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VARIATION IN MORPHOLOGICAL AND CHEMICAL TRAITS IN RED AND YELLOW MINI WATERMELON

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Abstract

Watermelon is an annual vegetable crop from *Cucurbitaceae* family. Five mini watermelon cultivars (red-fleshed 'Faerie' F1, 'Golden crown' F1, 'Bonanza' F1 and yellow-fleshed 'Sureness' F1, 'Yellow baby' F1) were grown in open field experiment from May to July 2018. Plants were grown on a fertile soil, covered with black mulch film, on a distance 75x120 cm. During vegetation period regular agricultural practices were applied (fertirrigation, weeding and preventive protection against diseases and pests). Fruits were harvested after 60 days from planting. The aim of this study was to examine morphological traits of five cultivars in full physiological maturity. Fruit weight ranged between 1.57-2.65 kg with the highest value in cultivar 'Sureness'. Number of fruits ranged from 20 ('Yellow baby', 'Sureness') to 35 ('Faerie'). Rind thickness ranged between 5.22-11.91 mm with the highest value in 'Yellow baby'. Total soluble solids ranged from 9.5-10.95 °Brix and randman between 37-49%. Among all cultivars, red-fleshed 'Bonanza' showed the highest randman and total soluble solids (49% and 10.95 °Brix, respectively). Opposite to that, the lowest total soluble solids showed yellow-fleshed cultivars 'Sureness' and 'Yellow baby'. Generally, yellow cultivars showed higher fruit weight and rind thickness, whereas red cultivars showed higher number of fruits per plant, total soluble solids and randman. The present study outlines that 'Bonanza' and 'Faerie' showed the highest quality (soluble solids content) among tested varieties.

Keywords: *Watermelon, Fruit weight, Rind thickness, Randman, Total soluble solids.*

Introduction

Watermelon is an annual vegetable crop from *Cucurbitaceae* family. Nutrition quality of watermelon fruits originate from lycopene, flavonoids, phenolics, vitamin C, citrulline and fibers. According to FAO (2017) total production in European Union was 3.216.037 t with the highest production in Spain (1.112.192 t), Greece (647.000 t) and Italy (570.762 t).

Watermelon production depends on genotype selection, environmental conditions, growing practices and consumer habits. Breeding programs allowed accomplishing different market demands for fruit size, shape and colour, flesh colour, rind thickness and taste. Fruit size of 4-6 kg, round or oval fruits, the maximum rind thickness 1.5 cm, high randman and total soluble solids 8-10% (Gvozdanovic-Varga et al., 2011). Guner and Wehner (2003) reported the existence of genes responsible for flesh colour (red, orange, white and yellow). The same authors emphasized importance of rind colour in breeding programs. Rind thickness is a quantitative trait (Sharma and Choudhury, 1988) with preference in thick rind and higher randman. Total soluble solids can describe sweetness degree and level of ripening (Sabeetha et al., 2017). Watermelon studies confirmed positive correlation between total soluble solid and sugar content (Soteriou et al., 2014).

New type of watermelons with reduced fruit size, mini watermelon, came to market in 2003 with round fruit shape, thin rind and average fruit weight 1.5-4 kg (Gusmini and Wehner,

2007). Mini watermelons are *characterized* as sweet, crisp, juicy, seed or seedless, from pink to red flesh colour. According to Magda (2016) they have more lycopene and beta-carotene (6.700-9.600 µg per 100 grams) compared to large watermelons (3.700-6.900 µg per 100 grams).

The objective of this study was to investigate five different mini watermelon cultivars, their morphological and chemical properties in conventional agriculture practice.

Material and Methods

Five mini watermelon cultivars were examined ('Faerie' F1, 'Golden crown' F1, 'Sureness' F1, 'Yellow baby' F1- Known-You Seed Co., Ltd and 'Bonanza' F1- Syngenta). 'Faerie' has a globe shaped fruit, average size 3 kg with light yellow rind and pinkish flesh. 'Golden crown' is an early watermelon, average size 2.5 kg, oblong, icebox-sized with golden yellow rind and red flesh. 'Bonanza' has a round fruit, average weight 1.5-3 kg, with thick light green rind and red flesh. 'Sureness' has oval fruit with green rind and yellow flesh, sized 4-5 kg. 'Yellow baby' has a globe shaped fruits, sized 3.5-4.5 kg with thin dark green rind and bright yellow flesh. An open field experiment was conducted during April-July 2018 at the company Iceberg Salat Centar, Surcin, Serbia. Before experiment chemical analysis of the soil showed sufficient levels of major nutrients and humus (nitrogen-0.18 %; phosphorus-66.6 mg/100g; potassium-27.2 mg/100g and humus-2.9 %).

