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RESEARCH ON THE CONSUMPTION OF CHEMICAL AND ORGANIC FERTILIZERS THROUGH FOLIAR FERTILIZATION WITH FOLIBOR ON SOME PHYSIOLOGICAL INDEXES OF WATERMELONS

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Abstract

The foliar fertilization with Folibor on the culture of watermelons influenced the physiological indexes of the plants as following: the activity of the catalase enzyme presented a low decrease by reducing the chemical and mineral fertilizers' doses at half and by applying the fertilizer-stimulator Folibor to the vegetation. Thus the values ranging from 25.6 to 24.9 ml $KMnO_4$ n/10 on the grounds with chemical fertilization, respectively from 25.6 to 25.0 ml $KMnO_4$ n/10 on the grounds with organic fertilization. The chlorophyll pigments recorded higher values for variants where there were applied foliar fertilizers which were based on organic compounds of boron while the chemical and organic fertilizers were reduced by half, the chlorophyll (a+b) presented an increase from 2.27 to 2.99 mg/g FW through reducing the chemical fertilizers, respectively from 4.00 to 4.31 mg/1 g in the case of the organic ones. The intensity of photosynthesis was influenced by foliar fertilization and also by chemical and organic one. The photosynthesis rate recorded a maximum value at the variant treated with organic fertilizers (30 t/ha) (V3) and at the vegetation treated with Folibor (V7).

***Key words**: watermelons, Folibor, foliar fertilization.*

INTRODUCTION

Chemical fertilizing is one of the main inputs that increase watermelon production costs. Watermelon grafting with compatible rootstocks and a vigorous root system may increase the efficiency of nutrients absorption (Santos et al., 2016).

Boron participates to a series of processes in plants having a high physiological importance because it stimulates the growing of roots, the forming of reproduction organs, the activity of some enzyme sand the absorption of some ions (K, Mg, NO_2). Also, it has a favourable effect on the flowering and fructification of plants because it stimulates the fast germination of pollen. Moreover, boron influences the synthesis in plants of the aromatic compounds, the permeability of protoplasmic membranes, the movement of carbohydrates, the division and extension of cells, the accumulation of free auxin and biosynthesis of nucleic acids (Cao et al., 2000; Huanget al., 2016; Öztekin et al., 2017).

Boron participates to processes of oxidation-reduction in plants, influences the process of forming the chlorophyll together with other micronutrients (Mn, Cu, Zn), favours the process of respiration. The deficiencies of boron into the soil represent a problem that concerns the quantity of crop, but also the quality of leaves and fruits (Popescu, 2012; Soteriou et al., 2014).

These nutritional demands may be suppressed by equilibrated doses of fertilizers into the soil at sowing or as proper topdressing. The absorption of nutrients differs according to plant development, and is higher at flowering, setting and fruit growth (Santos et al., 2016).

In the last decades the research regarding the boron was based more on supposition regarding the role of boron in the plants, establishing that the main property of boron in the plant represents the tendency of boronic acid to form complex with cis-diol functional groups. The reversible character of these complexes and their dependence of pH stops to characterize boron in vivo (Croitoru, 2009).

Regarding the fertilization strategies there was noticed the using of classical fertilizers in reduced doses together with consumption from expected crops and also the partial substitution of the fertilization basis through supplementary foliar fertilization (Ciuciuc et al., 1998; Calatayud et al., 2006; Rățoi et al., 2010; YuFeng et al., 2010; Özmen et al., 2015; Simonne et al., 2017; De Pascale et al., 2018; Kyriacou et al., 2018).

MATERIALS AND METHODS

The Folibor product, produced on the basis of organic compounds of boron, was used on different agrofunds, the variants of the experiment being the following:
V1 - non-fertilized;
V2 - chemically fertilized with $N150P_2O_5100$ K_2O100;
V3 - organically fertilized with 30 t/ha, dung;
V4 - non-fertilized agrofund, Folibor, 5 l/ha, 2 treatments;
V5 - $N150P_2O_5100K_2O100$+ Folibor, 5 l/ha, 2 treatments;
V6 - N 75 P_2O_550 K_2O 50+Folibor, 5 l/ha, 2 treatments;
V7 - dung, 30 t/ha + Folibor, 5 l/ha, 2 treatments;
V8 - dung, 15 t/ha + Folibor, 5 l/ha, 2 treatments. The experiment was placed in randomized blocks, four times.
The area of the experimental place was 18 m^2.The area of the experiment was 720 m^2.
The moments of applying of the foliar fertilizers were:
- treatment I at the beginning of forming the stem, on 9th of June, 2018;
- treatment II at 10 days after the first treatment, on 19th of June, 2018.

