THE EFFECT OF SUBSTRATE TYPE ON THE QUALITY OF WATERMELON SEEDLINGS

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Abstract
Watermelon is one of the leading vegetable crops grown in R. Macedonia. It is regularly produced by seedlings and very seldom by seed. The objective of the research was to determine the influence of growing substrate type on the quality of watermelon seedlings, variety Fantasy F_1. Three different substrates were tested as follows: homemade substrate mixture of organic cattle manure and soil in ratio 1:1 (Reference treatment), commercial Brill substrate with Trichoderma (Treatment 1) and mixture of homemade substrate and Brill substrate with Trichoderma in ratio 1:1 (Treatment 2). According to research methodology several biometrical parameters were measured in order to determine quality of the watermelon seedlings as follows: seedling length (cm), mass of the aerial seedling part (g), stem thickness (mm), leaves number, leaves mass (g), root length (cm) and root mass (g). The seedlings were measured 18 days after sprouting. The results showed that seedlings grown in Brill substrate with Trichoderma had the best parameters for mass of the aerial seedling part (5.10cm), stem thickness (3.30mm), leaves number (6.27), leaves mass (9.04g), root length (17.17cm) and root length (13.95g). Only seedlings from treatment 2 were longer (16.23cm) in comparison to the Reference treatment (14.6cm) and Treatment 1 (14.73cm).

Keywords: hybrid, growing medium, biometrical parameters.

Introduction

Watermelon and melon are one of the widely grown vegetables in R. Macedonia. According to State Statistical Office of the Republic of Macedonia (2016) watermelon and melon are grown on 5509 ha with total production of 131039 t and average yield of 23786 kg^{-ha}. Watermelon is grown either with direct sowing or more commonly with seedling production. Major factors that influence the quality of seedling production are: high quality and healthy seeds with good biological values (high germination rate and germination energy), optimal microclimate conditions (heat, light, humidity), optimal space between plants, rich growing (soil, soil mixes, organic and inorganic substrates), timely irrigation, proper nutrition with macro and micro elements and adequate plant protection (Bogevska, 2008). According to Yaping and Diankui (2005) the best maturity stage for watermelon seedling is between 20 and 25 days, when they are grown in a plug cell size of 78.4 cm^3 - 82.9 cm^3. Same authors recommend that ultimately a seedling maturity of 30 days with a cell size of 131.6 cm^3 can be acceptable. More often watermelon is produced by grafted seedlings. It is very important to choose the right rootstock as it influences on the plant growth as well as yield and quality of scion fruit, suggesting an important consideration in the potential use of grafting applications in watermelon (Yetisir and Sari, 2003). When seedlings are not grafted the choice of growing substrate is crucial. It includes its composition and irrigation water quality (Silva et al., 2015). That was the thesis of this research - to determine the quality of watermelon seedlings grown on different substrates.

Material and methods

For this trial the watermelon hybrid Fantasy F_1 was chosen. It is a very attractive hybrid of Allsweet type. This variety produces uniform, elongated fruit weighing 10 to 12 kg. The rind has dark green

stripes on a medium-green background. Its flesh is bright red and very sweet. The seedlings were sown in trays containing three different substrates as follows:

- Homemade substrate mixture of organic cattle manure and soil in ratio 1:1 (Reference treatment),
- Commercial brill substrate with Trichoderma (Treatment 1) and
- Mixture of homemade and brill substrate with Trichoderma in ratio 1:1 (Treatment 2).

Chemical composition of the organic cattle manure is: 18.74% $CaCO_3$, total nitrogen 0.246% phosphorous 76.20 mg/100 g, potassium 80.10 mg/100g, humus 3.17 % and pH-7.99. The composition of the commercial brill substrate with Trichoderma is as follows: 80% white peat, 20% frozen black peat, 500g NPK fertilizer (14+10+18)/m^3, 500g MikroTR/m^3, 100g trace elements/m^3, 100ml wetting agent/m^3, pH-value ($CaCl_2$): 5.7 with fine structure (0-10mm). The chemical properties content of the commercial substrate is: nitrogen (N) 70 mg/L, phosphorus (P_2O_5) 50 mg/l, potassium (K_2O) 90mg/L and salt content approximately 0.5g/L. Sowing date for all treatments was March 20th 2017. The plants sprouted after seven days. During the seedling production standard technology was applied. Just before transplanting, several biometrical parameters were measured in order to determine the quality of the watermelon seedlings as follows: seedling length (cm), mass of the aerial seedling part (cm), stem thickness (mm), leaves number, leaves mass (g), root length (cm) and root mass (g). The stem thickness was measured with caliper tool, the aerial seedling part, the leaves root mass were measured with digital balance. The seedling and root length were measured with a ruler. The seedlings were measured 18 days after sprouting. For each treatment 30 plants were recorded. Recorded measurement were statistically processed according to the method of Analysis of Variance and tested with LSD test at the level 0.05 and 0.01.

