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EFFECT OF SOME BIOPRODUCTS ON CHLOROPHYLL CONTENT AND MAIN NUTRIENTS IN PEACH LEAVES

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Abstract

The experimental work was carried out in the period 2014-2016 in a fruit-bearing peach plantation at the Fruit-Growing Institute Plovdiv, Bulgaria. 'Glohaven' cv. grafted on the vegetative rootstock GF 677 was investigated. Increasing doses of three bioproducts - Biohumus, Agriful and Humustim have been tested. The aim of the experiment was to study the influence of bioproducts on the content of chlorophyll and the main nutrients in the peach leaves. Bioproducts used had a positive effect on the chlorophyll accumulation. The highest total chlorophyll content (a + b) was reported in the variant treated with Biohumus and the differences with the non-fertilized control being statistically significant. Regarding the nutritional status of the trees, the best results were provided by Biohumus 1.8 kg/tree and Agriful 1 L/ha.

Key words*: peach, bioproducts, fertilization, leaf analysis, chlorophyll.*

INTRODUCTION

The importance of bioproducts as substitutes for synthetic agrochemicals is constantly growing. In recent years, attention has increasingly been paid on a global scale to the use of organic biofertilizers. They promote rapid, preventive correction of mineral nutriation. At the same time, plant production remains clean and that contributes to protecting the environment from pollution (Carbonaro et al., 2002).

Controversial results have been reported in literature about the impact of bioproducts on the mineral content, quality and quantity of the produce. In a many-years experiment in Italy, researchers followed out the effect of organic fertilization on the level of nutrient supply of fruit trees, as well as the nutrient export with fruits in a nectarine orchard (Toselli et al., 2013). The impact of manure 10 t/ha at planting and compost of 5 and 10 t/ha was studied. The content of nitrogen (N), magnesium (Mg), manganese (Mn), iron (Fe), copper (Cu) in the leaves of the trees treated with 10 t/ha of compost per year, was higher than in the other variants. In 2000, Monge et al. reported that organic fertilization in olive trees did not result in an increase in the mineral content of the leaves.

The effect of manure and biofertilizer, as well as combinations of magnesium preparations, on the growth and content of the elements in the leaves of the pear cultivar 'Le Conte', was also studied. The results showed that the application of different organic fertilizers combinations significantly increased the N, P, K and Mg contents and the content of chlorophyll *a* & *b* (Fawzi et a1., 2010).

The chlorophyll content in the leaves provides valuable information about the physiological status of the plants. Chlorophyll is one of the main characteristics showing the ability of the leaves to photosynthesize and the phytosanitary state of the plant. Changes in its amount affect the biosynthesis and the accumulation of the organic matter, directly related to plant productivity. Chlorophyll *a* and chlorophyll *b* absorb light in plants; they are the main pigments of photosynthesis. Chlorophyll *a* participates in the transformation of light energy into chemical energy (Singha & Townsend, 1989; Porra et al., 1989; Monje & Bugbee, 1992; Peng et al., 1993).

Despite the growing interest in organic products, the knowledge of how the different fertilizer levels affect nutrient components, is still limited.

The aim of the present study was to evaluate the effect of the different fertilization levels

with the bioproducts Biohumus, Agrifull and Humustim on the chlorophyll content and the main nutrients in the leaves of the peach cultivar 'Glohaven'.

MATERIALS AND METHODS

The experimental work was carried out in 2014-2016 in a fruit-bearing peach plantation on the territory of the Fruit-Growing Institute, in Plovdiv, Bulgaria. 'Glohaven' peach cultivar grafted on the vegetative rootstock GF 677 was the subject of study. The soil is alluvial-meadow, neutral with pH of 7.10, with a good phosphorus content of 22 mg/100 g and potassium 26 mg/100 g of soil. The planting distance is 3×5m. The following fertilization variants were studied: soil enrichment with Biohumus; soil nutrition with water solution of Agrifull; leaf-feeding with Humustim; untreated control, without soil and leaf nutrition.

Biohumus was introduced into soil around the stems of the experimental trees at three rates: 0.600 kg/tree; 1.200 kg/tree and 1.800 kg/tree per tree. Agrifull was applied as water solution. Two rates of 0.5 L/da and 1 L/da were tested. Humustim was applied as a leaf fertilizer at three rates: 100, 120 and 150 ml/da for one spray. Each variant was in three replications.

Fertilization in the different variants was applied five times during the vegetation, every 15-20 days from April to July inclusive.

