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Physiological researches on the effects of foliar biostimulators in *Malus domestica* Borkh. - *Idared* variety

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Abstract The physiological researches regarding the effects of the *Cropmax* foliar biostimulator were performed in *Malus domestica* Borkh., *Idared* variety, grown in the climatic conditions of Oltenia region.

At the analyzed plants was noticed that the photosynthesis and transpiration intensity vary during the day according to the climatic conditions presenting low value in the morning, a high value afternoon and low values for the evening, but the recorded values are always higher for the leaves of plant treated with the foliar biostimulator, in comparison with plants' leaves without treatments (Control).

In *Malus domestica* Borkh.- *Idared* variety positive correlations were established between the physiological processes intensity and photosynthetic active radiation, leaf temperature and stomatal conductance.

In the leaves of plants treated with the foliar biostimulator was recorded a higher water content and a lower dry substance content.
The chlorophyll content is positively correlating with the photosynthesis intensity, recording higher values at the leaves of plants treated with the foliar biostimulator, in comparison with the plants without the foliar biostimulator.

Key words

foliar biostimulators, leaves, Malus domestica Borkh., photosynthesis, transpiration

Malus sp. is originated from Central Asia, were its wild ancestor are still found nowadays. The plant has a thick trunk with smooth gray bark in the beginning, which then exfoliates in irregular plates and a crown consisting of both extended branches and of shorter branches with fruits.

The leaves have oval or elliptical tongue, have serate edge and are petiolated. The flowers are hermaphrodite, arranged in corymb inflorescence, present five triangular sepa, five large pale pinkish petals. Stamens are arranged in three circles, and the gyneceum consists of five carpels united only at the basis and which, after fertilization merge into receptacle. The fruit itself is a polyfollicles represented by five membranous lodges where seeds are found. The fleshy, edible part forms the false fruit, called grapes [10].

The dramatic increase in using fertilizers and higher production costs in the recent years requires more attention from producers to reduce pollution and production cost. This reduction can be obtained by selecting the proper form of fertilizers that is suitable for the soil type and plant species as well as using a beneficial biostimulants foliar spray to obtain a real increase in crop yield, and quality and thus has a high economic return [8].

In many production areas, foliar spray with biostimulant products are becoming more common for the purpose of improving production quantity and quality. These products vary in chemical composition and often contain mixture of organic and inorganic compounds inc lud ing essential macro - and micronutrients, humates, citrates and amino acids [1; 6].

Biostimulators are used in horticulture in order to obtain the highest possible yield and best quality crops, especially in conditions which are not optimal for growth and development of plants [7; 11].

Biostimulators are natural growth regulators or chemicals, most of them contain plant hormones as auxin, gibberellic acid, cytokinins and aminoacids. Effects of these components increase physiological activities in plants, first of all protein synthesis. Biostimulators help plants surviving stresses. These are used for protect fruit plants from spring frost damage [13].

The photosynthesis intensity depends on the degree in leaves light exposure [3].

The intensity of the photosynthesis process is higher in the case of the apple leaves located at a height of 1.8 m compared with those located at 1.0 m above the ground [4].

The efficiency of the photosynthetic apparatus depends on the chlorophyll contents [5].

Intensity of transpiration process commensurate increases with that of photosynthesis, both processes are dependent on solar radiation intensity [2].

The intensity of photosynthetically active radiations is higher near the edge of the crown and close to the stem axis and decreases from higher to lower levels [9].

The intensity of transpiration process at apple has higher values in the full flowering stage and gradually decreases after 100 days after petal fall [12].

The young leaves have the highest intensity of the transpiration process and as they get older, the transpiration intensity decreases, the lower values being recorded at senescent leaves. [3].

Material and Method

The physiological researches regarding the effects of foliar biostimulators were performed in the *Malus domestica* Borkh. - *Idared* variety grown in climatic conditions in Oltenia region.

The apple *Idared* variety, introduced in America in 1942 as a cross between *Wagner* and *Jonathan*, is characterized by plants with medium vigour and spherical crown. The fruits are medium to large in size (170-200 g), are shaped as flat sphere with intensely red surface. It is harvest in late September and reaches optimal maturity for consumption after 3-4 months of storage.

