

BEARING POTENTIAL OF RASPBERRY CV. 'POLKA' AS DEPENDENT ON THE TYPE OF ABOVEGROUND GROWTH

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ABSTRACT

The challenge facing raspberry production on a regular basis is knowledge of both the biology of growth and development and the characteristics of aboveground growth – pseudostems arising from the rhizome of raspberry, as dependent on the nature and position of adventitious buds from which they develop. In terms of the formation and realization of the bearing potential, fruiting canes as aboveground growth are classified according to the rooting degree of the supporting rhizome. The two-year research on the bearing potential of cv. 'Polka' as dependent on the type of aboveground growth indicates differences that are likely to affect the cost-effectiveness of raspberry production. The aboveground growth developing from primary adventitious buds positioned on horizontally growing roots exhibits significantly higher bearing potential compared to that arising from lateral buds positioned on etiolated belowground growth. The number of fruits per cane ranged from 310.20 to 429.15. Fruit characteristics were significantly affected by harvest date.

INTRODUCTION

Raspberry production in Bosnia and Herzegovina increased from 916 ha in 2006 to 1,682 ha in 2015, enjoying the leading position in the country's total fruit exports, accounting for about 13 thousand tonnes, worth BAM 51 million. According to FAO data, raspberry production in Bosnia and Herzegovina during 2003-2013 showed annual growth in acreage (13.07%), average yield (6.50%) and total production (20.42%). In raspberry production in Bosnia and Herzegovina, there has been a tendency for standard cultivars to reduce their average yields, thus allowing substantial expansion of primocane-fruiting raspberry production. The recent expansion of primocane-fruiting raspberries has brought new approaches associated with cultural and cane management practices, primarily with respect to planting systems and pruning techniques in the first year of growth (timing and severity of pruning) and their potential use for the purpose of fruiting in the second year (Milivojević et al., 2011; Kurtović et al., 2012; Maličević et al., 2013). The study of the morphology and differentiation of vegetative growing points on the raspberry rhizome i.e. the underground growth of the rhizome and rhizogenesis depending on the positioning of growing points that give rise to pseudostems (photophilous organs of the underground stem) i.e. aboveground growth as fruiting canes of raspberry shows that the degree of rooting of the rhizome as the support of the aboveground growth provides the basis for the control and realization of the fruit-bearing potential under given growing conditions (Mičić et al., 2015). The objective of the research was to determine the bearing potential of cv. 'Polka' (as the most important cultivar of this type of raspberries in B&H) as dependent on the type of aboveground growth i.e. the category of buds from which aboveground growth developed. Moreover, basic fruit characteristics of this cultivar as affected by harvest date were analyzed.

MATERIAL AND METHOD

The effect of the type of aboveground growth on the bearing potential of cv. 'Polka' was evaluated in a commercial planting located in the Municipality of Bugojno – Central Bosnia. The planting was established in 2014 and trained to a hedgerow system without trellis. Planting distance was 2.8 m between rows and 0.35 m within the row. Canes were simply mowed down early each spring and the crop was only borne on primocanes during summer and fall. The research was conducted in 2015-2016 (second and third year of fruit-bearing, respectively). Bearing potential parameters were analyzed in the planting by counting the total number of fruits on aboveground canes and determining fruit characteristics. Fruits were counted throughout the harvest period lasting from 5 August to 5 October in 2015 and from 20 July to 7 October in 2016. Upon harvest, canes were cut down through successive removal of harvested shoots.

Based on the type of buds from which they developed, aboveground canes were grouped into two categories: a) aboveground growth formed from primary adventitious buds positioned on horizontally growing roots (i.e. primary "root-type" canes) and b) aboveground growth formed from lateral buds positioned on etiolated belowground growth (i.e. primary "cane-type" shoots). During both experimental years, 30 canes per category were analyzed. In both categories of primary canes, the presence of secondary canes formed at their base was observed. All fruited secondary canes (regardless of their number) were covered by analysis. Both categories of canes were evaluated for average cane height and total number of harvested fruits per cane. Fruit analysis involved determination of average fruit weight (g), average fruit length (mm), average fruit width (mm), soluble solids in flesh (°Brix) and pH of fruit juice. Fruits were randomly sampled regardless of the type of the cane from which they were harvested. Fifty fruits at each harvest date were used for the analysis.

