Bulgarian Journal of Agricultural Science, 28 (No 6) 2022, 1000–1005

Correlation dependences between vegetative and reproductive characteristics of Meeker cultivar

Stanislava Atanasova[1*], Maria Georgieva[2] and Diyan Georgiev[2]

[1] *Trakia University, Faculty of Agriculture, 6015 Stara Zagora, Bulgaria*
[2] *Agricultural Academy, Research Institute of Mountain Stockbreeding and Agriculture, 5600 Troyan, Bulgaria*
[*]*Corresponding author:* stanislava.atanasova@trakia-uni.bg

Abstract

Atanasova, S., Georgieva, M. & Georgiev, D. (2022). Correlation dependences between vegetative and reproductive characteristics of Meeker cultivar. *Bulg. J. Agric. Sci., 28 (6)*, 1000–1005

The objective of the experiment was to trace the correlation dependences between the vegetative and reproductive manifestations of 'Meeker' raspberry cultivar. The field experiment was set at a row spacing of 3.00 m and two variants of intra-row spacing – 0.50 m and 0.30 m. 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 vegetative indicators and reproductive indicators, such as number of shoots, height and thickness of shoots per one linear meter of intra-row area were analyzed and also fruit weight (g), and yield per 1 linear m. In the first experimental year, the largest average number of shoots (23.00) was found from the shorter planting distance and the largest average plant height (216.59 cm) of the same variant. The average thickness of the shoots in "Meeker" cultivar was in the range from 5.98 mm (0.50 m) to 7.59 mm (0.50). The highest average yield of 1838.50 g/m was reported from the second variant of planting in 2020, while the highest average fruit weight of 3.07g was registered in the same variant, but in 2018.

Keywords: raspberries; vegetative indicators; fruit weight; yield

Introduction

Raspberry (*Rubus idaeus* L.) is a half shrub, berry plant belonging to the family *Rosaceae*, which has annual and biennial stems (shoots) and perennial root system. Depending on the cultivar, raspberries can be grown in different agroecological conditions, outdoors and indoors, but for good yields and high quality crops, optimal climatic factors are needed. The optimal conditions for growing raspberries are cooler summers with moderate rainfall during vegetation (late May and early June), humid late summers, favorable for the development of new shoots and relatively mild winters with temperatures not exceeding -18°C (Haffner et al., 2000). According to data from the world and Bulgarian literature, the foot-hill and mountain regions are suitable for raspberries, as they largely meet the soil and climatic requirements of this fruit species, such regions in Bulgaria are Troyan, Teteven, Berkovitsa, Velingrad etc. The advantages of raspberries over other fruit species are: earlier onset of fruit bearing; fast return on investment, high purchase price and the ability to apply modern technologies for cultivation and processing (Hristov & Boicheva, 1982; Rangelov, 1990; Pritts, 1991; Stiles et al., 2002; Knight, 2004; Bushway & Pritts, 2008; Fernandez & Krewer, 2008; Veljkovic et al., 2008; Petrović & Leposavić, 2011). This stimulates producers to create new raspberry plantations, to better grow existing cultivars, to introduce new cultivars and to strive for higher yields.

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 a 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 study on testing the fertility of raspberry cultivars.

In the period (2010-2011) in Bosnia and Herzegovina, Bećirspahić et al. (2014) compared the vegetative growth of three raspberry cultivars – Willamette, Meeker and Tulamin. The authors report that Meeker has the highest shoot height (212.65 cm) and Willamette has the lowest height (141.16 cm).

The results obtained can be compared with the studies of Attila et al. (2006), who observed the height of shoots of these raspberry cultivars in the conditions of Ankara – Turkey. In their experiment it was found that 'Willamette' is with the highest average height of shoots with 196.90 cm, then Meeker with 186 cm, while with the smallest height of plants is found in Tulameen with 139.90 cm.

Leposavic et al. (2013) conducted a test to determine the biological and pomological characteristics of raspberry cultivars, such as Meeker, Latham, Tulameen, Willamette and selection K 81-6, grown in the region of Western Serbia. They found that the average fruit weight of Tulameen and K 81-6 selection was higher (4.28 g and 4.11 g) than those of Willamette (3.40 g), which was superior to Meeker (3.29 g) and Latham (2.40 g).The authors prove that a significantly higher shoot height was registered in Meeker and Tulameen, and the largest plant diameter was reported in the selection of K 81-6.