The photosynthesis and transpiration intensity was determined with the analyzer LCi portable photosynthesis system. The ultra compact analyzer LCi recording and other parameters with the importance in physiological process: photosynthetic active radiations, leaf temperature, stomatal conductance etc. The results obtained were graphically represented and statistically interpreted.

The water contents and of dry substance were determined by the help of the drying stove - gravimetric method. The chlorophyll content was estimates by Minolta SPAD 502 chlorophyll meter.

In *Malus domestica* Borkh., *Idared* variety grown under climatic conditions in the Oltenia region were applied two foliar treatments with *Cropmax* solution, at two weeks intervals (the first treatment on May 15th 2016 and the second treatment on May 28th 2016).

Physiological analyzes were performed at the leaves of plant treated with the *Cropmax* foliar biostimulator, compared to those of untreated plants (Control) at the approximately two weeks after the last treatment (June 12th 2016).

Results

The treatments with foliar biostimulators are important for *Malus domestica* Borkh. plants by the intensifying of the photosynthesis process, contributing to the increase of the carbohydrate quantity, decrease of the metabolic deficiencies, contributing to the rapid development of the root system and intensification of the shoots formation, aspects that increase the resistance of the plants to drought conditions and stress (Fig. 1 and Fig. 2).

The physiological analyzes were performed in the leaves of plants treated with the *Cropmax* 0.2 % foliar biostimulator, compared to leaves of plants without treatments with the biostimulators (Control).

Fig. 1. *Malus domestica* Borkh. - *Idared* variety - leaves of the plant (Original).

Fig. 2. *Malus domestica* Borkh. - *Idared* variety - unripe fruits (Original).

The photosynthesis and transpiration intensity throughout the day, presents a minimum in the morning, a maximum afternoon and a minimum toward the evening with specific variations depending on climatic conditions.

Among the factors with importance upon photosynthesis intensity and transpiration intensity, there were analysed: the photosynthetic active radiation incident on the surface of the leaf, the leaf temperature and stomatal conductance.

The photosynthesis intensity throughout the day in the leaves of plants treated with the *Cropmax* foliar biostimulator is similar to that in plants without foliar biostimulator (Control), but the recorded values are higher in comparison with these, fact that is manifested by the qualitative and quantitative increase of production (Fig. 3).

The transpiration intensity throughout the day in the leaves of plants treated with the foliar biostimulator is similar to that in plants without foliar biostimulator, but the recorded values are higher in comparison with these, fact manifested by the increased radicular absorption of water and mineral substances (Fig. 4).

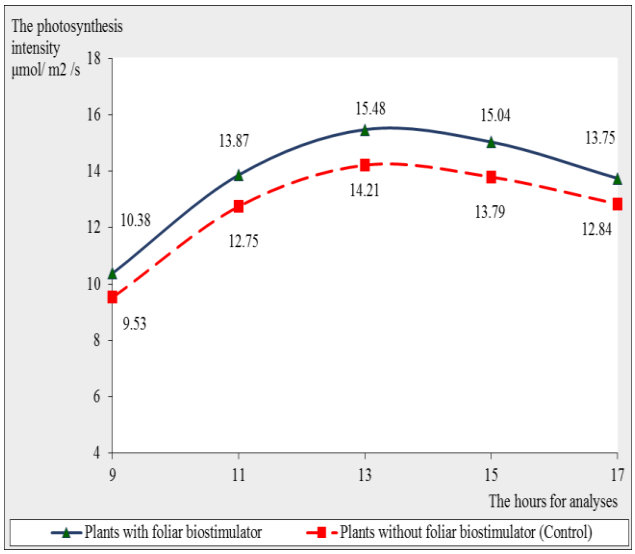

Fig. 3. The photosynthesis intensity throughout the day in *Malus domestica* Borkh. - *Idared* variety.

