content of sugars and acids (Souty and André, 1975; Génard and Souty, 1996; Dirlewanger et al., 1999). The sugar content is one of the most important quality traits perceived by the consumers. In order to assess the adaptability of fruit crops to the growing environment, information about the physiological status of the plants is also needed. Photosynthesis is the most important process in biological system, defining the limits of biomass production (Sofi et al., 2006) and is the major physiological parameter that is affected by stress factors (Misra et al., 2002; Satisha et al., 2007; Arabzadeh, 2009). Photosynthetic pigments, chlorophyll *a* and *b*, play a significant role in the process of photosynthesis, they are responsible for light absorption and energy transfer. Changes in the chlorophyll content affect the biosynthesis and accumulation of organic matter, which is directly related to plant productivity.

The aim of the present study was to investigate the effect of the organic products Agriful, Humustim and Lumbreco on the chemical composition of the fruit and on the content of photosynthetic pigments in the leaves, under the conditions of integrated fruit production.

2. Material and methods

The study was carried out in the period 2020-2021 in a fruit-bearing peach plantation on the territory of the Fruit-Growing Institute – Plovdiv. The object of the study was 'Laskava' cultivar grafted on peach seedling rootstock. The planting distance was 3 m × 5 m. The following fertilization variants were tested: soil fertilization with Agriful applied as an aqueous solution at three rates (1.3 L/da, 2.0 L/da and 2.70 L/da); foliar nutrition with Humustim at three rates (230 ml, 280 ml and 350 ml/da); fertilization with Lumbreco – foliar application (1 L/da), soil treatment (2 L/da), combined – foliar (1 L/da) + soil (2 L/da) and control – untreated. Each variant was in three replications. The organic products were applied five times every 20 days, the first treatment being made in April.

The following parameters were reported: soluble solids content by Brix, refractometrically; sugars – according to Schoorl – Regenbogen; acid content – titrimetrically, active acidity (pH) – potentiometrically; content of chlorophyll (*a*, *b*, *a+b*) and carotenoids – spectrophotometrically (in an extract with 95% ethyl alcohol).

The results obtained are subjected to mathematical analysis using the method developed by David B. Duncan (Duncan, 1955; Harter, 1960). Software used in the study are "R-3.1.3" in combination with "RStudio-0.98" and installed package "agricolae 1.2-2" (Mendiburu, 2015).

3. Results and discussions

An analysis was performed for the effect of the organic products Agriful, Humustim and Lumbreco on the chemical composition of fruit and on the content of photosynthetic pigments in the leaves, under the conditions of integrated peach production. The data presented in Table 1 show that the applied organic products had a significant effect on the chemical composition of the fruit. More pronounced differences in the studied parameters were observed between the different fertilization rates than between the applied organic products, the differences being statistically significant.

The nutrition had an effect on the soluble solids content by Brix, all fertilization variants had higher values compared to the control. In the second year of the study the best values were obtained in the variants with foliar nutrition with Lumbreco – 16.3°Brix, Humustim at the rate of 280 ml/da – 16.2°Brix and Agriful at the rate of 2.7 L/da – 16°Brix.

The content of total sugars increased in direct proportion to the increase in the fertilization rate when applying Agriful. The same trend was observed after treatment with Lumbreco – soil, combined and foliar application. Treatment with the highest rate of Humustim – 350 ml/da affected the sugar content in the fruit of 'Laskava' cultivar, but compared to the lowest (230 ml) and the average rate (280 ml), the effect of fertilization was weaker, the differences being statistically significant.

It was established that the values of total sugar content in the fruit flesh of the treated trees were higher compared to the control. The sugar content varied from 7.36% in the control to 14.74% in the variant with application of 2.7 L/da Agriful. In the first year of the study (2020) lower values for the soluble solids content and total sugars were observed in all the treated variants.

Sucrose is the dominant sugar in peach fruit. Sucrose values were about 2 times higher on average than the inverted sugar. The best sucrose values of 10.30% and 9.16% were reported in the variants of fertilization with Agriful at the rate of 2.70 L/da and with Humustim at the rate of 280 ml/da, respectively, the differences being statistically proven.