Watermelon seedlings were grown in a peat cubes, size 6 cm, from the substrate Potgrond H (Klasmann-Deilmann) in a controlled glasshouse conditions. Seedlings were sown on April 28 and their production lasted for 30 days. Watermelon plants were transplanted on May 29, in a black marsh soil, covered with black mulch film. During growing cycle regular cultivation practices were carried out (fertirrigation, protection against diseases and pests, weeding). Soluble commercial fertilizers were applied with drip irrigation system, 7 times, during growing cycle. During vegetation period air temperature, air relative humidity and precipitation were collected from meteo station in Surcin. Average air temperature, air relative humidity and total precipitation are presented in Table 1.

Table 1. Climate conditions during watermelon growing cycle

	Average temperature (°C)	Average humidity (%)	Minimum temperature (°C)	Maximum temperature (°C)	Total precipitation (mm)
April 2018	16.6	63.1	5.0	29.0	14.4
May 2018	19.9	64.4	10.1	30.3	13.4
June 2018	21.4	71.9	10.2	34.5	57.8
July 2018	21.9	73.5	10.7	31.1	138.3

The experiment was organized in a complete block design. Each plot consisted of 13 plants and distance was 75x120 cm. Fruits were harvested 60 days after planting, at full physiological maturity. For morphological and chemical analysis, we used 5 plants. All morphological traits were measured using scale, digital caliper and ruler. Total soluble solids were measured using refractometer (Brix/Specific Gravity Refractometer w/ATC, Vee Gee Scientific, USA) and results are presented in degrees Brix (°Brix).

Statistical analysis was performed using DSAA STAT (2011) and Microsoft Office Excel 2007. One-way ANOVA was used to examine the effect of genotype with LSD test for comparison. All tests were performed at a significance level α of 0.05.

Results and Discussion

Fruit weight, rind thickness, randman and total soluble solids were statistically affected by genotype.

Table 2. Different watermelon parameters affected by genotype

Cultivar	Fruit weight (kg)	Rind thickness (mm)	Randman (%)	Total soluble solids (°Brix)
Faerie	1.62	5.22	49	10.95
Bonanza	2.12	7.56	49	10.95
Golden crown	1.57	11.00	37	10.50
Sureness	2.65	10.67	47	9.50
Yellow baby	2.25	11.91	46	10.15
Min	1.57	5.22	37	9.50
Max	2.65	11.91	49	10.95
Average	2.04	9.27	46	10.41
CV (%)	13.59	15.51	8.12	5.39
LSD 0.05	0.3664	1.8977	4.9083	0.7404
LSD 0.01	0.4998	2.5885	6.6952	1.0099

Fruit weight ranged between 1.57-2.65 kg and the average weight was 2.04 kg (Table 2). Cultivar 'Sureness' showed the highest fruit weight (2.65 kg) and the lowest 'Golden crown' (1.57 kg). Among red-fleshed cultivars, the highest fruit weight showed 'Bonanza'. Generally, yellow-fleshed cultivars showed higher fruit weight and there was significant difference between yellow-fleshed and red-fleshed cultivars with exception between cultivars 'Yellow baby' and 'Bonanza'. Our results were similar to those found by Proietti et al. (2008) on ungrafted mini watermelon plants (2.27 kg). Experiments with black mulch film showed the highest watermelon yield and fruit weight (White, 2003) and it is recommended to cultivate watermelon on mulch film to decrease water and fertilizer loss from the soil, prevent weeds and contact between fruit and soil.

Total number of fruits ranged between 20-35. Yellow-fleshed cultivars, 'Sureness', 'Yellow baby', showed the lowest total number of fruits (20) compared to red. The highest total number of fruits showed cultivar 'Faerie' (35). Fruit number per plant was similar to results Proietti et al. (2008) with 74.7%, 49.4% and 54.5% increased fruit number per plant in red ('Faerie', 'Golden crown' and 'Bonanza', respectively) compared to yellow (data not presented in Table 2).