The objective of the present study is to determine whether there are correlation dependences between some vegetative and reproductive characteristics of the studied cultivar Meeker in the different variants of planting at 0.50 m and 0.30 m in intra-row area.

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 world-wide variety of raspberries – Meeker, characterized by high fruitfullness and suitability for cultivation in foot-hill and mountain region. 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/linear meter.

The experiment is based on two variants with six replications, each of them includes one linear meter of the intra-row area for the cultivar and variants.

– I var. – planting of the plants 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 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.

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 20.00 pcs. (0.50 m) to 23.00 pcs. (0.30 m) (Table 1). It can be noted that a higher average height of shoots was found in the variant with a shorter plant-

Table 1. Vegetative and reproductive indicators in Meeker cultivar for the period of (2018-2020)

Indicators \ Cultivar	I variant 0.50 m	II variant 0.30 m
2018		
Average number of shoots/m	20.00	23.00
Average height of shoots, cm	192.51	216.59
Average shoots thickness, mm	7.49	7.24
Average fruit weight, g	3.07	2.81
Average yield, g/m	873.00	1620.00
2019		
Average number of shoots per m	13.50	21.83
Average height of shoots, cm	173.82	179.91
Average shoots thickness, mm	7.59	7.38
Average fruit weight, g	2.74	2.57
Average yield, g/m	806.17	1318.00
2020		
Average number of shoots/m	12.50	18.17
Average height of shoots, cm	123.22	128.27
Average shoots thickness, mm	6.06	5.98
Average fruit weight, g	2.81	3.03
Average yield, g/m	1040.00	1838.50

Table 2. Correlation dependences between vegetative and reproductive indicators of Meeker 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	-0.36	1		
Average shoots thickness, mm	-0.18	0.92	1	
Average yield, g/m	0.88	-0.42	-0.10	1
0.30 m				
Average number of shoots /m	1			
Average height of shoots, cm	-0.80	1		
Average shoots thickness, mm	-0.27	0.55	1	
Average yield, g/m	-0.36	0.01	-0.55	1

ing distance (216.59 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. In the first experimental year, the yield obtained in the second variant of the tested cultivar was approximately twice higher (1620.00 g) than the first one.

In the first experimental year in both variants of planting for this cultivar, a strong positive correlation dependence was observed between the height and thickness of the shoots and the yield, respectively: (r = 0.92 and r = 0.88) (Table 2). Other correlations in the other indicators are observed only in the second variant, as a strong negative correlation is observed between the number and hight of shoots (r = -0.80) (Table 2). Certain dependence was observed in the height and thickness of shoots (r = 0.55) and significant, but negative dependence was reported between the thickness of shoots and their yield (r = -0.55).

In the second experimental year, the values for the average number of shoots in the second variant of planting were close to the previous year (21.83) (Table 1). In the first variant, a smaller number of shoots was reported in comparison with the beginning of the experiment (2018) (13.50 shoots). The average height of shoots was in the range from 173.82 cm (at 0.50 m) to 179.91 cm (at 0.30 m).The average thickness of shoots at the larger planting distance was greater (7.59 mm). The average fruit weight was lower in the second year and ranged from 2.57 g (0.30 m) to 2.74 g (0.50 m). In 2019 was registered lower average yield in both variants compared to the previous year – 806.17 g (0.50 m), 1318 g (0.30 m).

The statistical correlation among the indicators of Meeker in the second experimental year at a planting distance of 0.50 m showed a very strong positive relationship between the height and thickness of shoots, and a strong one between the number of shoots and yield, as the correlation coefficient was respectively (r=0.97; r=0.76) (Table 3). The strength of the dependence in the other indicators is negative, weak or moderate. For the smaller planting distance, there was a strong positive correlation dependence only between the height and thickness of the shoots (r = 0.87) and high, but negative correlation dependence between the thickness of shoots and the yield (r= -0.77). In all other indicators, a weak to moderate correlation dependence was observed (r < 0.5).