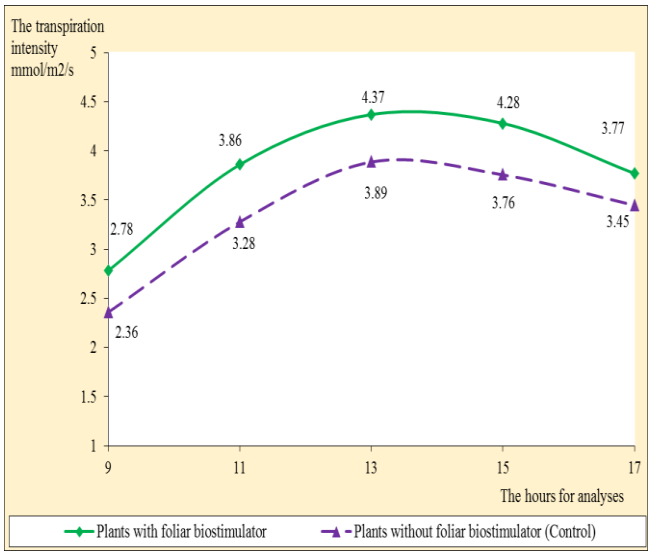

Fig. 4. The transpiration intensity throughout the day in *Malus domestica* Borkh. - *Idared* variety.

At the analized leaves of plants an increase in photosynthetic active radiations present on the surface of the leaves has been noticed starting with the morning (9 a.m.) when were recorded values of 1312 µmol / m^2 / s in the leaves of plant treated with the foliar biostimulator and of 1287 µmol / m^2 / s in the plants without foliar biostimulator (Control), their growth up until afternoon (1 p.m.) when were recorded values of 1596 µmol / m^2 / s) in the plants with the foliar biostimulator and 1524 µmol / m^2 / s after treatments in the plants without foliar biostimulator and towards evening (5 p.m.) when could be noticed a gradual decrease recording values of 1497 µmol / m^2 / s after treatments with the foliar biostimulator and of 1483 µmol / m^2 / s in the plants without foliar biostimulator.

Linear regression made between the photosynthesis intensity and photosynthetic active radiations show a positive correlation, the coefficient of determination (R^2) being of 0.95 for the leaves of plant treated with the *Cropmax* foliar biostimulator and 0.93 for the plants without foliar biostimulator, and linear regression made between the transpiration intensity and photosynthetic active radiations show a positive correlation - R^2 was 0.95 for the plants treated with the foliar biostimulator and 0.96 for the plants without treatments with the foliar biostimulator (Fig. 5 and Fig. 6).

In the leaves of *Malus domestica* Borkh. - *Idared* variety was noticed an increase of the leaf temperature starting with the early hours of the morning (9 a.m) when were recorded values of 28.2 ^oC in the leaves of plant treated with the *Cropmax* foliar biostimulator and of 27.3 ^oC in the plants without foliar biostimulator (Control), their growth up until afternoon (1 p.m.) when were recorded values of 34.6 ^oC in the plants treated with the foliar biostimulator and 33.0 ^oC in the plants without foliar biostimulator and towards evening (5 p.m.) was noticed a gradual decrease, recording values of 33.1 ^oC in the plants treated with the foliar biostimulator and of 32.2 ^oC in the plants without treatments with the foliar biostimulators.

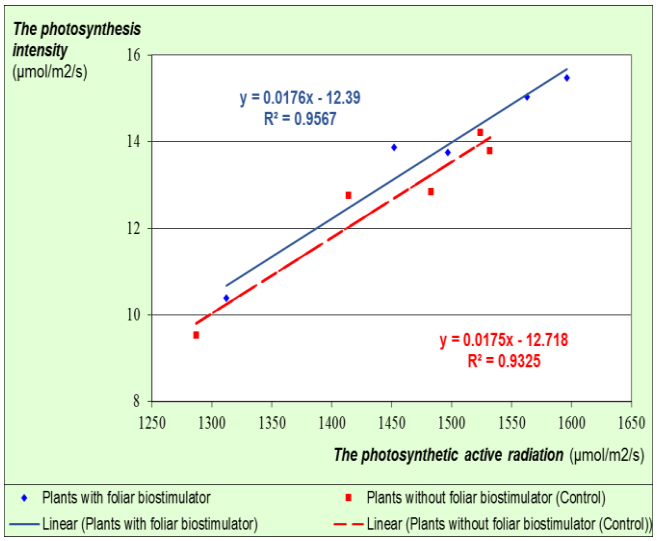

Fig. 5. The correlation between photosynthesis intensity and the photosynthetic active radiation in *Malus domestica* Borkh. - *Idared* variety.

