USING DIFFERENT POTASSIUM AND MAGNESIUM TREATMENTS IN WATERMELON PRODUCTION

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ABSTRACT
Since watermelon yield and quality are so greatly influenced by production practices, it is important that watermelon varieties be tested under adequate nutrition conditions. This study was conducted in 2009 and 2011 in county Békés. Watermelon cultivar ***Crisby*** was used in both year, furthermore in 2009 besides the non-grafted plants we used 2 grafted combinations, with the following rootstocks: ***Strongtosa*** (interspecific squash hybrid) and ***Nun 3001*** *(Lagenaria* type). Plants were grown under low tunnel conditions with intensive technology (soil covering, dripp-irragtion). 4 fertilization treatments were used with different potassium dose. In every treatment half of the plants got foliar magnesium fertilizer (EpsoMicrotop), applied in concentration of 5%. The measurement of the yield and fruit weight (kg, average mass) were carried out in the field, while the fruit quality analyses (dry matter content, soluble solid content (Brix%), sugar content) were taken place in laboratory. In 2009 our results showed that interspecific rootstock gave higher yield and with higher potassium dozen the fruit quality won't be decreased. In 2011 the yield and TSS content was parallel with the increasing potassium doses. In both year the effect of the magnesium foliar fertilizer was more remarkable by lower potassium doses.

Keywords: Watermelon, potassium, grafted watermelon, yield, magnesium, foliar fertilizer

INTRODUCTION

The watermelon is an important crop for growers in Hungary. It has the third biggest vegetable production area (cc. 6000 hectares) and a significant amount of the produced crop is exported.

Watermelon requires a certain amounts of nitrogen, phosphorous and potassium also. The nitrogen is essential for plant development and boosts both plant growth and crop yield. Adequate K nutrition has been associated with increased yields, fruit size, increased soluble solids and ascorbic acid concentrations, improved fruit colour, increased shelf life, and shipping quality of many horticultural crops. In order to obtain high yield and good quality of watermelon, there is need to augment the nutrient status of the soil to meet the crop's need and thereby maintaining the fertility of the soil (NAGY, 2005).

Many changes have occurred in watermelon production practices in the last few years, including new cultural systems such as polyethylene mulch and drip irrigation changes in cultivars and using grafted plants. Seed companies are currently experimenting with grafted plants under Hungarian conditions.

The fact that certain rootstocks show stronger resistance to soil pathogens, greater tolerance of low soil temperatures, as well as of salt stress has been well documented in the past (DAVIS ET AL., 2008; HOYOS, 2001; ODA, 2007). Thus, the selection of rootstocks is rarely based on characteristics related to nutrient uptake, but rather almost always on resistance to environmental stress (RUIZ ET AL., 1997). Knowledge of the rootstock/scion nutritional relationship could be decisive in choosing rootstocks tolerant or resistant to soils that are deficient or toxic in one or more nutrients, as well as in preparing fertilization programmes after the grafted plant is transplanted (CHAPLIN AND WESTWOOD, 1980). Some researcher reported that quality (Brix, firmness, rind thickness etc.) of watermelon was greatly affected by wich rootstock was used, but it can also be influenced by the nutrient dosage (GAO AND LIAO, 2006; LEE AND ODA, 2003; MASUDA ET AL., 1986; YAMASAKI ET AL., 1994). Since watermelon yield and quality are so greatly influenced by production practices, it is important that watermelon varieties be tested under adequate nutrition conditions.

MATERIAL AND METHOD

Plant material and culture conditions

In both experimental year (2009 and 2011) the used cultivar was: ***Crisby*** (seed source: Nunhems) In 2009 besides the non-grafted plants we used 2 grafted combinations with the following rootstocks: *Cucurbita maxima* x *Cucurbita moschata* interspecific (squash) hybrid: *Strongtosa* (seed source: Syngenta), and a *Lagenaria* type (bottle gourd): *Nun 3001* (seed source: Nunhems).

In 2009 the experiment was carried out in Békés county in Dombegyház, while in 2011 the experiment was set up in Kunágota. In both area the soil type is chernozem. Before planting soil analysis was carried out. The results showed that both area are very good provided in potassium and magnesium. Carbonate and mold content were also very high. The experiment was conducted in growers' farm using intensive technology (drip irrigation, plastic soil cover, low plastic tunnel covering). In 2009 plants were transplanted to the field on 100 cm spacing within the row and 320 cm between rows (3125 per ha). This arrangement is adequate for grafted plants, but for non-grafted plants the proposed plant density is 7000 per hectare or more. In spite of this we had to use equal spacing because of the arrangement of the irrigation system. The experiment was set up with 448 plant in total. In 2011 non-grafted plants were used only with a spacing 60 cm within the row and 170 cm between the rows (9804 plant/ha). In this year 1800 plants were planted.