Data were analyzed by fitting general linear models to subsequent post-hoc analysis in cases where statistically significant differences were established. Differences were considered significant at $p < 0.05$. Statistical analysis was performed in SPSS 23 (IBM 2013).

RESULTS AND DISCUSSIONS

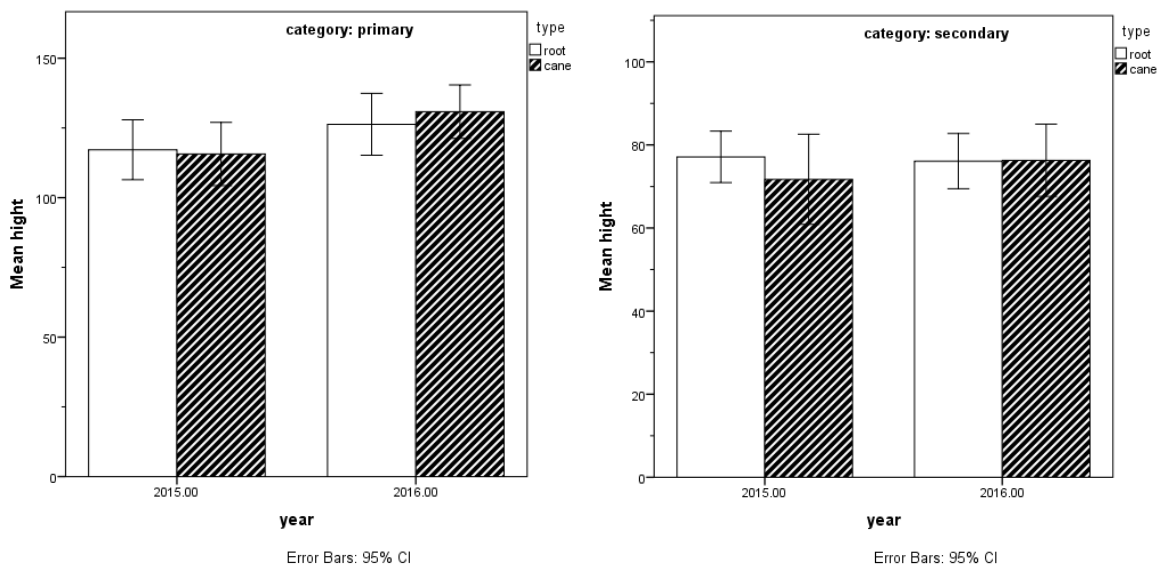
The average height of primary and secondary canes depending on their origin, and the average number of harvested fruits are presented in Table 1.

Table 1

Average cane height and average number of fruits

year	type	category	height		no. fruits	
			mean	SE	mean	SE
2015	root	primary	117.17	5.25	361.07	20.56
		secondary	77.12	3.09	173.35	11.51
	cane	primary	115.67	5.55	310.2	15.83
		secondary	71.72	5.29	124.31	19.25
2016	root	primary	126.3	5.39	429.15	17.41
		secondary	76.1	3.30	190.26	14.11
	cane	primary	130.83	4.69	334.90	16.13
		secondary	76.31	4.19	155.35	12.70

The analysis revealed no statistically significant differences in cane height between different types of canes ($p=0.868$), i.e. both canes originating from the root and those originating from the cut cane neck had similar height (Figures 1 and 2, respectively).