The leaf samples for determining the chlorophyll and mineral content were randomly collected from both sides of the tree crown, from the middle part of the annual shoots, for the fertilization variants. Each sample included about 30 leaves. The leaf samples for the chlorophyll content were collected in the middle of July; for the mineral content – at the beginning of August, according to the adopted methods for leaf analysis. The chlorophyll content (*a, b* and *a+b*) was determined spectrophotometrically in an extract, with 85% ethanol. The leaf samples were analyzed on variants for the content of: nitrogen – by Kjeldahl's distillation method, potassium – by flame photometry, phosphorus – colorimetrically with hydrazine sulfate as a reducer, calcium and magnesium – complexometrically. The results obtained were subjected to mathematical analysis using the Duncan test (Duncan, 1955).

RESULTS AND DISCUSSIONS

The experimental data obtained for the chlorophyll content mg/g DW, on average over the period 2014-2016, are presented in Table 1. The content of chlorophyll *a* in peach leaves is about twice higher than that of chlorophyll *b*.

The highest values for chlorophyll *a* (3.52 mg/g DW) were reported after applying Biohumus, but there was no statistically significant difference with the other fertilization variants and the untreated control (Table 1).

This is probably due to chlorophyll *a* instability and its rapid destruction under the influence of negative factors and aging of the assimilation tissues.

Table 1. Chlorophyll content (mg/g DW) in peach leaves in different variants of fertilization with bioproducts

Variant	Chlorophyll a	Chlorophyll b	Chlorophyll a+b
Biohumus	3.52 a	1.45 a	5.36 a
Agrifull	3.16 a	1.25 ab	4.41 b
Humustim	3.23 a	1.38 a	4.61 ab
Control	3.21 a	1.04 b	4.41 b

The concentration of **chlorophyll *b*** shows greater variations in response to the fertilization treatment. The application of the different bioproducts leads to an increase of the chlorophyll *b* content in all the three variants with fertilization and the differences to the untreated control were statistically significant. The highest values 1.45 mg/g DW and 1.38 mg/g DW were reported after treatment with Biohumus and Humustim. Referring to **chlorophyll *a+b***, the variant with the application of Biohumus again showed the highest values, differences in the **chlorophyll *a+b*** content to the untreated control and to the

application of the bioproduct Afrifull being statistically significant. The lowest values 4.41mg/g DW of the pigments were established in the unfertilized control.

The data obtained show that probably the bioactive components and potassium humates contained in organic fertilizers, promote the accumulation of chlorophyll in the peach leaves, which leads to an improvement in photosynthetic activity. The imported bioproducts have a favorable effect on the content of leaf pigments, which in turn provide valuable information about the physiological status of the plants. The mineral composition of leaves is used as an indicator to identify deficiency, excess or imbalance of nutrients within the plant (Childers, 1989; Gitelson et al., 2003).

During the years of the study (2014-2016) **nitrogen** content in the leaf samples varied from 2.28 to 2.67% in all the variants with fertilization (Figure 1).

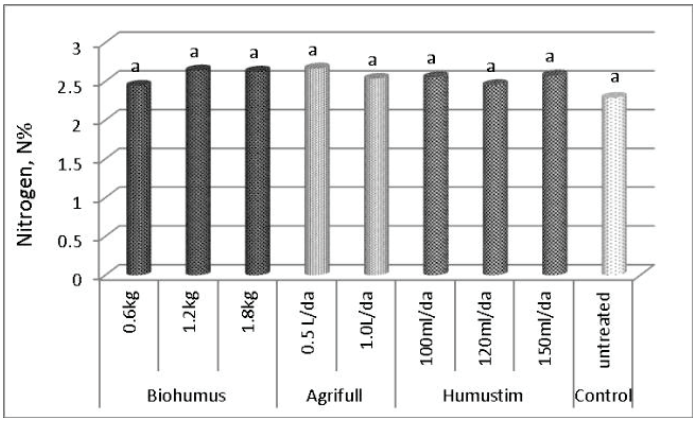

Figure 1. Nitrogen (N) (%) in the leaves of the peach cultivar 'Glohaven' (on average for the period 2014-2016), under different rates of bioproducts applied

Those values correspond to the average supply with that nutrient element. Values, however, are commensurate with the untreated control variants, i.e. the imported bioproducts appear to have no significant effect on the nitrogen content in the peach leaves.

Concerning the element **potassium**, data show that the application of high rates of Biohumus (1.8 kg/tree) and Agrifull (1 L/da) resulted in a higher potassium content in the leaves, the differences to the untreated control being statistically significant (Figure 2). The potassium values were within the optimum range at all the fertilization rates applied. The use of Humustim at different fertilization rates did not exert an effect on the potassium content during the years of the study.

Referring to the element **phosphorus**, treatment with Humustim at all the studied rates and the application of Biohumus at the rate of 1.8 kg/tree showed a statistically significant difference to the untreated control (Figure 3).