Table 3. Correlation dependences between vegetative and reproductive indicators of Meeker in 2019

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	-0.21	1		
Average shoots thickness, mm	-0.31	0.97	1	
Average yield, g/m	0.76	0.36	0.25	1
0.30 m				
Average number of shoots/m	1			
Average height of shoots, cm	0.04	1		
Average shoots thickness, mm	-0.33	0.87	1	
Average yield, g/m	0.00	-0.60	-0.77	1

In the third experimental year, the number of shoots in the first variant decreased significantly (12.50) (Table 1). This is the lowest result of this indicator in the three-year period. The lowest values in the third year were reported at the average height of shoots, which was in the range from 123.22 cm at 0.50 m to 128.27 cm at 0.30 m. The differences in values of the average thickness of shoots in both variants were minimal. There weren't any significant differences in the average thickness of shoots, although there was a minimal predominance in the second variant. In the third experimental year, a significantly higher average yield was reported for both variants of the tested cultivar with 1040.00 g (0.50 m) and 1838.50 g (0.30 m), which turned out to be the highest yield during the reported three-year period.

In the first variant (0.50 m), a strong correlation was reported again between the thickness and height of the shoots and between the number of shoots and the yield (Table 4). The correlation coefficient has a very high value (r = 0.87, r = 0.72), which means that there is a very large ascending dependence between both indicators. Significant correlation

Table 4. Correlation dependences between vegetative and reproductive indicators of Meeker 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	0.55	1		
Average shoots thickness, mm	0.64	0.87	1	
Average yield, g/m	0.72	0.54	0.64	1
0.30 m				
Average number of shoots /m	1			
Average height of shoots, cm	0.46	1		
Average shoots thickness, mm	0.45	0.94	1	
Average yield, g/m	0.42	0.36	0.22	1

Table 5. Average values of vegetative and reproductive indicators by variants in Meeker 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	15.33	21.00	(P > 0.05)
			A25.43
			B 31.58
			C 4.66
			D 38.32
Average height of shoots, cm	163.18	174.92	(P > 0.05)
			A 63.12
			B 2.12
			C 1.19
			D 33.57
Average shoots thickness, mm	7.05	6.86	(P > 0.05)
			A 44.53
			B 0.83
			C 0.14
			D 54.49
Average yield, g/m	921.00	1592.00	(P < 0.05)
			A 12.71
			B 63.05
			C 2.09
			D 22.15

Legend: A – degree of impact of years (%); B – degree of impact of the variants (%); C – degree of interaction between the variants and years (%); D – degree of impact of random factors (%)

dependences was observed in the number of shoots in relation to their thickness and between the thickness of shoots and the yield (r = 0.64). At a planting distance of 0.30 m, a very high correlation dependence was found only between the thickness of the shoots and their height (r = 0.94). 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 the higher values of the number of shoots (21.00), height (174.92 cm) and average yield (1592.00 g) than the variant with the shorter planting distance (Table 5). The analysis of variance shows that the factors of planting variants (31.58%) and random factors (38.32%) had the greatest impact on the average number of shoots, while the interaction between the years and both variants had the least impact. Statistically, the differences were not proven.

Regarding the average height of the shoots, the years during the test period (63.12%) and the random factors (33.57%) had an impact. The agrotechnics of planting had a low percentage of impact (2.12%). Mathematically, the differences were proved at the level of significance (P <0.05). The same factors had an impact also on the average thickness of shoots with statistically non-significant values (P < 0.05).

Mathematical proof (P < 0.001) was observed in the average yield with a significant impact of variants (63.05%) and random factors (22.15%). The years (12.71%) and their interaction with the variants had a low impact.

On average for the three-year period, a higher average fruit weight was registered than the variant with the larger planting distance of the plants (Figure 1). The average results for the whole period show values for the first variant – 2.87 g and for the second 2.08 g.

Linear regression was applied for the quantitative characterization of the dependences between the vegetative indicators (number of shoots, height and thickness of the shoots) and the reproductive indicator (yield) (Figures 2, 3, 4, 5).

