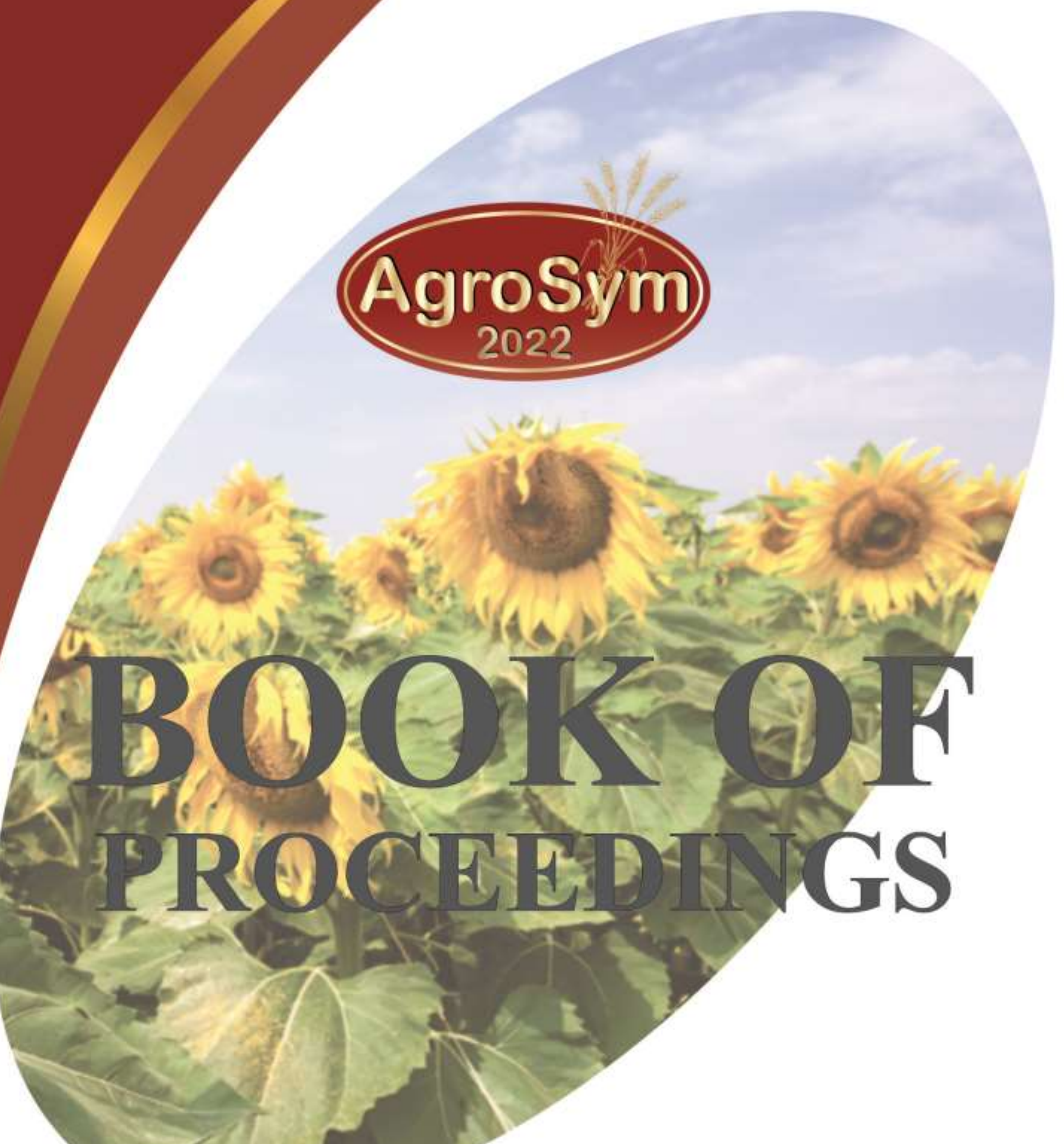

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EFFECTS OF ORGANIC FERTILIZERS APPLICATION ON FRUIT QUALITY IN MELONS

