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Interaction between vegetative and reproductive manifestations in raspberry candidate cultivar 'Magdalena'

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Abstract

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The interconnections between the vegetative and reproductive manifestations of the candidate raspberry cultivar 'Magdalena' were monitored. The scientific experiment was conducted in a collection plantation of the Research Institute of Mountain Stockbreeding and Agriculture in Troyan in the period of (2018-2020). The field experiment is based at intra-row spacings between plants (0.50 m and 0.30 m) and inter-row spacings of 3.00 m. The indicators, such as average number of shoots, average height and average thickness of shoots, average fruit weight (g), and average yield (g) per one linear meter of the intra-row area. The largest number of shoots (35.50) for the candidate cultivar 'Magdalena' was found in the planting spacing of 0.30 m variant, while the highest height of shoots (183.15) was registered at the larger (0.50 m) planting distance. The average thickness of the shoots varied from 6.31 mm to 7.52 mm. Significantly higher yields were found for 'Magdalena' candidate cultivar at the shorter planting distance in the first two experimental years, and this regularity changed in 2020, when the highest average yield from the tested period was reported (2543.67 g/m), but at 0.50 m planting distance. The highest average fruit weight of 3.30 g was reported from the greater planting distance in 2018.

Keywords: raspberries; vegetative indicators; fruit weight; yield

Introduction

Raspberry is widely used in the foot-hill and mountain regions, where soil and climate conditions are largely favourable for its development.

Their climate is cool and the soil and atmospheric humidity are higher. Nowadays, there is a growing interest in raspberry, which is due to its valuable economic and biological qualities, the rapid return on investment and continuous improvement of technologies for growing and processing of fruits (Hristov and Boicheva, 1982; Rangelov, 1990; Pritts, 1991; Stiles et al., 2002; Knight, 2004; Bushway and Pritts, 2008; Fernandez and Krewer, 2008; Veljkovic et al., 2008; Petrović and Leposavić, 2011). The research interest in raspberries is determined by its attractive appearance, excellent aroma and excellent nutritional and healing properties, which have a beneficial effect on human health.

The productivity of raspberries is determined by the number of shoots per linear meter, their development (height and thickness) and by the number and weight of fruits per one half bush. The yield and quality of the fruits are directly dependent on the latitude, agrometeorological conditions of the growing area, cultivar characteristics and applied agricultural techniques (Georgiev, 2006; Leposavić et al., 2013; Pešaković et al., 2013; Zorenc et al., 2017). A number of researchers have focused their research on testing the fruitfullness of raspberry cultivars (Hristov, 1991; Stanisavljevic

et al., 2004; Boicheva, 1999; Buskiene, 1999; Koron, 2004). The statement of Crandall (1980) is similar, according to which the number of shoots and their strength, as well as the applied technology of plant cultivation have a great impact on the yield of raspberry fruits. Crandall et al., (1974) concluded that larger-diameter shoots provide higher and more stable yields due to a better supply of nutrients to the buds than smaller-diameter shoots.

The objective of the present study is to determine whether there is an interaction between some vegetative and reproductive performances of the studied candidate cultivar 'Magdalena' in the different variants of planting in the intra-row area at 0.50 m and 0.30 m.

Material and Methods

The experiment was conducted in the period of (2018-2020) in a collection plantation of the Research Institute of Mountain Stockbreeding and Agriculture in Troyan. The objective of the study is the Bulgarian candidate raspberry cultivar 'Magdalena', which is promising, selected in RIMSA-Troyan. The candidate cultivar was obtained as a result of crossing the parent varieties Comet x Lyulin. The plants are grown under irrigated conditions with drip irrigation. Row-spacing are naturally grassed, with the application of the necessary mowing of the grass, and the intra-row area is maintained in black fallow by tillage.

The following indicators were observed:

– average number of shoots per linear meter;
– average height of shoots (cm);
– average thickness of shoots (mm), measured at 10 cm from the soil surface;
– average fruit weight (g);
– average yield (g/per linear meter).

The experiment was based on two variants with six replications, each one includes a linear meter of the intra-row area..

– I var. – planting at 0.50 m in the intra-row area;
– II var. – planting at 0.30 m in the intra-row area.

The plants were planted in pits measuring 0.30/0.30/0.30 m, with added granular chicken manure of 0.200 kg. In both variants the inter-row spacing was 3.00 m. The methodology for studying plant resources in fruit plants was used to report the indicators (Nedev et al., 1979). The data were processed by correlation analysis (Lidanski, 1988), the software product MS Excel – 2010 was used. Experimental data were processed by analysis of variance (one-factor and two-factor), multiple comparisons of averages were performed by Duncan's test.