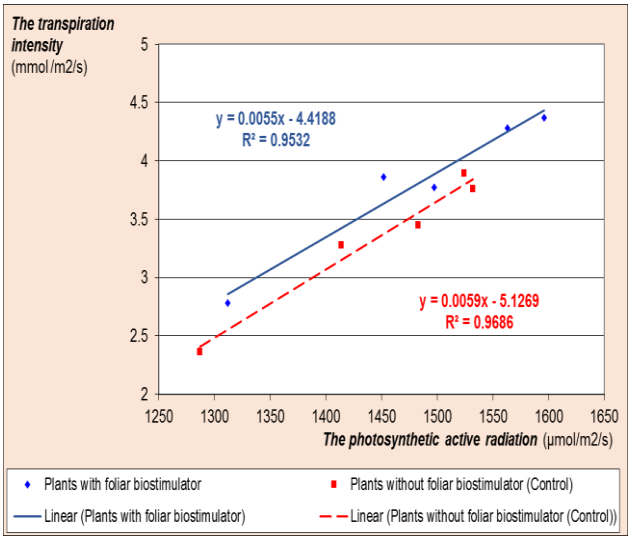

Fig. 6. The correlation between transpiration intensity and the photosynthetic active radiation in *Malus domestica* Borkh. - *Idared* variety.

Linear regression made between the photosynthesis intensity and leaf temperature shows a good positive correlation, the coefficient of determination (R^2) being of 0.98 for the leaves of plant treated with the foliar biostimulator and 0.96 for the plants without foliar biostimulator (Control), and linear regression made between the transpiration intensity and leaf temperature show a positive correlation - R^2 was 0.96 for the plants treated with the foliar biostimulator and 0.94 for the plants without foliar biostimulator (Fig. 7 and Fig. 8).

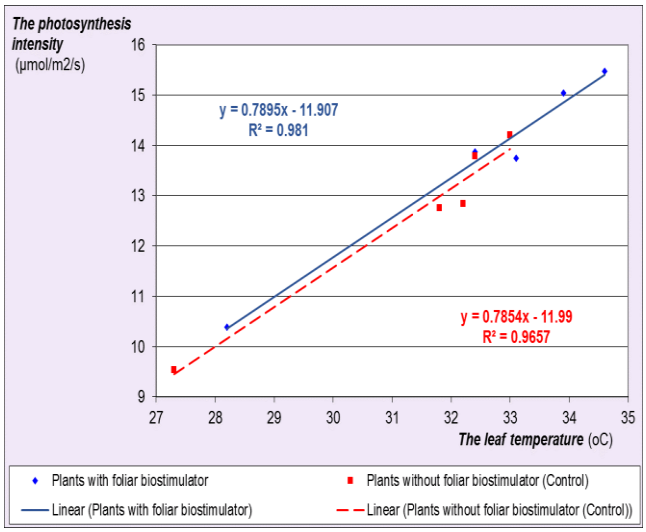

Fig. 7. The correlation between photosynthesis intensity and the leaf temperature in *Malus domestica* Borkh. - *Idared* variety.