Quantity of solution was 600 l/ha. All fruits were grown in an open field in the same area (Dăbuleni). During the 2018 campaign, samples were transported to our laboratory (Research Center for monitoring of the ecological and bioeconomical indicators for some horticultural species at regional level - BCUM from University of Craiova) within a day after harvest and processed.
For determination of physiological parameters was used a non-destructive method based on the use of LC Pro+ photosynthesis system, which causes multiple physiological and environmental indicators simultaneously: transpiration rate (mmol $H_2O/m^2/s$) and photosynthesis (μmol $CO_2/m^2/s$).
The dry matter content (%) was determined by dehydration of the plant material at 105°C, up to a constant mass.
The chlorophyll and carotenoids estimation were conducted following the method: the fresh leaf sample (0.1g) was mixed with 10 ml of 80% (V/V) acetone and kept in dark at room temperature for 24 hours until the leaves turned completely white. Absorbance of the solution for chlorophyll a and b was read at 663nm and 645nm wavelengths, respectively using the spectrophotometer. The absorbtion spectrum of 440.5 nm was used for carotenoids. The chlorophyll a and b were calculated using the following formulas:
Ca (mg/l = 12.7 x D663 – 2.59 x D645
Cb (mg/l) = 22.9 x D645 – 4.67 x D663
CT (mg/l) = Ca + Cb = 20.3 x D645 + 8.03 x D663. Chlorophyll content (mg/g FW) = C (mg/l) x total content of extract solution (ml) x dilution factor /FW of leaf (g) X 1000 (method by Ranganna, 1986).
The method for determination of the content in soluble solids was based on a rapid extraction protocol and spectrophotometric measurements to determine the total amount present in watermelons. The spectra of 680–950 nm were adopted to analysis for content in soluble solids (method by Hai-qing, 2007).
The activity of catalase was conducted following the method with hydrogen peroxide using a normal centrifuge, plastic microplates, the volume of 1% hydrogen peroxide, UV-spectrophotometric method. In the ultraviolet range, H_2O_2 shows a continual increase in absorption with decreasing wavelength. The rate of decomposition of H_2O_2 was followed by decrease in absorbance at 240 nm in a reaction mixture containing 1.5 ml phosphate buffer, 1.2 ml of hydrogen peroxide and 300 ml of enzyme extract. One unit of the enzyme activity was calculated as the amount of enzyme required to liberate half the peroxide oxygen from H_2O_2 and calculated from specific formula (method by Aebi, 1983).

RESULTS AND DISCUSSIONS

Applying Folibor to vegetation on different agrofunds revealed the differences regarding the accumulation of chlorophyll pigments in the leaves and the activity of catalase enzyme (Table 1). All the studied variants recorded higher values in comparison to the control variant. The variant fertilized with N 150 P_2O_5 100 K_2O 100 recorded 4.14 mg/g FW total chlorophyll (a+b) and 0.69 mg/g FW carotenoids.

A nutritional balance with nitrogen has to be correlated with an intense photosynthesis because this creates the premise to relate nitrogen with different organic acids and forming of an important quantity of amino acids, which favours the synthesis of chlorophyll. A high content of total chlorophyll was noticed also to the dung variant, 30 t/ha (4.46 mg/g FW), which constitutes a rich source of macro and microelements, among which boron, stimulating also the synthesis of chlorophyllian pigments.

Folibor, applied to soil, has favoured the accumulation of chlorophyllian pigments but in a smaller percentage comparing with chemical and organic fertilizers.

Applying Folibor to agrofunds formed of chemical and organic fertilizers in different doses led to higher values comparing with the non- fertilized variant, but lower values than at the variants fertilized only on soil. Reducing by half the doses with chemical and organic fertilizers and applying Folibor ferti-stimulator to vegetation, during the phenophases of growing and development of plants, the activity of catalase enzyme recorded a low decrease, the values ranging from 25.6 to 24.9 ml $KMnO_4$ n/10 on agrofund with chemical fertilization, respectively from 25.6 to 25.0 ml $KMnO_4$ n/10 on agrofund with organic fertilization. The chlorophyllian pigments recorded higher values, the total chlorophyll (a+b) ranging from 2.27 to 2.99 mg/g FW on agrofund with chemical fertilization, respectively from 4.00 to 4.31 mg/g FW in the case of the organic ones. The activity of catalase enzyme during the maturity period of fruits was more intense in the fertilized variants and the highest values were recorded by the variants where it was administrated dung 30 and 15 t/ha in combination with Folibor (15.3-15.7 $KMnO_4$) (Table 2).