Phosphorus is involved in many metabolic processes necessary for normal growth, such as photosynthesis, and also it has an effect of the stability of the chlorophyll molecule. Humustim is a product with a high content of humic acids, which result in an increase of the phosphorus content in the peach leaves.

The action of the humic acids is associated with increased nutrient absorption and increased cellular permeability (Chen et al., 2001). Due to the good soil supply with that nutrient element, the phosphorus content is high in all the variants.

The data obtained for the element **calcium** showed that all the studied bioproducts applied at the mentioned rates, had a positive effect on the content of that nutrient element (Figure 4).

Good calcium nutrition resulted in obtaining high quality fruit and in providing a broad-spectrum protection against many pathogens during fruit storage (Stoilov, 1977; James, 2010).

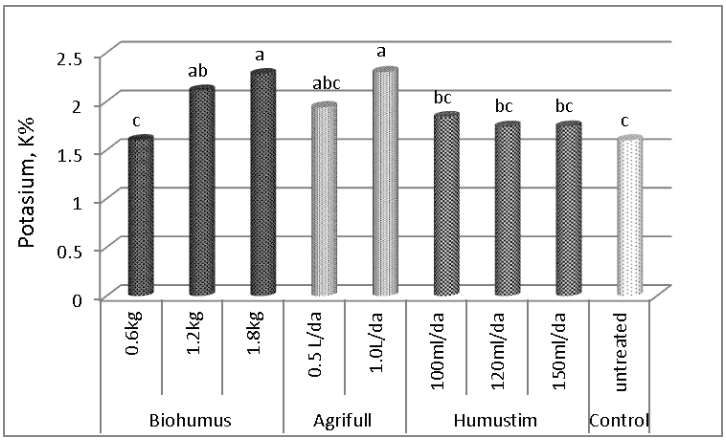

Figure 2. Potassium (K) (%) in the leaves of the peach cultivar 'Glohaven' (on average for the period 2014-2016), under different rates of bioproducts applied

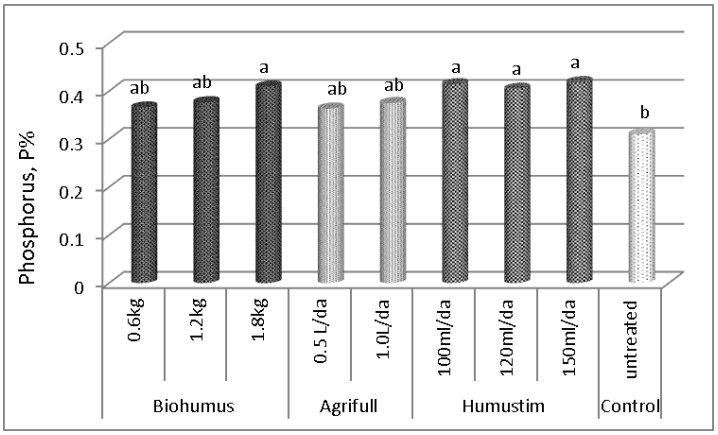

Figure 3. Phosphorus (P) (%) in the leaves of the peach cultivar 'Glohaven' (on average for the period 2014-2016), under different rates of bioproducts applied

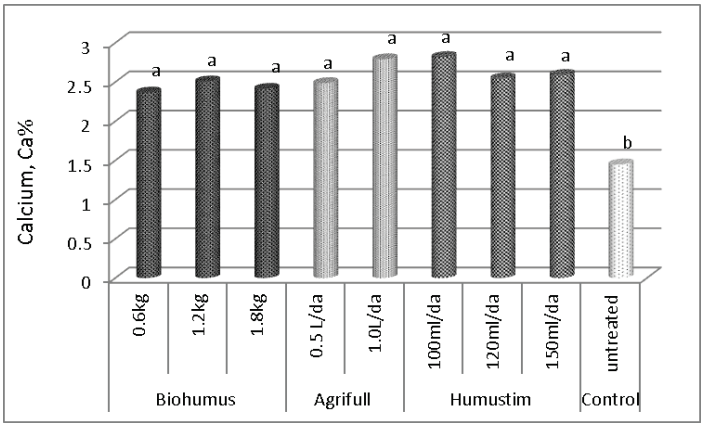

Figure 4. Calcium (Ca)(%) in the leaves of the peach cultivar 'Glohaven' (on average for the period 2014-2016), under different rates of bioproducts applied

Magnesium concentration was also increased after treatment with different bioproducts, but a statistically significant difference was reported only in the variant with Biohumus applied at the rate of 1.2 kg/tree (Figure 5).