Acids ranged from 0.42% to 0.94% in the different variants of fertilization. The acid content was slightly lower in 2021.

Chlorophyll is the basic catalyst of photosynthesis, as the green pigments exist in all plant tissues that do photosynthesis (Masinovsky et al., 1992). Although the content of photosynthetic pigments is not the only criterion for photosynthesis of plants, their content can be considered as an indicator of the photosynthetic competence of the plants. Plants with high values of chlorophyll *a* and *b* have more efficient photosynthesis (Arabzadeh, 2009). The results obtained for the photosynthetic pigments in the leaves (mg/g dry weight) are presented in Table 2.

The bioproducts used had an effect on the chlorophyll content in the leaves of the experimental trees. Data show that more pronounced differences were observed between the applied fertilization rates than between the organic products used, the differences being statistically significant. No symptoms of chlorosis were observed and the chlorophyll *a* content was significantly higher than that of chlorophyll *b* for all the variants, which is important because chlorophyll *a* is involved in the conversion of light energy into chemical energy (Porra et al., 1989; Singha and Townsend, 1989; Monje and Bugbee, 1992; Peng et al., 1993). In the second year of the study (2021), higher values for their content were reported in all the treated variants. The highest values of chlorophyll *a* (5.066 mg/g DW) and chlorophyll *b* (2.137 mg/g DW) were established in the variant with foliar application of Lumbreco, the differences being statistically significant. It is noteworthy that when applying Humustim, the content of chlorophyll *a* and *b* increased

proportionally to the increase in the applied rate of fertilization, but the differences between the variants were statistically insignificant. That trend was not observed with the application of Agriful. The application of the high rate of Agriful – 2.70 L/da affected the content of chlorophyll *a* and *b*, but compared to the applied average rate of 2.0 L/da, the effect of fertilization was weaker. Significantly higher values for chlorophyll *a* (4.804 mg/g DW) and chlorophyll a+*b* (6.803 mg/g DW) were found in the variant with the application of Agriful at the rate of 2.0 L/da, but the differences between the variants were statistically insignificant. The results for the total chlorophyll *a+b* followed over the two-year period, showed higher values in the second year of the study, which implies better adaptation of the plants to the growing conditions. The lowest values of 4.819 mg/g DW were found in the control variant. The values for the content of chlorophyll *a+b* in the fertilized variants ranged from 6.106 mg/g DW to 7.201 mg/g DW. The lowest values in the treated variants were reported after soil application of Lumbreco – 6.106 mg/g DW, in the variant with Agriful applied at the rate of 1.3 L/da – 6.321 and when applying Humustim at the rate of 230 ml/da – 6.415 mg/g DW. Carotenoids are another important element of the pigment complex. The increased content of carotenoids under unfavourable conditions during the summer vegetation season stimulated the adaptive responses and contributed to reducing the overall plant stress (Karnaukhov, 1988). The highest values were reported in the variant treated with 2 L/da Agriful – 4.359 mg/g DW, with the foliar application of Lumbreco – 4.258 mg/g DW and after the application of Humustim at the rate of 350 ml/da – 4.217 mg/g DW, the differences being statistically proven.

4. Conclusions

Treatment with the organic products Lumbreco, Agriful and Humustim led to an increase in the content of soluble solids and sugars in fruit flesh compared to the untreated control.

Sucrose is the dominant sugar in fruits, and its values are about 2 times higher on average than the inverted sugar values.

The application of the selected organic products had a favourable effect on the content of photosynthetic pigments in the leaves, which in its turn is a prerequisite for the good physiological status of the peach plants.