The content of chlorophyllian pigments decreases in leaves until the end of the period of vegetation but all the fertilized variants recorded a high content of total chlorophyll (a+b). The highest values for total chlorophyll were recorded for the variant fertilized with dung + Folibor (2.28 mg/g FW), a variant that recorded also a higher carotenoids content (1.02 mg/g FW).

The obtained results show that the fertilization with chemical and organic fertilizers together with the fertilizers based on natural organic compounds of boron in watermelons has influenced some physiological-biochemical processes in the plants and also the quality of products.

The intensity of transpiration recorded a diurnal variation being influenced by the increasing of air temperature to 28^0C and decreasing of humidity of air to 50% (Table 3). In the morning at 8^{00} o`clock, the values of transpiration ranged 3.8 mmol $H_2O/m^2/s$ (V1) in plants not-fertilized and 5.1 mmol $H_2O/m^2/s$ (V7) in plants fertilized with organic compounds. At noon (12^{00} PM), the transpiration values ranged 14.4 mmol $H_2O/m^2/s$ in plants not-fertilized and 17.8 mmol $H_2O/m^2/s$ in plants fertilized with organic compounds, and in the afternoon (4^{00} PM), they were ranging 12.0 mmol $H_2O/m^2/s$ (V1) and 15.0 mmol $H_2O/m^2/s$ (V7). The maximum diurnal transpiration was recorded by all the studied variants at 12^{00} PM. Nicolae et al., 2014 says that the intensity of transpiration presents the highest values at noon (12 a.m.) for watermelon plants fertilized with organic compounds. The average daily value shows a higher transpiration in the plants treated with organic and foliar fertilizers. The quantity of water in the watermelon's leaves ranged between 86.9% and 88.2% and the quantity of dry matter recorded values between 11.8 – 13.1% (Table 4). The plants fertilized with dung had a lower foliar hydration.

Table1. The influence of treatment with Folibor on the content of the assimilatory pigments (mg/g FW) and catalase enzyme activity according to the optimization of consumption of chemical and organic fertilizers in watermelons in the phase of fruit maturation

Variant	Assimilatory pigments (mg/g FW[1])		Catalase activity (ml $KMnO_4$ n/10)
	Total chlorophyll (a+b)	Carotenoids	
V1- non fertilized	2.14	0.49	19.2
V2 - chemically fertilized with N 150 P_2O_5 100 K_2O100	4.14	0.69	25.6
V3 - fertilized with dung, 30 t/ha	4.46	0.73	23.7
V4 - non -fertilized agrofund, Folibor, 5 l/ha, 2 treatments	3.36	0.73	25.6
V5 - N 150 P_2O_5 100 K_2O 100 + Folibor, 5 l/ha, 2 treatments	2.27	0.53	25.6
V6 - N 75 P_2O_5 50 K_2O 50 + Folibor, 5 l/ha, 2 treatments	2.99	0.68	24.9
V7 - dung, 30 t/ha + Folibor, 5 l/ha, 2 treatments	4.00	0.63	25.6
V8 - dung, 15 t/ha + Folibor, 5 l/ha, 2 treatments	4.31	0.79	25.0

FW[1] = fresh weight

Table 2. The influence of foliar fertilization with Folibor, also with chemical and organic compounds on the content of the assimilatory pigments (mg/g FW) in the leaves of watermelons and the catalase enzyme activity in the phase of fruit maturation

Variant	Catalase activity ml $KMnO_4$	Total chlorophyll (a + b) mg/g FW[1]	Carotenoids mg/g FW[1]
V1 - non-fertilized	13.2	1.27	0.91
V2 - chemically fertilized with N 150 P_2O_5 100 K_2O100	14.5	1.76	0.53
V3 - fertilized with dung, 30 t/ha	14.8	2.27	0.53
V4 - non-fertilized agrofund, Folibor, 5 l/ha, 2 treatments	15.0	2.22	1.01
V5 - N 150 P_2O_5 100 K_2O 100 + Folibor, 5 l/ha, 2 treatments	14.7	1.97	0.98
V6 - N 75 P_2O_5 50 K_2O 50 + Folibor, 5 l/ha, 2 treatments	14.6	1.76	0.96
V7 - dung, 30 t/ha + Folibor, 5 l/ha, 2 treatments	15.3	2.28	1.02
V8 - dung, 15 t/ha + Folibor, 5 l/ha, 2 treatments	15.7	2.12	0.96

FW[1] = fresh weight

Table 3. The diurnal variation of transpiration (mmol $H_2O/m^2/s$) according to the optimization of consumption of chemical and organic fertilizers by using natural complex boron fertilizers in watermelons in the phase of fruit maturation