Figures 1, 2. Average height of aboveground canes

Different categories of the cane differed significantly ($p<0.001$), i.e. primary canes were significantly higher than the secondary canes. The year also had significant influence on the cane height ($p=0.033$), i.e. canes were higher in year 2016 in comparison to the year 2015. Aboveground cane height in floricane raspberries has an important effect on fruit-bearing (Glišić et. al. 2010) without affecting the quality of the fruit produced, thereby contributing to the cost-effectiveness of raspberry production. The total number of fruits per primary and secondary cane is presented in Graphs 3 and 4, respectively.

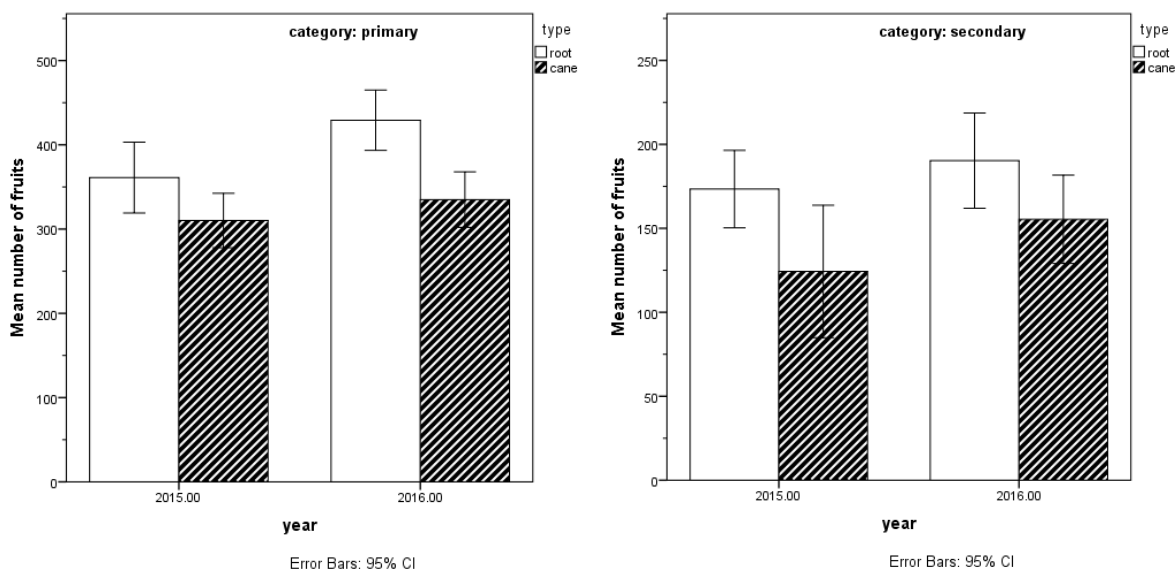


Figure 3, 4. Average number of fruits per aboveground cane

There was highly significant ($p<0.001$) influence of branching category, type of canes and a year of production on the number of fruits per cane. Namely, canes originating from the root produced more fruit than canes originating from the cut cane neck. Secondary canes yield significantly less fruits in comparison to primary canes.

In 2015 canes produced significantly less fruit than in year 2016. In 2016, the difference in fruit numbers between canes originating from the roots and those arising from the neck was highly significant, i.e. canes originating from the root had more fruits per cane in comparison to those developing from the neck of the cut-down cane. A tendency was observed for canes arising from lateral buds to produce fewer fruits compared to canes emerging from adventitious buds of the root system. Given that no significant difference in cane height was determined, the difference in the fruit-bearing potential may be attributed to the difference in the biological potential of the different categories of aboveground growth (Mičić et al. 2015). The key factor in the bearing potential of aboveground canes arising from the root system is based on the degree of rooting of the belowground growth which occurs parallel to the growth of the aboveground cane. On the other hand, in terms of production system intensification, aboveground canes originating from lateral buds have lower bearing potential primarily due to the fact that their growth and development process relies on the secondary roots of the belowground growth which at the same time contributes to the primary aboveground growth, thus indicating competition between the two categories of growth (Mičić et al. 2015). The number of fruits was significantly higher than the results of Milivojević et al. (2012). The number of fruits developing on secondary canes cannot be neglected, particularly in aboveground canes arising from the root (Table 2).