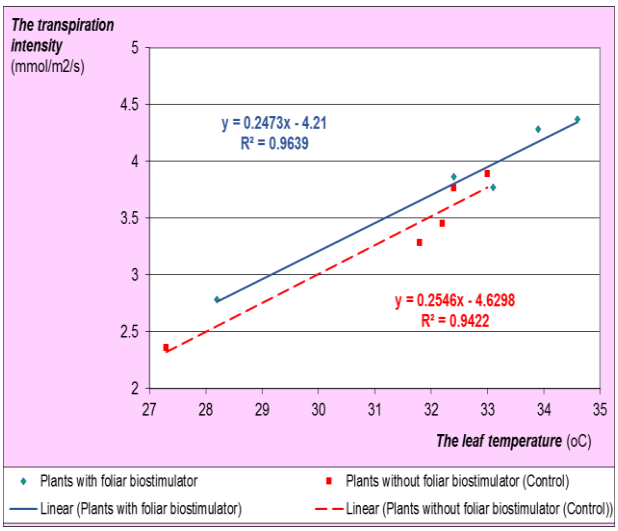

Fig. 8. The correlation between transpiration intensity and the leaf temperature in *Malus domestica* Borkh. - *Idared* variety.

At the leaves of plants was seen an increase in the stomatal conductance starting in the morning (9 a.m.) when were recorded values of 0.11 mol / m^2 / s in the leaves of plants treated with the foliar biostimulator and 0.09 mol / m^2 / s in the plants without foliar biostimulator, their growth up until afternoon (1 p.m.) when were recorded values of 0.21 mol / m^2 / s in the plants treated with the foliar biostimulator and 0.18 mol / m^2 / s in the plants without foliar biostimulator and towards evening (5 p.m.) a gradual decrease could

be noticed, recording values of 0.16 mol / m^2 / s in the plants treated with the foliar biostimulator and 0.13 mol / m^2 / s in the plants without the foliar biostimulator.

Linear regression made between the photosynthesis intensity and stomatal conductance shows a positive correlation, the coefficient of determination (R^2) being of 0.93 for the leaves of plant treated with the foliar biostimulator and 0.89 for the plants without the foliar biostimulator and linear regression made between the transpiration intensity and stomatal conductance show a positive correlation - R^2 was 0.92 for the plants treated with the foliar biostimulator and 0.88 for the plants without foliar biostimulator (Fig. 9 and Fig. 10).

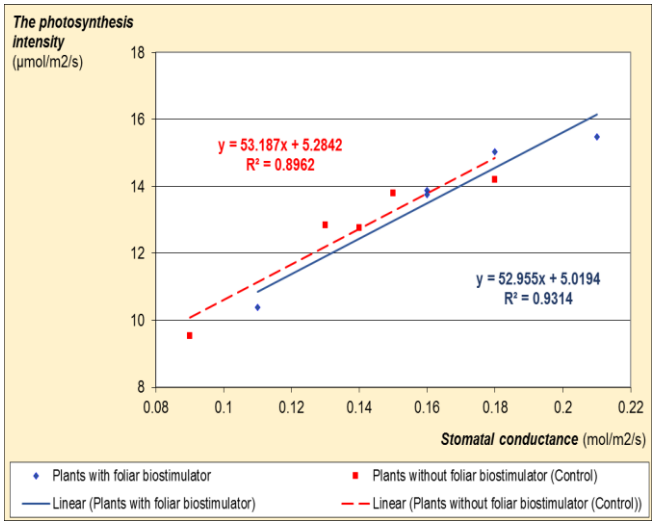

Fig. 9. The correlation between photosynthesis intensity and the stomatal conductance in *Malus domestica* Borkh. - *Idared* variety.

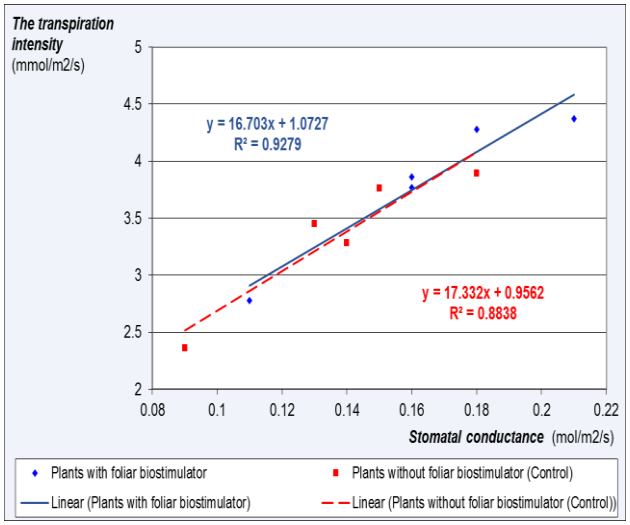

Fig. 10. The correlation between transpiration intensity and the stomatal conductance in *Malus domestica* Borkh. - *Idared* variety.