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References

1. Arabzadeh N., 2009. The Examination of Dryness Induction Effect in Growth, Some of Physiological Relations (Parameters of Water Relations), Physiological Changes and Increasing of Drought Tolerance Range in Haloxylon persicum and H. Aphyllum. Doctoral dissertation, Ph. D. Thesis, Department of Biology Sciences, Teacher Training (Tarbiyat Moallem) University of Tehran, Iran.
2. Dirlewanger E., A. Moing C., Rothan L., Svanella V., Pronier A. Guye, Monet R., 1999. Mapping QTLs controlling fruit quality in peach (*Prunus persica* (L.) Batsch). Theoretical and Applied Genetics, 98(1): 18-31.
3. Duncan D.B., 1955. Multiple Range and Multiple F Tests. Biometrics 11 (1): 1-42.
4. Génard M., Souty M., 1996. Modeling the peach sugar contents in relation to fruit growth, J. Am. Soc. Hortic. Sci., 121: 1122-1131.
5. Génard M., Bruchou C., Souty M., 1991. Variabilité de la croissance et de la qualité chez la pêche (*Prunus persica* L Batsch) et liaison entre croissance et qualité. Agronomie, 11(10): 829-845.
6. Harter H.L., 1960. Critical Values for Duncan's New Multiple Range Test. Biometrics 16 (4): 671-685.
7. Karnaukhov V.N., 1988. Biologicheskie funktsii karotinoi dov (Biological Functions of Carotenoids), Moscow, Nauka, 240 p. (Ru).
8. Masinovsky Z., Lozovaya G.I., Sivash A.A., 1992. Some Aspects of the Early Evolution of Photosynthesis. Adv. Space Res., 12(4): 199-205.
9. Mendiburu F., 2015. Statistical Procedures for Agricultural Research., URL:http://cran.r-project.org/web/packages/agricolae.
10. Misra A.N., Biswal A.K., Misra M., 2002. Physiological, Biochemical and Molecular Aspects of Water Stress Responses in Plants, and the Biotechnological Applications. Proc. Nat. Acad. Sci., 72(2): 115-134.
11. Monje A., Bugbee B., 1992. Inherent limitations of nondestructivechlorophyll meters: a comparison of two types of meters. HortScience, 27: 69-71.
12. Peng S., Garcia F.V., Laza R.C., Cassman K.G., 1993. Adjustment for specific leaf weight improves chlorophyll meter's estimate of rice leaf nitrogen concentration. Agronomy Journal, 85: 987-990.

13. Porra R.J., Thompson W.A., Kriedemann P.E., 1989. Determination of accurate extinction coefficients and simultaneous equations for assaying chlorophylls a and b extracted with four different solvents: verification of the concentration of chlorophyll standards by atomic absorption spectroscopy. Biochimica et Biophysica Acta-Bioenergetics, 975: 384-394.
14. Satisha J., Prakash G.S., Bhatt R.M., Kumar P.S., 2007. Physiological Mechanisms of Water Use Efficiency in Grape Rootstocks under Drought Conditions. Int. J. Agric. Res., 2(2): 159-164.
15. Singha S., Townsend E., 1989. Relationship between chromaticity values and chlorophyll concentration in apple, grape, and peach leaves. HortScience, 24: 1034.
16. Sofi P., Rather A.G., Zargar M.Y., 2006. Breaking Yield Barriers in Rice: Remodeling Photosynthesis. Am. J. Plant Physiol., 1(2): 113-126.
17. Souty M., André P., 1975. Composition biochimique et qualité des pêches, Annales de Technologie Agricole, 24: 217-236.

Tables

Table 1. Effect of organic products on the chemical composition of fruit for the period 2020-2021