Both year the planting was took place on 15th April.

In 2009, when grafted plants were also studied the applied fertilizer dose was calculated on the basis on average yield 90 t $ha^{-1.}$ In 2011, when the experiment included non-grafted plants only it was calculated on average yield 50 t ha^{-1}.On the score of potassium there were 4 different treatment and a control treatment. In **2009** the control treatment did not contain fertilizers at all. The following fertilizer doses were applied in the 4 treatment: N:145 kg ha^{-1}, P_2O_5: 65 kg ha^{-1} by all treatments, K_2O: **1. treatment** 0 kg ha^{-1}, **2. treatment** 160 kg ha^{-1}, **3. treatment:** 325 kg ha^{-1}, **4. treatment:** 485 kg ha^{-1}.

In **2011** the growers fertigation tecnology (N: 90 kg ha^{-1}, P_2O_5: 28 kg ha^{-1}, K_2O: 50 kg ha^{-1}) was used as a control to avoid yield loss. The fertilizer doses in the 4 treatment were: N:80 kg ha^{-1}, P_2O_5: 36 kg ha^{-1} by all treatments, K_2O: **1. treatment:** 0 kg ha^{-1}, **2. treatment:** 90 kg ha^{-1}, **3. treatment:**180 kg ha^{-1}, **4. treatment:** 270 kg ha^{-1}.

One treatment was one row because of the build up of the irrigation system. The drip lines for each row were equipped with a valve at the header line. This allowed water/fertilizer to be directed to selected rows during application.

The total amount of the active substances were given divided in different development phase (radication, intensive growth, first female flowers, small melons, ½ size crops).

In every treatment half of the plants got foliar magnesium fertilizer (EpsoMicrotop 15% MgO12%+S12%+B1%+Mn1%). These fertilizer mixtures were diluted with water and applied 5% concentration. In 2009 the number of the application varied with the treatments. The 1st treatment were sprayed 4 times (15kg ha^{-1}), the 2nd treatment 3 times

(11.25 kg ha^{-1}), the 3rd treatment 2 times (7.5 kg ha^{-1} and the 4th treatment 1time (3.75 kg ha^{-1}). In 2011 plant were treated with foliar fertilizer three times in each treatment (MgO 11.25 kg ha^{-1}), started with initial fruit set. All foliar applications were made with a backpack sprayer and hand boom equipped with flat fan nozzles.
Fungicides and insecticides were applied separately, but in a similar manner as needed throughout the season. For evaluation the treatments we collected the fruits in every row in four replication.

Measurements:
The measurement of the yield and fruit weight (kg, average mass) was carried out in the field, while the fruit quality analyses were taken place in laboratory. These contained the following measurements: (1) dry matter (%) (husk+fruitflesh and just fruitflesh), (2) soluble solid content (Brix%) (fruitflesh), (3) sugar content (%) (fruitflesh): a) total sugar content (%), b) glucose+fruktose content (%), c) sucrose content (%)

Table 1. The effect of K doses and EpsoMicrotop foliar fertilization on the yield of watermelon in 2009

Treatment (K_2O kg ha-1)	Yield (kg m^{-2})			Increase (%)			The effect from EpsoMicrotop on the yield on the given K_2O doses (%)		
	non-grafted	Crisby/ Strongtosa	Crisby/ Nun 3001	non-grafted	Crisby/ Strongtosa	Crisby/ Nun 3001	non-grafted	Crisby/ Strongtosa	Crisby/ Nun3001
Controll	2.25	2.3	2.25	100	100	100			
1. (0)	2.7	7.40	7.32	120	329	325			
2. (160)	4.12	7.36	6.78	183	327	301			
3. (325)	2.6	8.45	7.18	116	376	319			
4. (485)	3.16	9.28	9.37	140	412	416			
1.(0)+ EpsoMicrotop	2.48	8.93	7.83	100	100	100	92	121	107
2. (160)+ EpsoMicrotop	3.47	8.24	6.33	140	92	81	84	112	93
3. (325)+ EpsoMicrotop	2.31	8.46	7.42	93	95	95	89	100	103
4. (485)+ EpsoMicrotop	3.26	9.24	9.37	131	103	120	103	100	100