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Abstract

The need for consumption of vegetable fruits obtained from organic production has increased significantly in the last ten years. Melons (melons and watermelons) play a significant role in human nutrition. Compared to conventional melon production, the biggest problem in organic production is lower yield. This can be overcome by creating melon and watermelon varieties that are more suitable for growing in the organic production system. In this two-year field experiment, 5 melon, and 5 watermelon genotypes were used. The trial was conducted in an open field in the Smederevska Palanka. The effect of the application of four different commercial organic fertilizers on five characteristics of melons was observed. Mineral fertilizer was included in the trial as a control. The aim of the study was to determine the best melon and watermelon genotypes for the organic system of production. The greatest positive effects of the application of organic fertilizers were determined in the watermelon genotype Fairfax. Compared to the control, the fruit weight was increased by 15%, the sugar content up to 5%, while the thickness of the rind was decreased by 11%. In melon has been observed a smaller effect of the application of organic fertilizers, especially for the observed traits: weight of fruit and total sugar content. For Passport (melon genotype) was recorded 22% higher weight of fruits harvested from plants treated with organic fertilizers than in the control. The results showed that the Charentais, Passport (melon), Fairfax, and Greybelle (watermelon) are the genotypes that could be recommended for organic production systems.

Keywords: *Cucumis melo* L., *Citrullus lanatus (Thunb.) Matsum. et. Nakai), sustainable agriculture, conventional production.*

Introduction

Melon and watermelon are popular annual vegetable species belonging to the family *Cucurbitaceae*. Annually, in the world producers harvest about 130 million tons of fruits of these two vegetable species from about 4 million ha (FAO, 2020). The crop ratio in the production of melons and watermelons is 1: 3, in favor of watermelons. In the Republic of Serbia, melons are grown on approximately 20,000 ha, with a total production of 400,000 t fruits per year (Girek et al., 2014). Melons have a long history of growth. The center of origin of watermelon is Northeast Africa, while the center of origin of melons is Asia. In the past, watermelons were used as a source of drinking liquid, while melons were used exclusively in the form of young fruits (Paris, 2016). The development of civilization and raising people's awareness regarding nutrition has also affected the quality of the fruits of these vegetables. Today, when more and more attention

is paid to a healthy diet, the demands of consumers on the market are formulating the method of production and quality of watermelon fruits (Kyriacou et al., 2018; Dalorima et al., 2021).
Organic production is most commonly associated with production on small, family farms, and the average size of these farms is about 3.5 ha (Zrakić et al., 2017). In the last 20 years, the production in the organic production system has increased about 7 times in the world (Mpanga et al., 2021). In the Republic of Serbia, the transition from the conventional to the organic cultivation system goes slower. The total area under the organic vegetable growing system in Serbia in 2019 was only 184 ha, and the share of all organic fields in total arable agricultural land was only 0.61% (Simić, 2020). One of the reasons is the yield, which is 19 - 25% lower in the organic cultivation system compared to the conventional cultivation system (Seufert, 2019). One of the reasons for the lower yields is the fact that most of the existing varieties were not bred for the organic growing system and were not tested for specific conditions of the organic growing system during the breeding process (Park et al., 2018).
Today, many breeding companies have breeding programs that focus exclusively on creating varieties intended for the organic cultivation system (Boyhan et al., 2019;). New varieties are tested for resistance to specific diseases and pests, yield, fruit quality characteristics, and tolerance to local climatic conditions. In such programs, the most important is the availability of genetic material of old varieties and local populations that already have the adaptability to agro-climatic conditions of a particular region (Szamosi, 2005).
The aim of this study was to examine the influence of different commercial organic fertilizers with different nutrient ratios on the qualitative properties of fruits in melons. Also, to identify varieties that could be recommended for cultivation in the organic production system. One of the goals was to single out genotypes that would be a good starting material in melon and watermelon breeding programs for the creation of new varieties designed for the organic cultivation system.