Result and Discussion

Shoot-forming ability is an important factor characterizing the potential of the cultivar, as well as largely determining the cultivation technology. The results from the first experimental year showed a big difference between the variants of the cultivar in the range of 34.17 pcs. (0.50 m) to 35.50 pcs. (0.30 m) (Table 1). A higher average shoot height was reported in the variant with the larger planting distance (184.00 cm). The differences in values of the average thickness of shoots in both planting variants were minimal. Regarding the reproductive indicators, the average fruit weight in both agricultural techniques did not show significant differences – 3.30 g (0.50 m) and 3.26 g (0.30 m). In the first experimental year, the yield obtained in the second variant of the tested candidate cultivar was higher (944.50 g/m) than the first one.

In the first experimental year, there was only one significant positive correlation dependence between the height and thickness of shoots (r = 0.69) (Tables 2). For all other indicators, a weak interaction was observed (r <0.3). Other correlations in the other indicators are observed in the second variant, as a strong negative correlation is observed between the average thickness of shoots and yield (r = -0.73) (Table 2). Significant correlation was observed between shoot height and their number (r = 0.50).

Table 1 shows that in the second year of the experiment, the average number of shoots in the first variant of planting,

Table 1. Vegetative and reproductive indicators in candidate cultivar 'Magdalena" for the period of (2018-2020)

Cultivar / Indicators	I variant 0.50 m	II variant 0.30 m
2018		
Average number of shoots /m	34.17	35.50
Average height of shoots (cm)	183.15	139.44
Average shoots thickness (mm)	6.44	6.47
Average fruit weight (g)	3.30	3.26
Average yield (g/m)	821.17	944.50
2019		
Average number of shoots /m	34.17	23.00
Average height of shoots (cm)	117.72	108.42
Average shoots thickness (mm)	6.31	7.52
Average fruit weight (g)	2.32	2.48
Avarage yield (g/m)	1843.5	2267.34
2020		
Average number of shoots per m	15.83	12.33
Average height of shoots (cm)	84.69	78.29
Average shoots thickness (mm)	6.69	6.53
Average fruit weight (g)	2.32	2.40
Average yield (g/m)	2543.67	2396.83

Table 2. Correlation dependences between vegetative and reproductive indicators of candidate cultivar 'Magdalena' in 2018.

Indicators	Average number of shoots /m	Average height of shoots (cm)	Average shoots thickness (mm)	Average yield (g)/m
0.50 m				
Average number of shoots /m	1			
Average height of shoots (cm)	0.31	1		
Average shoots thickness (mm)	-0.19	0.16	1	
Average yield (g/m)	-0.02	0.69	-0.03	1
0.30 m				
Average number of shoots /m	1			
Average height of shoots (cm)	0.50	1		
Average shoots thickness (mm)	0.27	0.21	1	
Average yield (g/m)	0.06	-0.23	-0.73	1

the cultivar was the same as in the previous year (34.17). In the second variant a smaller number of shoots was reported from the same variant of the previous year (23.00). The average height of shoots was in the range from 108.42 cm at 0.30 m to 117.22 cm at 0.50 m. The average thickness of shoots at the smaller planting distance was greater (7.52 mm). The average fruit weight was lower in the second year and ranged from 2.32 g (0.50 m) to 2.48 g (0.30 m). In 2019 was registered higher average yield in both variants compared to the previous year – 1843.5 g (0.50 m), 2267.34 g (0.30 m).

The statistical correlation between the indicators of candidate cultivar 'Magdalena' in the second experimental year in the planting variant at 0.50 m shows a significant negative correlation between shoot thickness, number of shoots and yield and significant but positive between the number of shoots and yield, as the correlation coefficient is respectively (r = -0.70; r = -0.61; r = 0.57) (Table 3). The strength of the dependence for the other indicators is negative, weak or moderate. There was a strong positive correlation dependence only between the height and thickness of the shoots (r = 0.71) and significant between the number of shoots and yield (r = 0.69) at the shorter planting distance. In all other indicators, a weak to moderate correlation dependence was observed (r < 0.3).

In the third experimental year, the number of shoots in both variants decreased significantly as their number was 15.83 pcs. (0.50 m) and 12.33 (0.30 m) (Table 1). This is the lowest result of this indicator in the three-year period. The lowest values in the third year were reported for the average height of shoots, which was in the range from 78.29 cm at 0.30 m to 84.69 cm at 0.50 m. Regarding the average thickness of shoots, the differences in the results in both planting variants were minimal – 6.53 mm in the second variant and 6.69 mm in the first variant.

There weren't any significant differences in the average fruit weight in both planting designs, although there was a minimal predominance in the second variant. In 2020, a significantly higher average yield was reported in both variants of the tested candidate cultivar with 2396.83 g (0.30 m) and 2543.67 g (0.50 m), which turned out to be the highest yield during the reported three-year period.

Table 3. Correlation dependences between vegetative and reproductive indicators of candidate cultivar 'Magdalena', with a planting distance at 0.50 m in 2019.

