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THE INFLUENCE OF ALTERNATIVE TECHNOLOGICAL SEQUENCES ON THE QUALITY OF MELON PRODUCTION

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Abstract

At present, there is a growing consumer interest in high value-added vegetable products. It is therefore necessary to limit the use of fertilizers and synthetic chemical pesticides because of the harmful effect on the environment. In this regard, a melon culture was established in the polyethylene tunnels to which Lignohumat biostimulator product was applied in vegetation as an alternative for chemical foliar fertilization. It is a humic product, granulated with microelements and with the effect of growth and protection against stress factors. Three treatments were applied in three doses of fertilization. The specific of variants was: V1 (Control)-unfertilized; V2-fertilized with 100 g/ha; V3-fertilized with 150 g/ha; V4-fertilized with 200 g/ha. The determinations focused on the quality of the production. The 200 g/ha Lignohumat dose influenced the quality attributes and the dose of 100 g/ha Lignohumat the antioxidant activity of fruit. Thus, was recorded a SUS content of 8.05%, SUT of 12.29%, reducing sugars of 3.73%, vitamin C of 29.4 mg/100 g, TP of 42.03 mg GAE/100 g, carotene of 20.98 mg/100 g f.w. and antioxidant activity of 184.44 µMTE/100 g.

Key words*: Cucumis melo, carotene, organic fertilization.*

INTRODUCTION

In Romania, the watermelon (*Cucumis melo* L.) is highly appreciated and annually cultivated especially in South and South-East Romania, and in recent years there has been an increase in protected crops. Melon fruits are consumed at physiological maturity, fresh or mixed with other fruits, such as dessert salads and also processed in the form of jams, etc. Cantaloupe is a very good source of vitamins A, C and β-carotene and can be used as juice fruit (Mohamed and Maha-Mohamed, 2016). Also, the melon seeds are a good source of natural antioxidants with significant biological functions and may serve as food ingredients (Zeb., 2015). By its composition, melon can be a rich source of many nutrients related to human health (Lester, 2008).

It is very important to find the optimal fertilization dose as well as the appropriate combinations of fertilizersfor plant health, high productivity and fruit quality (Dinu et al., 2017; Bouzo and Cortez, 2015). Potassium is an important macronutrient and the most abundant cation of the superior plants. Also, K^+ is essential for enzyme activation, protein synthesis, for photosynthesis and mediates osmoregulation during cell expansion and for stomatal movements and tropisms (Silva et al., 2007). Nutritional imbalances, particularly inadequate K supply, often contribute significantly to yields and low crop quality (Jifon, 2011).

In recent years, bio-fertilizers based on humic acids are increasingly used, preparations that reduce the negative effects of chemical fertilizers on the environment. Fertilizers with humic substances can be used on different types of soil, as well as in technologies for improving degraded or contaminated soils and are efficient for many cultures (Sîrbu et al., 2016). Humic acids replace the requirements of other fertilizers, increase productivity, improve soil drainage and establish a favorable environment for the development of soil microorganisms (Salman et al., 2005). In addition, they can induce changes in plant primary and secondary metabolism related to abiotic stress tolerance which collectively modulate plant growth (Canellas et al., 2015). The application of humic acids has been reported by many authors with a positive effect on tomato plant growth and production (Dinu et al., 2015), the growth of pepper production (Karakurt et al., 2009), germination of tomato seeds (Dinu et al., 2013), growth and development of *Spathiphyllum wallisii* (Manda et al., 2014). Thus, the application of biostimulators can be considered a good strategy of vegetative and generative growth of plants, a high nutritional value of production and low impact on the environment (Becherescu et al., 2016; Dobrin et al., 2016; Naidu et al., 2016; Parađiković et al., 2011).

This study aims to investigate the effect of Lignohumat doses, biological fertilizer based on humic acids, on the quality of melon fruit.

MATERIALS AND METHODS

The experience was placed in the polyethylene tunnels of the Faculty of Horticulture and Faculty of Agriculture, University of Craiova, Romania, in randomized blocks, in three repetitions, in 2015-2016. The biological material was Ananas cultivar (*Cucumis melo* var. *reticulatus*) oval fruits with a pineapple scent and orange skin with reticulated appearance. Date of planting to the polyethylene tunnels was in the first decade of May while plant density was 3.2 plants m/2. The specific of the variants was: V1 (Control) - unfertilized; V2- fertilized with 100 g/ha Lignohumate; V3-fertilized with 150 g/ha Lignohumate; V4- fertilized with 200 g/ha Lignohumate. This is a foliar humic biostimulator, containing microelements in the form of chelates having the highest dose of Potassium Humate 850 g/kg.