The performed linear regression analysis shows a high dependence between the vegetative indicators of height and thickness of the shoots in both variants of 'Meeker' in 2020. (R^2 = 0.76; R^2 = 0.89) in the first variant of the cultivar in 2019 (R^2 = 0.94), as well as between the number of shoots and the yield at the variant of planting at 0.50 m in 2020. (R^2 = 0.88).

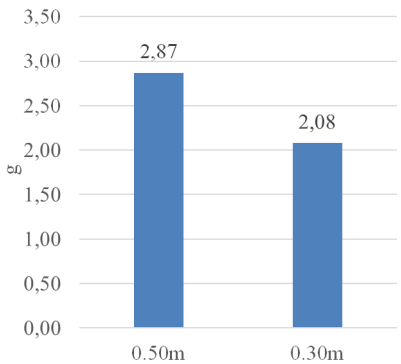

Fig. 1. Average fruit weight (g) for Meeker variants for the period (2018-2020)

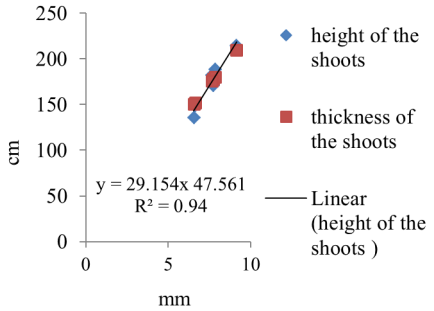

Fig. 2. Regression analysis between vegetative indicators of Meeker, with a variant of planting 0.50 m in 2019

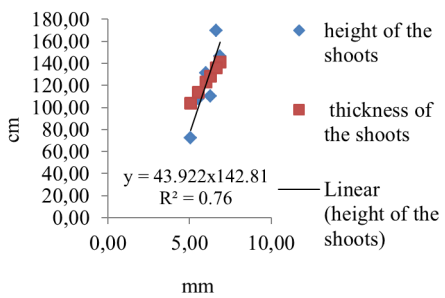

Fig. 3. Regression analysis between vegetative indicators of Meeker, with a variant of planting 0.50 m in 2020

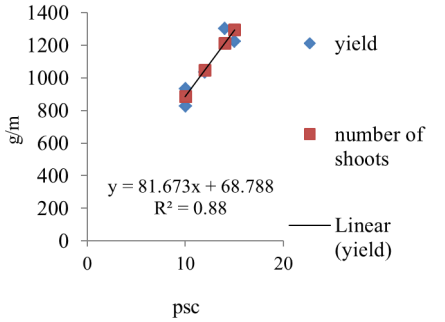

Fig. 4. Regression analysis between vegetative and reproductive indicators of Meeker, with a variant of planting 0.50 m in 2020

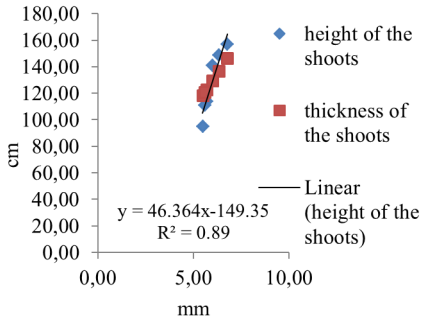

Fig. 5. Regression analysis between vegetative indicators of Meeker, with a variant of planting 0.30 m in 2020

Conclusions

From the results for the correlation dependences of the vegetative and reproductive characteristics of plants during the three experimental years, it can be concluded that at a planting distance at 0.50 m a very strong positive correlation was reported between the average thickness and height of the shoots in 2018 and 2019, and a strong dependence in 2020.

A significant to very strong correlation was found between the average thickness and the height of the shoots at a planting distance at 0.30 m.

In all three experimental years with the variant with a longer planting distance (0.50 m), a high positive dependence was found between the indicators average number of shoots and yield.

The average results of the three-year period show that in 0.30 m planting variant, the average number of shoots (21.00), average height (174.92 cm) and average yield (1592.00 g) were higher. In the planting variant of 0.50 m, a higher value was reported only for the average thickness of shoots (7.05 mm).

From the results of the regression dependences of the vegetative and reproductive manifestations of the plants we can summarize that at planting distances of 0.50 m a very strong dependence between thickness, shoot height and yield in 2019 and 2020 was reported, and at a planting distance of 0.30 m, a strong dependence between the height and thickness of the shoots in 2020 was reported.