The leaves of plants treated with the foliar biostimulator present an higher water content and a lower dry substance content, in comparison with the leaves of plants without the foliar biostimulator (Fig. 11).

The leaves of *Malus domestica* Borkh. - *Idared* variety treated with the foliar biostimulator have a higher content in chlorophyll, this being correlated with the increase in the intensity of photosynthesis (Fig. 12).

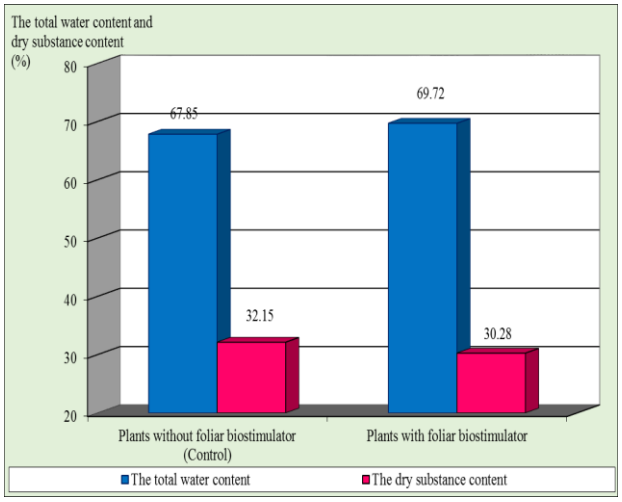

Fig. 11. The water content and the dry substance content in *Malus domestica* Borkh. - *Idared* variety.

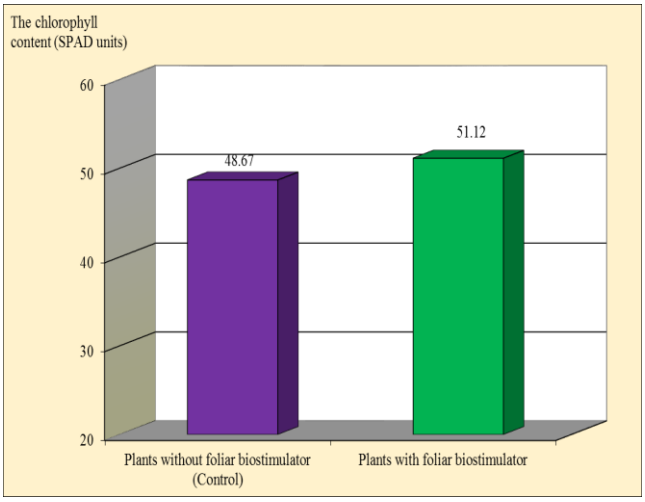

Fig. 12. The chlorophyll content in *Malus domestica* Borkh. - *Idared* variety.

Conclusions

In Malus domestica Borkh., Idared variety was observed that the photosynthesis and transpiration intensity varies during the day according to climatic conditions, presenting a lower value in the morning, a higher value afternoon and lower values for the evening, but the recorded values are always higher for the leaves of plant treated with the foliar biostimulator, compared to leaves of plants without the foliar biostimulators.

The linear regressions performed at the Malus domestica Borkh., Idared variety between the physilological processes and the photosynthetic active radiation, the leaf temperature and the stomatal conductance shows a positive correlation between them.

In the plants treated with the foliar biostimulator was recorded a higher water content and a lower dry substance content, compared with the plants without the foliar biostimulator. The chlorophyll content was higher in the plants treated with the foliar biostimulator, compared with the plants without it, being a positive correlation between the chlorophyll content and the photosynthetis intensity, fact materialized by increasing apple production.

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