Variants/Rate	Soluble solids content (°Brix)	Total sugars (%)	Inverted sugar (%)	Sucrose (%)	Total acids (%)	pH
2020						
Lumbreco – soil 2 L/da	13.6 ab	11.60 ab	3.68 ab	7.53 ab	0.72 a	3.43 a
Lumbreco – foliar 1 L/da + soil 2 L/da	14.6 a	11.00 ab	3.56 ab	7.07 ab	0.73 a	3.46 a
Lumbreco – foliar 1 L/da	15.9 a	13.42 a	4.50 a	8.47 a	0.92 a	3.34 a
Agriful 1.3 L/da	13.4 ab	10.10 b	2.66 b	7.07 ab	0.69 a	3.15 a
Agriful 2.0 L/da	13.2 ab	11.16 ab	2.80 b	7.94 ab	0.73 a	3.42 a
Agriful 2.70 L/da	14.8 a	11.16 ab	2.88 b	7.87 ab	0.94 a	3.27 a
Humustim 230 ml/da	13.8 ab	9.32 b	2.60 b	6.38 b	0.79 a	3.16 a
Humustim 280 ml/da	14.2 a	12.66 a	3.34 ab	8.85 a	0.42 a	3.37 a
Humustim 350 ml/da	13.4 ab	11.16 ab	3.76 ab	7.03 b	0.64 a	3.35 a
Control	12.4 b	7.36 b	2.40 b	4.71 b	0.65 a	3.25 a
2021						
Lumbreco – soil 2L/da	13.8 ab	11.36 ab	5.46 a	5.61 b	0.49 a	3.46 a
Lumbreco – foliar 1 L/da + soil 2 L/da	14.8 ab	12.66 ab	4.36 ab	7.89 ab	0.62 a	3.72 a
Lumbreco – foliar 1L/da	16.3 a	12.96 ab	4.24 ab	8.28 ab	0.60 a	3.36 a
Agriful 1.3 L/da	12.7 b	10.58 b	4.02ab	6.23 b	0.63 a	3.38 a
Agriful 2.0 L/da	15.9 a	13.64 ab	4.58 ab	8.61 ab	0.73 a	3.42 a
Agriful 2.70 L/da	16.0 a	14.74 a	3.90 b	10.30 a	0.60 a	3.47 a
Humustim 230 ml/da	14.7 ab	12.96 ab	4.70 a	7.85 ab	0.63 a	3.47 a
Humustim 280 ml/da	16.2 a	14.42 a	4.78 a	9.16 a	0.61 a	3.6 a
Humustim 350 ml/da	13.1 b	12.14 ab	4.10 ab	7.64 ab	0.68 a	3.27 a
Control	12.5 b	9.16 b	2.53 b	6.26 b	0.63 a	3.56 a

Table 2. Effect of bioproducts on photosynthetic pigments in the leaves for the period 2020-2021

Variants/Rate	Chlorophyll *a* mg/g (DW)	Chlorophyll *b* mg/g (DW)	Chlorophyll *a+b* mg/g (DW)	Carotenoides mg/g (DW)
2020				
Control	2.801 b	0.586 b	3.385 ab	3.254 b
Lumbreco – soil 2 L/da	3.258 a	0.950 ab	4.205 a	3.576 b
Lumbreco – foliar 1 L/da + soil 2 L/da	3.275 a	0.985 ab	4.258 a	3.874 b
Lumbreco – foliar 1 L/da	3.293 a	0.756 b	4.047 a	4.015 ab
Humustim 230 ml/da	2.865 b	0.750 b	3.612 b	3.987 ab
Humustim 280 ml/da	3.130 a	1.083 a	4.211 a	4.004 ab
Humustim 350 ml/da	3.131 a	1.160 a	4.288 a	4.102 ab
Agriful 1.3 L/da	2.859 b	0.601 b	3.459 b	3.981 ab
Agriful 2.0 L/da	3.292 a	0.713 b	4.003 ab	4.288 a
Agriful 2.70 L/da	2.933 ab	1.235 a	4.165 a	4.102 ab
2021				
Control	3.395 b	1.427 b	4.819 b	3.447 b
Lumbreco – soil 2 L/da	4.256 ab	1.852 ab	6.106 ab	3.559 b
Lumbreco – foliar 1 L/da + soil 2 L/da	4.496 ab	1.906 ab	6.398 ab	3.973 ab
Lumbreco – foliar 1 L/da	5.066 a	2.137 a	7.201 a	4.258 a
Humustim 230 ml/da	4.583 ab	1.833 ab	6.415 ab	3.968 ab
Humustim 280 ml/da	4.601 ab	1.857 ab	6.456 ab	3.918 ab
Humustim 350ml/da	4.712 ab	1.921 ab	6.630 ab	4.217 a
Agriful 1.3 L/da	4.253 ab	2.071 ab	6.321 ab	3.778 ab
Agriful 2.0 L/da	4.804 ab	2.001 ab	6.803 ab	4.359 a
Agriful 2.70 L/da	4.786 ab	1.919 ab	6.703 ab	4.147 ab