Lignohumat organic fertilizer was applied foliarly in three treatments at 10 days interval and the culture technology was that specific to melons grown in polyethylene tunnels. During the growing season, it also pursued the application of some products to combat weeds, diseases and pests with low environmental impact products for sustainable agriculture. Thus, at the basic fertilization was applied 20 t/ha compost.

Samples preparation

A quantity of100g of each sample was broken up in blenduire to mix. 1 gram of homogenized sample (pulp) was mixed with 10 mL 80% methanol, intensely agitated for 10 minutes using avortex. The extraction of phenolic compounds was carried out by keeping the mixture in an ultrasonic bath for 70 minutes. The mixture was filtered, and to the residue solid was added 5 mL of 80% methanol and the extraction procedure repeated. Obtained the two extracts were combined and analyzed using protocols specific work to determine the total polyphenols and antioxidant capacity.

Dry matter content was determined gravimetrically at 105°C to constant weight (ISO751: 2000) (%) and the soluble solids content (SSC) (%) was determined using a digital refractometer (KrussOptronic DR 301-95) at 20°C.

The acidity was determined by titration with 0.1 N sodium hydroxide (NaOH) and expressed as (%) citric acid and reducing sugars (%) were extracted in distilled water (1:50 w/V) and assayed colorimetric with 3.5-dinitrosalicylic acid using glucose as standard.

The determination of vitamin C content

A sample of 5-10 g of tomatoes, previously ground with quartz sand has been put into a 100 ml balloon by using a solution of 2% hydrochloric acid. It has been stirred and after sedimenting it has been filtered into a dry glass. A 10 ml aliquot has been passed into a Berzelius glass, to which 30 ml of distilled water; 5 ml of 1% potassium iodate and 1 ml solution of starch have been added. It has been then titrated with potassium iodate N/250 stirred until becoming bluish (Chowdhury, 2004).

The determination of total carotenoids

The weighed samples, having been put separately in 95% in acetone (50 ml for each gram), were homogenized with Braun MR 404 Plus for one minute. The homogenate was filtered and was centrifuged using the Hettich Universal 320/320R centrifuge at 2500 rpm for ten minutes. The supernatant was separated and the absorbances were read at 400-700 nm on Cary 50 spectrophotometer.

The total phenols (TP) in melon fruit was estimated by the method proposed by Mallick and Singh (1980).

The capacity of extracts to reduce the radical 2.2-diphenyl-1-picrylhydrazyl was assessed colorimetric. 2 mL of 0.075 mM DPPH solution in ethanol was mixed with 0.1 mL extract and vortexed thoroughly. The absorbance of the remaining DPPH radicals was measured at 517 nm. The results were expressed as µMTrolox equivalents (TE)/100 g. The ABTS radical cation scavenging activity of the methanolic extract was assessed colorimetric. ABTS was dissolved in water to a 7 mmol/l concentration. ABTS radical cation was produced by reacting ABTS stock solution with 2.45 mmol/l potassium persulfate and allowing the mixture to stand in the dark at room temperature for 12-16 h before use. The ABTS radical cation solution was diluted with ethanol to an absorbance of 0.70 at 734 nm. 0.1 ml of sample extract was mixed with 2.9 ml of diluted ABTS radical cation solution. After reaction at room temperature for 6 min., the absorbance at 734 nm was measured. The Trolox calibration curve was plotted as a function of the percentage of ABTS radical cation scavenging activity. The final results were expressed as µMTrolox equivalents (TE)/100 g fw (Soare et al., 2016).

Statistical analysis

The data recorded were statistically processed by using the analysis of the variance (ANOVA) with a significance level of $p<0.05$ by Duncan's multiple range test. Also, were carried correlations between the analysed characters (Pearson's correlation analysis).

RESULTS AND DISCUSSIONS

Inappropriate fertilizations with N, P and K cause nutritional imbalances, also inducing deficiencies of calcium and boron, forming fruits with deformations, abnormal color and low storage capacity (Silva et al., 2007). Precise estimates of quantities of nutrients for crops as well as application in critical times are essential for increasing production and quality while protecting the environment.