Rind thickness ranged between 5.22-11.91 mm and the average rind thickness was 9.27 mm (Table 2). Cultivar 'Yellow baby' showed the highest rind thickness (11.91 mm) and the lowest cultivar 'Faerie' (5.22 mm). Yellow-fleshed cultivars showed thicker rind compared to red-fleshed. Significant difference was found between yellow and red-fleshed cultivars with exception between two yellow fleshed cultivars 'Yellow baby' and 'Sureness' with 'Golden crown'. Gusmini et al. (2004) separated watermelon fruits into 3 groups according to rind thickness (higher than 19 mm, 10-19 mm, less than 10 mm). According to this classification cultivars 'Faerie' and 'Bonanza' belong to first group (less than 10 mm) and 'Golden crown', 'Sureness' and 'Yellow baby' belong to second group (10-19 mm). Our results are in agreement with Proietti et al. (2008) on ungrafted mini watermelon plants (8.9 mm). On contrary, results of White (2003) showed higher values of rind thickness (16.7-22.3 mm).

Watermelon randman ranged between 37-49 % and the average randman was 46 % (Table 2). Cultivar 'Bonanza' showed the highest randman (49 %) and the lowest cultivar 'Golden crown' (37%). Cervenski et al. (2008) studied randman of two watermelon genotypes and showed higher randman compared to our results ('Danka' 62.74 %, 'Crimson Sweet' 53.38 %).

Mainly, red-fleshed cultivars showed higher randman compared to yellow but this difference wasn't significant. Cultivar 'Golden crown' showed statistically lower randman compared to all cultivars.

Total soluble solids ranged between 9.5-10.95 °Brix and the average total soluble solids were 10.41 °Brix (Table 2). Cultivars 'Bonanza' and 'Faerie' showed the highest total soluble solids (10.95 °Brix) and the lowest 'Sureness' (9.50 °Brix). Red-fleshed cultivars showed significant higher total soluble solids compared to yellow with exception between 'Golden crown' and 'Yellow baby'. Within cultivars in red-fleshed group and yellow-fleshed there wasn't significant difference. Our results were in the range for red and yellow-fleshed watermelons (Pardo et al., 1997; Sabeetha et al., 2017) or even higher (Proietti et al., 2008). Sabbetha et al. (2017) reported lacking information of total soluble solids in yellow-fleshed watermelons. Their research showed no significant difference between red and yellow-fleshed watermelons (10.46 and 9.91 °Brix). Results of Davis et al. (2008) showed positive correlation between flesh colour (orange, yellow, red, pink) and total soluble solids. Their results indicated lower total soluble solids in yellow-fleshed compared to red (8.8 and 11.5 °Brix, respectively). According to Vasquez et al. (2005) 8-10 °Brix is a market tolerable value. All our results are in this range and compared to previous results are in agreement with lower total soluble solids in yellow compared to red-fleshed cultivars. Total soluble solids depend on environmental factors and maturity (harvest). Watermelon requires temperature 23-28 °C, relatively low air humidity, long day (Costa and Leite, 2007). During vegetation period average air temperature (16.6-21.9 °C) and air relative humidity (63.1-73.5 %) were almost optimal for watermelon production. During last month of their production total precipitation was higher and that could influence on lower total soluble solids. Even though it was a rainy period (especially July) we obtained satisfactory value of total soluble solids.

Conclusions

Mini watermelons have a round fruit shape, thin rind and average fruit weight 1.5-4 kg. The present study indicated that genotype (cultivar) affected fruit fresh weight, rind thickness, randman and total soluble solids. Yellow-fleshed cultivar 'Sureness' showed the highest fruit weight. The highest rind thickness showed yellow cultivar 'Yellow baby'. Mainly, yellow-fleshed cultivars showed higher fruit weight and rind thickness compared to red-fleshed. Red-fleshed cultivars showed higher total number of fruits, fruit number per plant, randman and total soluble solids. Among tested cultivars, we can recommend 'Faerie' and 'Bonanza' as a source of sweetness and for the highest quality parameter (total soluble solids), as well as the highest randman.

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