RESULTS

Quantitative parameters
In 2009 fruit were obtained from multiple harvests, started with the non-grafted plants in the second half of June. Last harvest date was on 15th July. From the grafted plants we could harvest longer than from the non-grafted ones (*Table 1*). In 2011 the harvest was begun in mid-June and continued until early August. The harvested fruit were numbered and measured in the field and some fruit were transported to the University's laboratory for qualitative analysis.
In 2009 the grafted and the non-grafted plants were planted with equal spacing because of the arrangement of the irrigation system. It follows that some parameters are not comparable among grafted and non-grafted plants.
The very big difference in the yield of grafted and non-grafted plants was due to plant density only favourable to grafted plants. The yield showed positive correlation with the potassium dose by grafted '*Crisby*' on the rootstock *Strongtosa*. The foliar fertilization has

higher effect by lower potassium dose. In total yield the interspecific squash rootstock produced a higher yield.
Connection between the yield and the treatments could not be found by grafted '*Crisby*' on rootstock *Nun 3001*. Tough he foliar fertilization gave significant higher yield by the highest potassium dose.
In 2011 the highest yield was obtained from the higher potassium dose (180 and 270 kg K_2O ha^{-1}). The applied doses gave significant differences compared to the control (the grower's technology), the enhanced dose increased the yield with 18% and 20% (*Table 2.*). Magnesium, given as a foliar fertilizer, had similar effect on the yield. The last column from *Table 2.* shows the effect from EpsoMicrotop, The effect was more remarkable by lower potassium doses. It is notable that by 0 kg K_2O ha^{-1} the increase was 15%.
Evaulate the resultes from fruit weight we found the same resultes, the only difference was that by 270 kg K_2O ha^{-1} dosen the fruit size decreased but not significantly.

Table 2. The effect of K doses and EpsoMicrotop foliar fertilization on the yield of watermelon in 2011

Treatment (K_2O kg ha^{-1})	Yield (kg m^{-2})	Increase (%)	+ EpsoMicrotop yield kg m^{-2}	Increase (%)	The effect from EpsoMicrotop on the yield on the given K_2O doses (%)
Controll (50)	5.45	100	5.68	100	104.2
1. (0)	4.21	77	4.84	85	115
2. (90)	5.83	107	6.02	106	103
3. (180)	6.42	118	6.48	114	100.9
4. (270)	6.57	120.5	6.65	117	101.2

Qualitative parameters

For determination of total soluble solids (TSS) digital refractometer were used.
Lower fruit quality issues reported for watermelon due to grafting, include reduced solible solids content, insipid taste, poor texture (TRAKA-MAVRONA ET AL., 2000) Our results were parallel, in the non-grafted fruits higher solible solid content were measured. TSS ranged between 10,6 and 12,5 Brix%.
Using the two different rootstock type, significant difference were observed. The mature fruit from the *Crisby/Nun3001* combination had significantly lower soluble solid contents compared to that from *Crisby/Strongotsa* seedlings. The higher potassium dose resulted higher TSS content, and EpsoMicrotop treatments improved it even more.
In 2011 measuring the total soluble solids (TSS) in the fruits, significant correlations were found between the values and the applied fertigation. The values increased parallel with the increasing doses of potassium. The effect from EpsoMicrotop was remarkable by 0 kg K_2O ha^{-1}.
The total sugar content (%) and the different sugar fractions were measured from the fruitflesh. Glucose, fruktose and sucrose content was dissociated.
Concerning non-grafted watermelon the sugar content showed correlation with the potassium dose in both years. In case of the two types of rootstock the results were similar to the total soluble solid content. The *Lagenaria* rootstock resulted lower sugar content compared to interspecific squash rootstock and non-grafted plants. But higher potassium dose increased the sugar content significantly (from 3.7% to 6.9%) by enhancing the sucrose content (from 0.2% to 4.3%). The foliar fertilization revised the sugar content even more in all treatments, both years.

CONCLUSIONS

In the first experiment (2009) grafted plants were also studied besides non-grafted *Crisby*. Both rootstock-scion combination resulted higher yield compared to non-grafted plants. The effect of potassium was more conspicuous by the interspecific squash rootstock (*Strongtosa*). By grafted plants the foliar fertilization with magnesium has also good effect on the yield. In 2009 regarding the non-grafted *Crisby* the lower potassium dose (treatment 2) resulted the highest yield, while in 2011 the yield was parallel with the potassium dose. The highest potassium dose enhanced the yield by 20% compared to control (grower's technology).

EpsoMicrotop as a magnesium foliar fertilizer showed also positive results, especially by reduced potassium dose.

Sugar content appears to be one of the most important characteristics of a good-quality watermelon, based on the fruit quality indices routinely measured by scientists. Some previous research has generally shown that grafting has negative effect on TSS content in watermelon fruit when grafting watermelon onto *C. maxima* x *C.moschata*, or *L. siceraria* rootstocks (IOANNOU ET AL., 2002). In our experiment we got similar results, but with higher potassium dose we could reduce the decrease. Regarding the non-grafted plants the increased potassium dose resulted higher sugar content in both years. The magnesium revised the sugar content of the fruits in every treatment, especially besides lower potassium dose.

Considering the opportunities for grower's, among the many plant mineral nutrients, potassium and magnesium stands out as a cautions having very strong influence on quality attributes that determine fruit marketability.

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