Results and discussion

According to the results the seedling grown in mixture of homemade substrate and brill substrate with Trichoderma in ratio 1:1 resulted in longest seedlings (16.23cm) which was statistically significant at probability level of 0.01 in comparison to the seedlings from Reference treatment that were 14.60cm long in average (Table 1). The seedlings grown in mixture of homemade substrate and Brill substrate with Trichoderma in ratio 1:1 showed significant statistical difference in length of 1.63cm at a level of 0.01 compared to the length of the seedlings from commercial Brill substrate with Trichoderma (Treatment 1) with seedlings of 14.73cm length in average. The most heterogeneous measurements about this trait were observed in the homemade substrate (Reference treatment) with coefficient of variation 4.62.

Table 1. Seedling length (cm)

Treatment	Arithmetic Mean	Standard Deviation	Standard error of the mean	Coefficient of Variation
Reference	14.60	0.67	0.12	4.62
Treatment 1	14.73	0.45	0.08	3.05
Treatment 2	16.23	0.57	0.10	3.50
Comparison between treatments				
Reference	14.60	-0.13	-1.63	
Treatment 1	0.13	14.73	- 1.5	
Treatment 2	1.63 [ab]	1.50 [ab]	16.23	
	Reference	Treatment 1	Treatment 2	

LSD 0.01 = 0.66[a] LSD 0.05 = 0.40[b]

Table 2. Aerial seedling mass (g)

Treatment	Arithmetic Mean	Standard Deviation	Standard error of the mean	Coefficient of Variation
Reference	4.13	0.26	0.05	6.24
Treatment 1	5.10	0.27	0.05	5.21
Treatment 2	3.72	0.19	0.03	5.02
Comparison between treatments				
Reference	4.13	-0.97	0.41 [ab]	
Treatment 1	0.97 [ab]	5.10	1.38 [ab]	
Treatment 2	-0.41	-1.38	3.72	
	Reference	Treatment 1	Treatment 2	

LSD 0.01 = 0.33[a] LSD 0.05 = 0.20 [b]

Seedlings with highest mass (5.10g) of the aerial part were recorded in commercial Brill substrate with Trichoderma, as presented in Table 2. The lowest aerial seedling mass of 3.72g was observed in the seedlings grown mixture of homemade substrate and Brill substrate with Trichoderma in ratio 1:1 (Treatment 2). The seedlings from both treatments had statistically higher aerial mass at a level of 0.01 compared to the aerial seedling mass from the reference treatment. The aerial seedling mass from Treatment 1 (commercial Brill substrate with Trichoderma) showed significant statistical difference at a level of 0.01 compared to the one from Treatment 2 (mixture of homemade substrate and Brill substrate with Trichoderma in ratio 1:1). The least uniform seedlings regarding the seedling mass had the homemade substrate (Reference treatment) with the coefficient of variation 6.24%. The highest value for stem thickness (3.30mm) was observed in the seedlings grown commercial Brill substrate with Trichoderma (Treatment 1) while the lowest one (3.03mm) was recorded in seedlings grown in homemade substrate and Brill substrate with Trichoderma in ratio 1:1 (Treatment 2), as presented in Table 5. According to the research of Kokalis-Burelle et al. (2003) thickness of the watermelon stem varied from 3.6 to 4.6 mm which was little bit higher in comparison to our findings. The thickness of stem from commercial Brill substrate with Trichoderma showed significant statistical difference at a level of 0.05 compared to the Reference treatment. The stem thickness of seedlings grown in the commercial Brill substrate with Trichoderma was significantly larger at a probability level of 0.01 compared to the thickness of stem from mixture of homemade substrate and Brill substrate with Trichoderma in ratio 1:1 (Treatment 2). The most homogenous stem thickness was observed in the seedlings grown on mixture of homemade substrate and Brill substrate with Trichoderma in ratio 1:1 with coefficient of variation 6.02.

Table 3. Stem thickness (mm)

Treatment	Arithmetic Mean	Standard Deviation	Standard error of the mean	Coefficient of Variation
Reference	3.13	0.35	0.06	11.03
Treatment 1	3.30	0.47	0.09	14.12
Treatment 2	3.03	0.18	0.03	6.02
Comparison between treatments				
Reference	**3.13**	-0.17	0.1	
Treatment 1	0.17 [b]	**3.30**	0.27 [ab]	
Treatment 2	-0.1	-0.27	**3.03**	
	Reference	Treatment 1	Treatment 2	

LSD 0.01 = 0.25[a] LSD 0.05 = 0.15[b]

According to the biometric parameter number of leaves the highest value of 6.27 in average had the seedling grown on commercial Brill substrate with Trichoderma (Treatment 1) followed by the seedlings grown on mixture of homemade substrate and Brill substrate with Trichoderma in ratio 1:1 (Treatment 2) that had 6,23leaves in average and the lowest number of leaves (6.0) was recorded in the Reference treatment as presented in Table 4. There was statistical difference at a level of 0.05 compared with the Reference treatment in number of leaves from commercial Brill substrate with Trichoderma and mixture of homemade substrate and Brill substrate with Trichoderma in ratio 1:1. There are no statistical differences between Treatments 1 and 2 (Table 4). The number of leaves was the same in all measured seedling grown on homemade substrate Reference treatment which can be concluded form calculated standard deviation and coefficient of variation. The average values for the leaves mass per seedling are given in table 5. The highest leaves mass of 9.04g was recorded for the seedlings grown in commercial Brill substrate with Trichoderma (Treatment 1) with a significant statistical difference at a level of 0.01 compared with the mixture of homemade substrate and Brill substrate with Trichoderma in ratio 1:1 (Treatment 2) and the Reference treatment. The most heterogeneous seedlings in regards to leaves mass were observed in homemade substrate with 7.47 coefficient of variation.