Fruit quality is determined by complex networks of metabolic pathways developed during fruit ripening. melon (*Cucumis melo* L.) comprises a broad array of genotypes, in which the fruit accumulate soluble sugars, organic acids, secondary metabolites of pigmentation and aroma volatiles to varying levels. In addition, *Cucumis melo* includes fruit with different biochemical accumulations in ripening physiology, levels of ascorbic acid, additional secondary metabolites and other components of quality (Katzir et al., 2008).

In the present paper, the total dry substance (TDS) of melon fruit recorded upward values, along with increasing the fertilization dose, from 7.59% at the control variant to 12.29% at the fertilized variant with Lignohumat 200 g/ha. Regarding the soluble solids content (SSC), it also recorded upward values with the fertilization dose (Table 1). The values found are similar to those reported by Salman et al. (2005), on the growth of total dry substance and the soluble solids content with the increase in humate acid potassium, in watermelon, Aswan hybrid. Some authors have concluded that in cucumber plants treated with nitrogen-based biofertilizer at higher doses, it resulted total soluble solids higher compared to lower doses (AbdAlla et al., 2009; Oliveira et al., 2003)

The effect of the culture system on titratable acidity may actually be an important factor in the quality fruit. The titratable acidity varied in the four studied variants depending on the fertilization dose. The highest values were recorded in variant which had the highest fertilization dose, Lignohumat 200 g/ha. Different concentrations of humic acid-based products can influence the acidity level of edible cabbage (Soare et al., 2017) or from pepper (Aminifard et al., 2012).

Table 1. Analysis of some quality attributes of melon fruits

Variant	TDS (%)	(SSC) (%ºBrix)	Acidity (citric acid %)	Reducing sugars (%)	Vitamin C (mg/100g f.w.)
V1(Control)- unfertilized	7.59b	5.55c	0.123ab	3.15b	21.2b
V2- fertilized with Lignohumat 100 g/ha	7.94b	6.25bc	0.112bc	1.81c	29.4a
V3- fertilized with Lignohumat 150 g/ha	7.86b	6.95b	0.074c	2.84b	17.9c
V4- fertilized with Lignohumat 200 g/ha	12.29a	8.05a	0.156a	3.73a	22.8b
LSD≤0.05	0.82	0.69	0.04	0.50	1.85

Different letters within the same row indicated significant differences ($P < 0.05$) among variants

Reducing sugars, an important parameter for determining fruit quality of melon, recorded fluctuating values depending on the variant. The content of reducing sugars in fruits treated with Lignohumat 200 g/ha was signicantly higher (3.73%) in comparison with fruits from the control variant. The increase of reducing sugars under the influence of products based on humic acids was also recorded in autumn white cabbage (Soare et al., 2017). Lester (2008) claims that the accumulation of sucrose in melon depends on several factors and is maximal in the final stages of fruit maturation.

The antioxidant potential was evaluated by total polyphenols and vitamin C contents, carotenes, and antioxidant capacity. The presence of phenolic compounds, such as flavonoids, phenolic acids and anthocyanins, besides the vitamins C, E and carotenoids, contribute to the beneficial effects on human health (Podsedek, 2007).

Concerning the vitamin C, in the present study, it was registered a variation amplitude of 17.9 mg/100g f.w. (Lignohumat 150 g/ha) to 29.4 mg/100g f.w. (Lignohumat 100 g/ha). In the variant fertilized with Lignohumat 200 g/ha, vitamin C was 22.8 mg/100g f.w. There is a high variability of ascorbic acid (active form of vitamin C) influenced by Lignohumat concentration. Similar results have been reported Salandanan et al. (2009) in a study regarding the antioxidant properties and quality attributes or 10 melon (*Cucumis melo* L.) cultivars grown under conventional and organic conditions, recorded a variation from 16.2 to 38.1 mg/100 g fresh weight C vitamin. According to some authors, the vitamin C content of vegetables can vary depending on the intensity of light, temperature, humidity, pollution (Dinu et al., 2016).