Indicators	Average number of shoots /m	Average height of shoots (cm)	Average thickness of sheets (mm)	Average yield (g/m)
0.50 m				
Average number of shoots /m	1			
Average height of shoots (cm)	-0.07	1		
Average shoots thickness (mm)	-0.70	0.43	1	
Average yield (g/m)	0.57	-0.20	-0.61	1
0.30 m				
Average number of shoots /m	1			
Average height of shoots (cm)	-0.12	1		
Average shoots thickness (mm)	-0.28	0.71	1	
Average yields (g/m)	0.69	0.27	-0.03	1

Table 4. Correlation dependences between vegetative and reproductive indicators of candidate cultivar 'Magdalena' in 2020.

Indicators	Average number of shoots/m	Average height of shoots (cm)	Average shoots thickness (mm)	Average yield (g)/m
0.50 m				
Average number of shoots /m	1			
Average height of shoots (cm)	-0.15	1		
Average shoots thickness (mm)	-0.40	0.77	1	
Average yield (g/m)	0.61	0.00	-0.47	1
0.30 m				
Average number of shoots /m	1			
Average height of shoots (cm)	0.32	1		
Average shoots thickness (mm)	0.19	0.77	1	
Average yield (g/m)	0.74	0.11	-0.21	1

For the first variant (0.50 m) in 2020, a strong correlation was reported between the thickness and height of the shoots (r = 0.77) and significant between the number of shoots and the yield (r = 0.61) (Table 4). At a planting distance of 0.30 m, a strong correlation dependence was found again between the height of shoots and their thickness, and between the number of shoots and their yield (r = 0.77; r = 0.74). In all other indicators, a weak to moderate correlation dependence was observed (r < 0.5).

The average values for the three-year period take into account higher values of number of shoots (28.06), their height (128.52 cm) than the variant with larger planting distance and higher average yield (1869.56 g) and thickness of shoots (6.84 mm) than the variant with the shorter planting distance (Table 5). The analysis of variance shows that the years (68%) and random factors (21.59%) had the greatest impact on the average number of shoots, while the interraction between both variants had the least.

Table 5. Average values of vegetative and reproductive indicators by variants in candidate cultivar 'Magdalena' for the period (2018 – 2020).

Cultivar / Indicators	I variant	II variant	Level of significance (P) Degree of impact of factors (%)
Average number of shoots /m	28.06	23.61	(P > 0.05)
			A 68.00
			B 4.45
			C 5.96
			D 21.59
Average height of shoots (cm)	128.52	108.72	(P > 0.05)
			A 38.74
			B 3.69
			C 2.63
			D 54.94
Average shoots thickness (mm)	6.48	6.84	(P > 0.05)
			A 10.12
			B 8.95
			C 25.35
			D 55.57
Average yield (g/m)	1736.11	1869.56	(P > 0.05)
			A 75.33
			B 0.74
			C 2.26
			D 21.67

Regarding the average height of the shoots, the years during the test period (38.74%) and the random factors (54.94%) had an impact. The degree of impact of the variants is minimal (3.69%), as well as between the variants with the years of the period (2.63).

The average thickness of the shoots is most strongly influenced by random factors (55.57%) and least by agricultural techniques (8.95%).

From the reproductive indicators, the average yield is significantly influenced by the years (75.33%) and random factors (21.67%). The variants (0.74%) and their interaction with the years (2.26%) had a low impact.

During the three years, the average fruit weight was higher in the variant with the larger planting distance (Figure 1). On average for the three-year period, the first variant had a value of 2.65 g and the second 2.71 g.

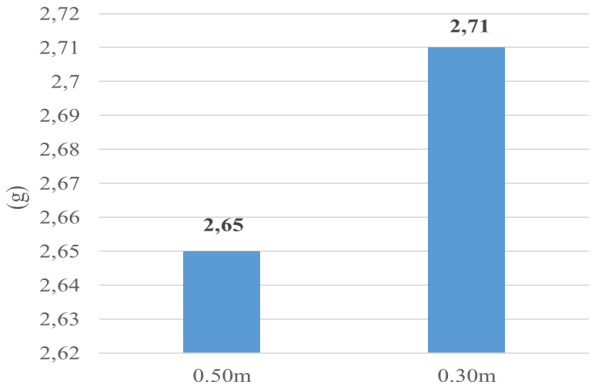

Fig. 1. Average fruit weight (g) by variants of the candidate variety Magdalena for the period (2018-2020).

Conclusions

From the results for the correlation dependences of the vegetative and reproductive characteristics of plants, it can be concluded that for a planting distance at 0.50 m a strong positive correlation was reported only between the average thickness and height of the shoots in 2020. In the first two years, the dependencies between the indicators were from weak to significant.

In the variant of planting at 0.30 m, a strong negative correlation was found between the average thickness of shoots and the yield in 2018, and a strong positive one between the average thickness and the height of the shoots in 2019 and 2020.

The average values from the three-year period show that in the variant of planting at 0.50 m higher values were reported for the average number of shoots (28.06) and average height of the plants (128.52 cm). In 0.30 m planting variant, higher results were reported for the average shoot thickness (6.84 mm) and average yield (1869.56 g).

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