Materials and methods

The two-year experiment was conducted in Smederevska Palanka (latitude 44°21'22.46"N, longitude 20°57'08.97"E, elevation 101 m). Five different melon genotypes (1 - Fiata, 2 - Cerovača, 3 - Galia, 4 - Charentais, 5 - Passport) and five watermelon genotypes (1 - Crimson sweet, 2 - Fairfax, 3- Greybelle, 4 - Mramorka, 5 - Dunay) were used in this study. Four commercial organic fertilizers available in Serbia with different nutrition ratios were used: Italpollina (4% N : 4% P_2O_5 : 4% K_2O), DCM Ekomix (9% N : 3% P_2O_5 : 3% K_2O), Guanitto (6% N : 15% P_2O_5 : 3% K_2O) i Duetto (5% N : 5% P_2O_5 : 8% K_2O). One-fifth of plants fertilized with mineral fertilizer NPK (15% N : 15% P_2O_5 : 15% K_2O) were considered the control in this experiment. All ten genotypes were seeded in the first decade of April.
Melons seedlings were produced in clay pots (diameter 10 cm), in the greenhouse of the Institute for vegetable crops. When the plantes reached the phase of 7 permanent leaves, they were transplanted to the open field. The experiment was set up in three replications using a complete randomized block design. Each replicate was composed of 50 rows (5 fertilizers x 10 melon and watermelon genotypes; 10 plants per row – 100 x 150 cm). Two weeks after transplanting, the plants were fertilized. The fruits were harvested successively. For watermelon 5 traits were observed: 1. Fruit weight, 2. Fruit length, 3. Fruit width, 4. Pericarp thickness, and 5. Sugar content. In melon 6 traits were observed: 1. Fruit weight, 2. Fruit length, 3. Fruit width, 4.

Pericarp thickness, 5. Mesocarp thickness, and 6. Sugar content. The agronomic measures that were implemented were in accordance with the organic system of cultivation.
All the obtained results were statistically analyzed. The differences between fruits harvested from plants fertilized with commercial organic fertilizers and controls were determined. All results were statistically analyzed using the Fisher’s Least Significant Difference (LSD) test (Fisher, 1935). Also, the most important traits were singled out and the correlation between traits was determined using PCA analysis. The principal components method was analyzed using the statistical program Statistica 8.0 (StatSoft, 2007).

Results and discussion

The results in Tables 1 and 2 show that commercial organic fertilizers had a significant effect on all observed traits in both watermelon and melon.

Table 1. Average values of five observed watermelon traits and comparison of effect of commercial organic fertilizers and mineral fertilizer NPK on these observed traits (%)

Genotype	Treatment	Fruit weight – g (%)	Fruit length – cm (%)	Fruit width – cm (%)	Pericarp thickness – cm (%)	Sugar content - ^{0}brix (%)
1	Control	4159.52	20.76	18.49	1.11	8.23
	I	4083.52 (↓1.83)	20.53 (↓1.14)	18.34 (↓0.83)	1.07 (↓3.61)	9.26 (↑12.51)
	II	4256.32 (↑2.33)	21.01 (↑1.20)	18.86 (↑1.99)	1.15 (↑2.97)	8.20 (↓0.40)
	III	4097.59 (↓1.49)	20.66 (↓0.48)	18.39 (↓0.53)	1.10 (↓1.61)	8.59 (↑4.32)
	IV	4144.56 (↓0.36)	20.79 (↑0.14)	18.38 (↓0.62)	1.09 (↓1.81)	8.74 (↑6.20)
2	Control	4078.33	32.58	15.41	1.11	7.92
	I	4696.94 (↑15.17)	33.97 (↑4.26)	15.63 (↑1.44)	0.99 (↓10.64)	7.97 (↑0.59)
	II	4456.21 (↑9.27)	33.55 (↑2.98)	15.75 (↑2.22)	1.01 (↓9.02)	8.02 (↑1.23)
	III	4653.64 (↑14.11)	33.96 (↑4.23)	15.90 (↑3.17)	1.03 (↓7.17)	8.26 (↑4.28)
	IV	4201.21 (↑3.01)	32.06 (↓1.60)	15.77 (↑2.38)	1.03 (↓6.63)	8.37 (↑5.64)
3	Control	2466.90	17.46	16.01	1.04	9.18
	I	2919.15 (↑18.33)	18.94 (↑8.47)	16.57 (↑3.47)	1.01 (↓2.85)	9.56 (↑4.15)
	II	2472.76 (↑0.24)	18.19 (↑4.23)	15.98 (↓0.20)	0.96 (↓7.47)	9.19 (↑0.15)
	III	2356.95 (↓4.46)	17.53 (↑0.41)	15.80 (↓1.32)	0.96 (↓7.90)	9.83 (↑7.06)
	IV	2534.76 (↑2.75)	18.03 (↑3.27)	16.00 (↓0.06)	1.00 (↓3.21)	9.66 (↑5.26)
4	Control	3273.95	16.83	18.61	0.70	8.97
	I	3506.62 (↑7.11)	17.07 (↑1.47)	18.97 (↑1.92)	0.74 (↑5.46)	9.04 (↑0.78)
	II	2959.86 (↓9.59)	15.97 (↓5.08)	18.19 (↓2.24)	0.69 (↓0.82)	8.87 (↓1.15)
	III	2790.29 (↓14.77)	15.93 (↓5.31)	17.85 (↓4.06)	0.68 (↓2.80)	9.46 (↑5.47)
	IV	3083.46 (↓5.82)	16.63 (↓1.16)	18.22 (↓2.11)	0.71 (↑1.10)	9.29 (↑3.58)
5	Control	3590.43	19.85	17.87	0.96	7.90
	I	3750.74 (↑4.46)	20.38 (↑2.68)	18.24 (↑2.09)	0.92 (↓4.41)	8.29 (↑4.99)
	II	3415.90 (↓4.86)	19.24 (↓3.08)	17.48 (↓2.18)	0.88 (↓8.83)	7.96 (↑0.73)
	III	3511.75 (↓2.19)	19.66 (↓0.97)	↓0.74	0.88 (↓8.68)	7.91 (↑0.16)
	IV	3710.00 (↑3.33)	20.74 (↑4.47)	18.01 (↑0.80)	1.02 (↑6.04)	7.82 (↓1.06)
		$lsd_{0.05}$ = 24.86	$lsd_{0.05}$ = 0.09	$lsd_{0.05}$ = 0.12	$lsd_{0.05}$ = 0.02	$lsd_{0.05}$ = 0.05