Table 4. Number of leaves per seedling

Treatment	Arithmetic Mean	Standard Deviation	Standard error of the mean	Coefficient of Variation
Reference	6.00	0.00	0.00	0.00
Treatment 1	6.27	0.45	0.08	7.18
Treatment 2	6.23	0.43	0.08	6.90
Comparison between treatments				
Reference	**6.00**	-0.27	-0.23	
Treatment 1	0.27 [b]	**6.27**	0.04	
Treatment 2	0.23 [b]	-0.04	**6.23**	
	Reference	Treatment 1	Treatment 2	

LSD 0.01 = 0.31[a] LSD 0.05 = 0.19[b]

Table 5. Leaves mass (g)

Treatment	Arithmetic Mean	Standard Deviation	Standard error of the mean	Coefficient of Variation
Reference	4.73	0.35	0.06	7.47
Treatment 1	9.04	0.18	0.03	2.01
Treatment 2	7.13	0.31	0.06	4.28
Comparison between treatments				
Reference	**4.73**	-4.31	-2.4	
Treatment 1	4.31 [ab]	**9.04**	1.91 [ab]	
Treatment 2	2.40 [ab]	-1.91	**7.13**	
	Reference	Treatment 1	Treatment 2	

LSD 0.01 = 0.29[a] LSD 0.05 = 0.18[b]

The root length of 17.17cm was largest in the seedlings grown in commercial Brill substrate with Trichoderma followed by the mixture of homemade substrate and Brill substrate with Trichoderma with seedlings root length of 15.97cm in average and 15.23cm for the ones grown in homemade substrate. As presented in Table 6 the roots length in mixture of homemade substrate and Brill substrate with Trichoderma in ratio 1:1 (Treatment 2) was significantly larger at statistical a level of

0.05 compared to the ones grown in homemade substrate. The seedlings grown in commercial Brill substrate with Trichoderma (Treatment 1) had better developed roots at a level of 0.01 compared to the ones in Reference substrate. A difference with same statistical significance was observed between both Treatment 1 and 2. The highest value of variation of 5.74 for root length was calculated for the seedlings grown on commercial Brill substrate with Trichoderma.

Table 6. Root length (cm)

Treatment	Arithmetic Mean	Standard Deviation	Standard error of the mean	Coefficient of Variation
Reference	15.23	0.43	0.08	2.82
Treatment 1	17.17	0.99	0.18	5.74
Treatment 2	15.97	0.89	0.16	5.57
Comparison between treatments				
Reference	15.23	-1.94	-0.74	
Treatment 1	1.94 [ab]	17.17	1.20 [ab]	
Treatment 2	0.74 [b]	-1.20	15.97	
	Reference	Treatment 1	Treatment 2	

LSD 0.01 = 0.98[a] LSD 0.05 = 0.59[b]

Average values for the root mass per seedling and comparison between treatments are given in Table 7. The highest root mass of 13.95g in average was measured in the seedlings grown in commercial Brill substrate with Trichoderma (Treatment 1) while lowest one of 8.84g in average was recorded in the seedlings grown in the Reference substrate. There is a significant statistical difference at a level of 0.01 between and among the both Treatments 1 and 2, compared to the Reference substrate, as presented in Table 7. The most heterogeneous seedlings in regards to root mass with coefficient of variation 8.54 were the ones grown in homemade substrate, the Reference treatment.

Table 7. Root mass (g)

Treatment	Arithmetic Mean	Standard Deviation	Standard error of the mean	Coefficient of Variation
Reference	8.84	0.76	0.14	8.54
Treatment 1	13.95	0.17	0.03	1.19
Treatment 2	10.59	0.49	0.09	4.62
Comparison between treatments				
Reference	8.84	-5.11	-1.75	
Treatment 1	5.11[ab]	13.95	3.36 [ab]	
Treatment 2	1.75 [ab]	-3.36	10.59	
	Reference	Treatment 1	Treatment 2	

LSD 0.01 = 0.86[a] LSD 0.05 = 0.52[b]

Similar results were gained by Balicevic et al. (2008) in tomato seedling planted with two substrates: specialized substrate for production of seedlings by German manufacturer Gebr. Brill Substrate GmbH & Co (substrate I), and randomly taken mixture of garden mould (substrate II). Tomato plants planted in substrate I Brill substrate had better state of health and higher plant number if compared to the seedlings planted in substrate II.

Conclusions

According to the results obtained from a field trial with watermelon seedlings grown on different substrates it can be concluded that the best quality of seedlings can be achieved by growing watermelon seedlings on commercial Brill substrate mixed with Trichoderma (Treatment 1).

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