Table 2

Average number of secondary canes as dependent on the type of the primary cane

year	type	category	No. of secondary canes
2015	root	primary	2.2
	cane	primary	1.2
2016	root	primary	2.0
	cane	primary	1.4

Fruit size was recorded at four different dates during two experimental years (Graph 5). The data obtained show that fruit size was somewhat greater in the second year (Milivojević et al., 2012) and that the fruits picked at the beginning of harvest were larger than those harvested in the second part of the growing season.

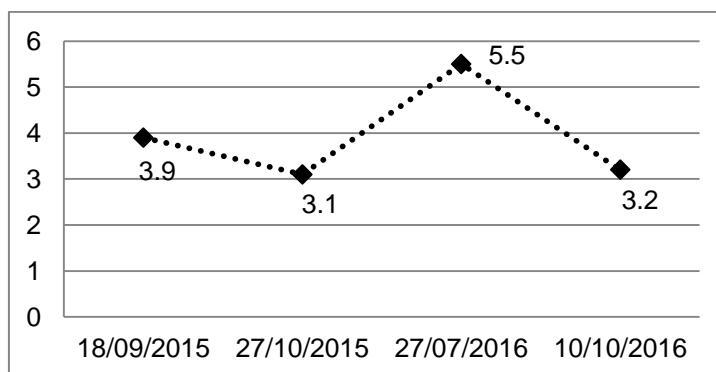


Figure 5. Average fruit weight (g) as a function of harvest date

Overall, fruit size decreased from the beginning to the end of the harvest period, and the difference in fruit size was particularly pronounced at the beginning of harvest. In the second part of the harvest period, fruit size was stabilized.

Fruit length and width were consistent with fruit weight (Table 3). Fruit size was quite uniform, this result being supported by the coefficients of variation for the traits analyzed.

Table 3

Average fruit length (mm) and width (mm) as a function of harvest date

	length		width	
	$\bar{X} \pm S_{\bar{x}}$	V_c	$\bar{X} \pm S_{\bar{x}}$	V_c
18/09/2015	21.9 ± 0.21	6.811	22.5 ± 0.25	7.619
27/10/2015	19.6 ± 0.53	18.849	18.4 ± 0.26	10.041
27/07/2016	25.3 ± 0.29	8.000	21.4 ± 0.29	9.519
10/10/2016	19.4 ± 0.26	9.280	17.5 ± 0.25	9.911

The average soluble solids content of the fruit differed across harvest dates (Table 4).

Table 4

Average soluble solids content in the fruit (°Brix) and pH of fruit juice as a function of harvest date

	°Brix		pH
	$\bar{X} \pm S_{\bar{x}}$	V_c	
18/09/2015	8.8 ± 0.21	19.592	3.00
27/10/2015	8.1 ± 0.53	16.949	3.20
27/07/2016	10.5 ± 0.29	3.929	3.09
10/10/2016	7.4 ± 0.26	28.600	3.05

These results are considerably lower than those reported by Miliivojević et al. (2011), which may be due to different fruit loads with respect to the bearing potential, as induced by prolonged harvest time and its overall realization.

CONCLUSIONS

'Polka' has substantial bearing potential during early years after planting. The type of aboveground growth has an important effect on the total number of fruits formed. The number of secondary aboveground canes is also dependent on the type of the primary aboveground cane. To increase yields in the hedgerow system, with aboveground canes bearing fruit only in the summer to autumn period (all aboveground canes are removed after fruiting at the end of the growing season), reduction cuts of secondary aboveground canes are recommended, involving removal of lateral buds developing on stumps – remnants from old canes that fruited in the previous season and that were removed just before winter. Cultural operations that stimulate the development of self-rooted aboveground canes should be used. Harvest date has an important effect on fruit characteristics, which must be considered when defining a marketing strategy for the fruits to acquire their position in the market.

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