*% - the difference between control and treatment in percent; **1** - Crimson sweet, **2** - Fairfax, **3**- Greybelle, **4** - Mramorka, **5** – Dunay; **I** - Italpollina, **II** - DCM Ekomix, **III** – Guanitto, **IV** - Duetto*

In watermelon, the best results were recorded on plants fertilized with commercial fertilizer Italpollina. With the application of this fertilizer in 4 out of 5 genotypes were recorded higher yields (from 4.46 - Dunay to 18.33% - Greybelle) than in the control. The largest increase in fruit length was also recorded on plants fertilized with Italpollina. A higher decrease in the thickness of pericarp was observed in fruits harvested from plants of genotype Greybelle fertilized with

organic fertilizers, in relation to the control. This is an extremely good result, considering that one of the important tasks of every watermelon breeder is to create watermelon varieties with the thinnest possible fruit pericarp (Jiao et al., 2015).
The sugar content measured on the mesocarp of the fruit harvested from the plant which was fertilized with organic fertilizers was higher (especially with Italpollina), in all genotypes, compared to control. The largest increase in sugar content compared to the control was recorded in the genotype Crimson sweet (12.51%). For early-maturing genotypes, Fairfax and Greybelle, were recorded the highest overall positive effect of all four commercial organic fertilizers.
In melon genotypes, a smaller positive effect of the use of commercial organic fertilizers was recorded. The greatest positive effect of the application of organic fertilizers, compared to the control, was determined for Passport genotype (for all observed traits).