Variant	June			
	8^{00} AM	12^{00} PM	4^{00} PM	Average
V1 - non-fertilized	3.8	14.4	12.0	10.0
V2 - chemically fertilized with N 150 P_2O_5 100 K_2O100	4.0	19.0	12.4	10.4
V3 - fertilized with dung, 30 t/ha	4.2	15.6	12.9	10.9
V4 - non-fertilized agrofund, Folibor, 5 l/ha, 2 treatments	4.4	15.9	13.0	11.1
V5 - N 150 P_2O_5 100 K_2O100 + Folibor, 5 l/ha, 2 treatments	3.9	16.1	13.6	11.2
V6 - N 75 P_2O_5 50 K_2O 50 + Folibor, 5 l/ha, 2 treatments	4.8	16.4	13.9	11.7
V7 - dung, 30 t/ha + Folibor, 5 l/ha, 2 treatments	5.1	17.8	15.0	12.4
V8 - dung, 15 t/ha + Folibor, 5 l/ha, 2 treatments	5.0	16.4	15.2	12.3

Table 4. The variation of some physiological indexes according to the optimization of chemical and organic fertilization consumption by using complex natural boron fertilizers in watermelons

Variant	Water (%)	Dry matter (%)	Total soluble solids (%)	Photosynthesis (µmol $CO_2/m^2/s$)
V1- non-fertilized	87.5	12.5	3.5	30.2
V2 - chemically fertilized with N 150 P_2O_5 100 K_2O 100	88.0	12.0	3.4	44.0
V3 - fertilized with dung, 30 t/ha	87.9	12.1	3.6	48.2
V4 - non-fertilized agrofund, Folibor, 5 l/ha, 2 treatments	88.1	11.9	3.4	40.4
V5 - N 150 P_2O_5 100 K_2O 100 + Folibor, 5 l/ha, 2 treatments	88.2	11.8	3.8	45.6
V6 – N 75 P_2O_5 50 K_2O 50 + Folibor, 5 l/ha, 2 treatments	87.4	12.6	3.9	42.4
V7 - dung, 30 t/ha + Folibor, 5 l/ha, 2 treatments	87.0	13.0	4.5	60.2
V8 - dung, 15 t/ha + Folibor, 5 l/ha, 2 treatments	86.9	13.1	4.8	58.4

FW[1] = fresh weight

The content of soluble solids was between 3.4 – 4.8%, being higher also at the plants treated with organic fertilizers. The soluble solids content increases on sandy soils when the pedological drought is accentuated as a measure to adapt to drought. So, the water is present in opposition to the lost one through transpiration. Croitoru et al. (2016) have also performed such studies and obtained similar results (10.70% total dray matter and 89.30% water). The intensity of photosynthesis was easily influenced by agrotechnical factor, but also by climatic ones. The non-fertilized foliar variant recorded the intensity of photosynthesis at 30.2 µmol $CO_2/m^2/s$ and the plants fertilized with foliar and organic fertilizers (V7), recorded maximum values of photosynthesis (60.2 µmol $CO_2/m^2/s$), value being almost double than the one recorded by the non-fertilized variant. By offering all the macro and microelements that the plants need in the phase of vegetation, the intensity of photosynthesis increases in all the species of plants.

CONCLUSIONS

Applying Folibor to vegetation on different agrofunds revealed different aspects regarding the accumulation of assimilatory pigments in leaves and the activity of catalase enzyme. Reducing by half the doses of chemical and organic fertilizers and by applying Folibor ferti-stimulator to vegetation during the phenophases of growing and development of plants, the activity of catalase enzyme recorded a lower decrease ranging on the agrofund with chemical fertilization compared to organic fertilization. The content of assimilatory pigments recorded higher values in the case of the organic ones.

The activity of catalase enzyme and the content of chlorophyll pigments in the period of maturation of fruits recorded the highest values in the V7 and V8 variants. The intensity of transpiration recorded maximum diurnal value at 12^{00} PM, in all the studied variants and the average daily value shows higher transpiration in plants fertilized with organic and foliar fertilizers. The non-fertilized foliar variant (V1) recorded a small the intensity of photosynthesis, plants fertilized with foliar and organic fertilizers (V7), recorded maximum values of photosynthesis, the value being almost double than the one recorded by the non-fertilized variant. Reducing by half the doses of chemical and organic fertilizers and applying Folibor ferti-stimulator to vegetation, during the phenophases of growing and development of plants, the total soluble solid sand also the photosynthesis recorded close values. The obtained results show that the fertilization with doses reduced by half of complex chemical and organic fertilizers and foliar fertilization with Folibor product (based on the natural organic compounds of boron) in watermelons determined some values of the studied physiological and biochemical processes close or even higher than those recorded by the fertilization based on chemical and mineral fertilizers with double doses.

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