Total polyphenols in the present study recorded significant differences in the variant treated with 100 g/ha of Lignohumat, 42.03 mg GAE/100 g f.w., after which it decreased with the increase of the fertilization dose. Salandanan et al. (2009) noted a high variability of the total polyphenols in some melon varieties, influenced by yearly environmental effects and production system (conventional and organic), from 40.5 to 71.7 mg GAE/100 g f.w. and Selale et al. (2012) in their paper, at 42 melon lines and cultivars of different types, reported that total phenolic content in the melon ranged from 118.5 to 357.8 mg GAE/kg^{-1}.

The highest value of antioxidant activity was also recorded in the fertilized variants compared to the control. Astfel, the ABTS value ranging between 88.76 μMTE/100 g (unfertilized) and 150.72 μMTE/100 g (fertilized with Lignohumat 100 g/ha). Increasing doses of Lignohumat did not influence the antioxidant capacity, probably due to the higher content of Potassium Humate and microelements. The results are similar to those reproted by Salandanan et al. (2009) at the organically and conventionally fertilized melon cultivars values of antioxidant capacity from 49 to 220.5 μmol TEAC/100 g f.w.

Table 2. Biochemical determinations of melon fruit

Variant	Total phenolics (mg GAE/100 g f.w.)	Total carotene (mg/100 g f.w.)	Antioxidant activity	
			ABTS μMTE/100 g	DPPH μMTE/100 g
V1(Control)- unfertilized	30.1b	17.38d	88.76c	91.46d
V2- fertilized with Lignohumat 100 g/ha	42.03a	20.98c	150.72a	188.44a
V3- fertilized with Lignohumat 150 g/ha	23.91c	26.28a	113.29b	136.39b
V4- fertilized with Lignohumat 200 g/ha	23.24c	25.1b	89.89c	113.13c
LSD≤0.05	3.36	2.72	5.79	4.50

Different letters within the same row indicated significant differences ($P < 0.05$) among variants

The same, DPPH radical scavenging activity decreased as the fertilization dose increased from 188.44 μMTE/100 g, (Lignohumat 100 g/ha) to 113.13 μMTE/100 g (Lignohumat 200 g/ha). The unfertilized variant recorded the lowest value of 91.46μMTE/100 g.

Parađiković et al. (2011) have claimed that biostimulators improve antioxidant activity, vitamin C content and phenols, compared to untreated fruits. Some authors said that cultivars selection, climate conditions, fertilizer types, culture system (conventional or organic) may influence the antioxidant activity of vegetables (Apahidean, 2017; Dinu et al., 2016; Salandanan et al., 2009; Salman et al., 2005). Other authors state that irrespective of the analysed index, variants organically fertilized are significantly superior to the control variant (Draghici et al., 2016). Also, the maturing stage is an important factor in the antioxidant properties of melon, and the cultivar must determine the appropriate harvesting time for fruits with high antioxidant potential (Wulandari et al., 2016).

Regarding the correlation coefficient between some quality characters, positive correlation coefficient values were obtained between ABTS and total polyphenols (0.935), between DPPH and total polyphenols (0.962) and between DPPH and ABTS (0.996) (Table 3). These results agreed with those reported by Selale (2012) which showed significant correlation between antioxidant capacity and phenolic content.

Table 3. Coefficients of correlation (r) between some quality characters of melon

Specification	Total phenolics (mg GAE/100 g)	Total carotene (mg/100 g f w)	ABTS µMTE/100 g	DPPH µMTE/100 g	Reducing sugars (%)	Vitamin C (mg/100 g)
Total phenolics	1					
Total carotene	-0.970	1				
ABTS	0.935*	-0.822	1			
DPPH	0.962*	-0.867	0.996*	1		
Reducing sugars	-0.900	0.767	-0.995	-0.984	1	
Vitamin C	0.891*	-0.974	0.675	0.735	-0.605	1

Correlation coefficient statistically significant *$p \leqslant 0.05$

CONCLUSIONS

The differences between the variants determined by the Lignohumat biofertilizer were due both to the quality, the balance of the nutrients contained in the composition and also to the treatment doses. Thus, the 200 g/ha Lignohumat dose significantly influenced the quality attributes (TSS, acidity and reducing carbohydrates) and the 100 g/ha Lignohumat dose significantly influenced the antioxidant capacity compared to the untreated variant. Although the study was limited only to the influence of biofertilization on a single variety, the differences between the studied variants regarding the antioxidant properties and quality attributes suggest that research can contribute to fertilization opportunities with this product in optimal doses to the melon culture.

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