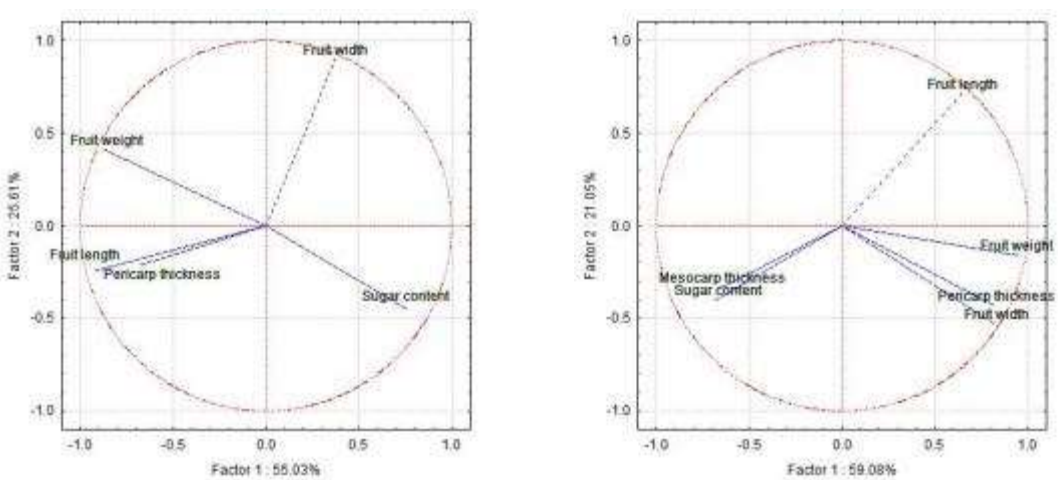
Table 2. Average values of six observed melon traits and comparison of effect of commercial organic fertilizers and mineral fertilizer NPK on these observed traits (%)

Genotype	Treatment	Fruit weight – g (%)	Fruit length – cm (%)	Fruit width – cm (%)	Pericarp thickness – cm (%)	Mesocarp thickness – cm (%)	Sugar content - ^{0}brix (%)
1	Control	1597.14	13.73	15.53	0.87	2.77	13.30
	I	1453.33 (↓9.00)	13.30 (↓3.12)	14.88 (↓4.21)	0.71 (↓18.24)	2.93 (↑5.54)	10.85 (↓18.42)
	II	1492.35 (↓6.56)	13.63 (↓0.72)	14.39 (↓7.31)	0.66 (↓24.73)	2.80 (↑1.03)	11.80 (↓11.28)
	III	1498.13 (↓6.20)	13.53 (↓1.48)	15.06 (↓3.03)	0.65 (↓25.41)	2.96 (↑6.74)	10.38 (↓21.99)
	IV	1426.00 (↓10.72)	13.66 (↓0.47)	14.11 (↓9.12)	0.72 (↓17.84)	2.88 (↑3.77)	10.53 (↓20.86)
2	Control	2381.88	19.61	16.95	1.04	2.58	6.50
	I	1995.40 (↓16.23)	18.56 (↓5.35)	16.18 (↓4.54)	1.03 (↓0.53)	2.62 (↑1.75)	7.47 (↑14.87)
	II	1773.38 (↓25.55)	17.26 (↓11.97)	15.88 (↓6.32)	1.06 (↑2.34)	2.33 (↓9.54)	8.60 (↑32.31)
	III	2166.21 (↓9.05)	19.01 (↓3.05)	16.31 (↓3.77)	0.97 (↓6.94)	2.83 (↑10.08)	8.55 (↑31.54)
	IV	2187.76 (↓8.15)	19.04 (↓2.91)	16.73 (↓1.30)	0.98 (↓5.39)	2.74 (↑6.39)	7.32 (↑12.62)
3	Control	1643.57	18.39	13.29	0.76	2.64	10.22
	I	1366.59 (↓16.85)	17.51 (↓4.74)	13.07 (↓1.60)	0.63 (↓16.55)	2.55 (↓3.34)	9.89 (↓3.23)
	II	1512.42 (↓7.98)	18.06 (↓1.78)	13.45 (↑1.25)	0.62 (↓18.62)	2.66 (↑0.82)	10.67 (↑4.40)
	III	1439.13 (↓12.44)	17.43 (↓5.20)	13.45 (↑1.25)	0.57 (↓24.77)	2.63 (↓0.47)	9.50 (↓7.05)
	IV	1380.83 (↓15.99)	17.53 (↓4.64)	13.04 (↓1.87)	0.65 (↓14.15)	2.66 (↑0.59)	9.21 (↓9.88)
4	Control	1250.00	17.20	12.48	0.44	2.87	9.70
	I	1299.67 (↑3.97)	17.59 (↑2.29)	12.63 (↑1.19)	0.39 (↓11.50)	2.81 (↓1.86)	9.25 (↓4.64)
	II	1441.96 (↑15.36)	18.63 (↑8.31)	13.01 (↑4.30)	0.47 (↑5.27)	2.76 (↓3.82)	9.21 (↓5.05)
	III	1375.16 (↑10.01)	17.93 (↑4.27)	12.71 (↑1.83)	0.44 (•0)	2.86 (↓0.15)	10.70 (↑10.31)
	IV	1517.07 (↑21.37)	17.24 (↑0.24)	13.32 (↑6.76)	0.44 (•0)	2.80 (↓2.45)	9.90 (↑2.06)
5	Control	1205.00	14.78	12.95	0.33	2.95	8.60
	I	1308.40 (↑8.58)	14.98 ()↑1.36	13.22 (↑2.05)	0.55 (↑69.85)	3.04 (↑3.19)	9.36 (↑8.84)
	II	1326.59 (↑10.09)	14.99 (↑1.46)	13.27 (↑2.46)	0.41 (↑27.27)	3.17 (↑7.40)	10.80 (↑25.58)
	III	1270.71 (↑5.45)	14.45 (↓2.18)	13.29 (↑2.59)	0.48 (↑47.99)	3.26 (↑10.41)	10.08 (↑17.21)
	IV	1389.44 (↑15.31)	15.27 (↑3.33)	13.72 (↑5.96)	1.04 (↑221.37)	3.07 (↑4.14)	8.88 ()↑3.29
		$lsd_{0.05}$ = 18.65	$lsd_{0.05}$ = 0.12	$lsd_{0.05}$ = 0.07	$lsd_{0.05}$ = 0.03	$lsd_{0.05}$ = 0.03	$lsd_{0.05}$ = 0.15