References

Atila, S. P., Agaoglu, Y. S. & Celik, M. (2006). A research on the adaptation of some raspberry cultivars in Aya (Ankara) Conditions. *Pak. J. Biol. Sci., 9 (8),* 1504-1508.

Bećirspahić, D., Kurtović, M., Drkenda, P., Skender, A. & Aliman, J. (2014). Morphological Characteristics of the Raspberry Production Range in Bosnia and Herzegovina. In: 49th Croatian & 9th International Symposium on Agriculture, Dubrovnik, Croatia.

Bushway, L. J., Pritts, M. P. & Handley, D. T. (2008). Raspberry and blackberry production guide for the Northeast, Midwest, and Eastern Canada. *NRAES*, *35*, 1-2.

Fernandez, G. E. & Krewer, G. (2008). Southwest Regional Bramble Production Guide, NCSU and A&TSU Cooperative Extension, *AG-697-W*, 30.

Georgiev, D. (2006). Agrobiological and economic evaluation of new varieties of raspberries and black currants. PhD Thesis, Rimsa, Troyan, Bulgaria, (Bg).

Haffner, K., Rosenfeld, H. J. & Skrede, G. (2002). Quality of red raspberry *Rubus idaeus* L. cultivars after storage in controlled and normal atmospheres. *Postharvest Biology and Technology*, *24 (3),* 279-289.

Hristov, L. & Boycheva, R. (1982). Selection and introduction of raspberries in our country, Requirements for industrial varieties. *Fruit Growing*, *7,* 30-33, (Bg).

Knight, V. H. (2004). Rubus Breeding Worldwide and the Raspberry Breeding Programme at Horticultural Research International, East Malling. J Yugoslav Pomol, (*38),* 23-38

Leposavić, A., Đurović, D., Keserović, Z., Popović, B., Mitrović, O., Miletić, N. & Magazin, N. (2013). Evaluation of raspberry cultivars grown in the Western Serbia Region. *Horticultural Science*, *40 (1),* 1-7.

Lidanski, T. (1988). Statistical Methods in Biology and in Agriculture. *Zemizdat,* Sofia, 43-52, 106-134, 135-183, (Bg).

Nedev, N., Grigorov, Y., Baev, Hr., Serafimov, S., Strandzhev, Al., Kavardzhikov, L., Lazarov, Kr., Nikolov, N., Dzhuvinov, V., Popova, L., Slavov, N., Iliev, P., Stoyanov, D., Kanev, Il., Krinkov, H., Vishanska, Yu., Topchiyska, M. & Petrova, L. (1979). Methods for studying of planting resources of fruit crops. Plovdiv, 151, (Bg).

Pešaković, P., Karaklajić-Stajić, Ž., Milenković, S. & Mitrović, O. (2013). Biofertilizer affecting yield related characteristics of strawberry (Fragaria × ananassa Duch.) and soil micro-organisms. *Scientia Horticulturae, 150,* 238-243.

Petrović, S. & Leposavić, A. (2011). Raspberry – new technologies of cultivation, preservation and processing. Fruit Research Institute, Čačak, 230.

Pritts, M. (1991). Bramble Production Guide. *NRAES*, *35,* 1-2.

Rangelov, L. (1990). The production of raspberries in the World and in our country. *Agricultural Science*, XXVIII (1) 16-22, (Bg).

Stiles, H. D., Donohue, S. J. & Baker, J. C. (2002). Selected topics for raspberry producer in Virginia. Virginia Cooperative Extension. Publication 423-700, 5.

Veljkovic, B., Glisic, I. & Leposavic, A. (2008). An analysis of raspberry production conditions in Serbia. *Acta Agriculturae Serbica*, *XIII (25),* 9-16.

Zorenc, Z., Veberic, R., Koron, D. & Mikulic-Petkovsek, M. (2017). Impact of raspberry (*Rubus idaeus* L.) Primocane Tipping on fruit yield and quality. *No Tulae Botanicae Horti Agrobotanici Cluj-Napoca*, *45 (2),* 417-424.

Received: December**, 19, 2021**; *Accepted***: February, 9, 2022**; *Published*: **December, 2022**