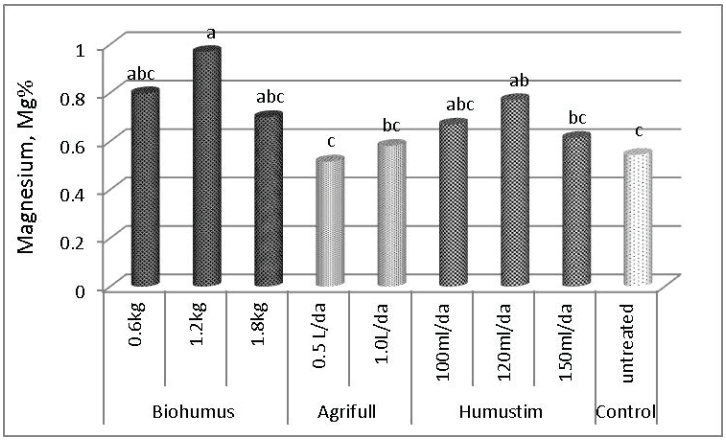

Figure 5. Magnesium (Mg) (%) in the leaves of the peach cultivar 'Glohaven' (on average for the period 2014-2016), under different rates of bioproducts applied

The results obtained for the nutritional status of 'Glohaven' peach cultivar were analogous to the average yields obtained after the application of the different fertilization levels. The highest yield was reported after treatment with Agrifull at the rate of 2,950 kg/da, followed by Biohumus (2,600 kg/da) and Humustim (2,550 kg/da), (Staneva et al., 2018).

CONCLUSIONS

Fertilization with different levels of the bioproducts Biohumus, Agrifull and Humustim successfully maintained the nutrient supply of the peach leaves. The studied products can be used in organic peach production and the higher fertilization rate is recommended: 1.8 kg/tree of Biohumus and 1 L/da of Agrifull.

REFERENCES

Duncan, D. B. (1955). Multiple Range and Multiple F Tests. Biometrics 11(1), 1-42.

Carbonaro, M., Mattera M., Nicoli S., Bergamo P., & Cappelloniat M. (2002). Modulation of Antioxidant Compounds in Organic vs Conventional Fruit (Peach, Prunus persica L., and Pear, Pyrus communis L.), Journal Agricultural Food Chemestry 50(19), 5458–5462.

Chen, Y., Magen, H. & Clapp, C E. (2001). Plant growth stimulation by humic substances and their complex with iron. *Proceedings N 470, International Fertilizer Society, York,* UK, 1-14.

Childers, N. (1989). Peaches. In: Plucknett, D.L., Sprague, H.B. (Eds.), Detecting Nutrient Deficiencies in Tropical and Temperate Crops. *Westview Tropical Agriculture* Series 7. Westview Press, Colorado, 317–326.

Fawzi M.I.F., Shahin F.M., Elham, Daood A. & Kandil E.A. (2010). Effect of organic and biofertilizers and magnesium sulphate on growth yield, chemical composition and fruit quality of "Le-Conte" pear trees. Nature and Science, 8(12), 273-280.

Gitelson A. A., Gritz Y., Merzlyak M. N. (2003). Relationships between leaf chlorophyll content and spectral reflectance and algorithms for non-destructive chlorophyll assessment in higher plant leaves, Journal of Plant Physiol. 160, 271–282.

James, P. (2010). Australian Cherry Production Guide. DAFF-TIAR-Rural Solutions SA, 209.

Monje, A. & Bugbee B. (1992). Inherent limitations of nondestructivechlorophyll meters: a comparison of two types of meters. HortScience, 27, 69-71.

Monge, E., Val, J., Espada, J.L., Orús, F. & Betran, J. (2000). Effects of organic wastes on olive mineral nutrition and its influence on fruit quality. Preliminary results for macronutrients. Acta Horticulturae, 512, 199-208 doi: 10.17660/ActaHortic.2000.512.20

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.

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.
Singha, S. & Townsend E. (1989). Relationship between chromaticity values and chlorophyll concentration in apple, grape, and peach leaves. HortScience, 24, 1034.
Staneva I., G. Kornov, M. Gospodinova (2018). Effect of fertilization with bio-products on the yield of the peach cv. 'Glohaven' under the conditions of integrated plant production, Journal of Mountain Agriculture on the Balkans, 21 (1), 231-241.
Stoilov, G. (1977). Mineral nutrition of fruit crops and methods of its control. Plovdiv BG: "H.G. Danov" Publishing House.
Toselli, M., Baldi E., Marcolini G., Quartieri M., Sorrenti G., Marangoni B., &Innocenti A. (2013). Effect of organic fertilization on soil fertility, tree nutritional status and nutrient removal of mature nectarine trees. Acta Horticulturae, 1001, 303-310.