% - the difference between control and treatment in percent; ***1*** *- Fiata,* ***2*** *- Cerovača,* ***3*** *- Galia,* ***4*** *- Charentais,* ***5*** *- Passport;* ***I*** *- Italpollina,* ***II*** *- DCM Ekomix,* ***III*** *– Guanitto,* ***IV*** *- Duetto*

The positive effect of the application of commercial organic fertilizers, which was determined in this experiment, is in line with the results of Davis et al. (2007) where was determined a higher content of sugar and lycopene in watermelon fruit grown in an organic cultivation system in comparison to the conventional cultivation system. The positive effect of the application of the organic cultivation system was also found in watermelon and melon (Curuk et al., 2004), pepper (Berova and Karanatsidis, 2008), and potatoes (El-Sayed et al., 2015). Although many studies and practices have shown that due to limited inputs in the organic cultivation system, the quality of vegetable fruits is lower than those harvested in conventional production, this is not always the rule.

In order to determine the relationship between the observed traits, the obtained results were analyzed using principal component analysis. Based on this analysis, it was found that PC1 explains 59.08% of the total variability of the observed traits in melon, and 55.03% in watermelon, while PC2 explains 21.05% of the total variability in watermelon and 25.61% in melon. In watermelon fruit weight, fruit length, and sugar content explain the most PC1 variability, while fruit width explains the most PC2 variability. In melon, fruit weight, fruit width, and pericarp thickness explain the most variability of PC1, while the most PC2 variability explains trait fruit length. Based on the results shown in Graph 1a, we can conclude that the sugar content and fruit weight in watermelon are negatively correlated, while the fruit length and the pericarp thickness are in a high positive correlation. In melon, fruit length is significantly negatively correlated with mesocarp thickness and sugar content, which are mutually positively correlated (Graph 1b).



Graph 1– Projection of the traits based on eigenvalues of PC1 and PC2 (a – watermelon; b – melon)

Conclusion

The usage of commercial organic fertilizers can positively impact the quality of fruit traits in melons and watermelons. On watermelon genotypes, Fairfax and Greybelle, and on melon genotypes, Charentais and Passport, all four commercial organic fertilizers had the best positive effect and these genotypes can be recommended for inclusion in organic farming systems. Italpollina had the greatest positive effect on observed fruit quality traits in watermelon, in all five genotypes. In the organic cultivation system, the size of the fruit in watermelon is negatively correlated with the sugar content in the mesocarp of the fruit. In melons, mesocarp thickness and sugar content are positively correlated. These results are important when the breeder makes breeding plans and in a process of creating new varieties of watermelon and melon intended for the organic cultivation system.

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