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GROWTH AND FRUIT-BEARING OF RASPBERRY VARIETIES ACCORDING TO PRODUCTION CYCLE

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ABSTRACT

One of the main goals of the research is to have clarity regarding the systems of growing remontant raspberries on a single production cycle compared to 2 production cycles. Biometric analyses demonstrated greater height growth in variants with annual or only biennial stems. The object of the research were plants of the remontant varieties Enrosadira, Polonez and Polana cultivated in open ground. The planting distance was 2.5 m x 0.5 m. The following variants were studied: V1 - 10 annual stems per linear meter; V2 - 10 biennial stems per linear meter; V3 - 8 annual stems and 8 biennial stems per linear meter (Control). Higher productivity was obtained in the Polonez variety, with fruiting on annual and biennial stems in the same growing season, followed by the ,,Enrosadira'' variety, with fruiting on annual stems.

INTRODUCTION

The remontant raspberry (Rubus idaeus L.), characterized by the ability to bear fruit on annual shoots (from the first year), has become an increasingly popular crop due to its extended harvest period and high economic potential. The success of a remontant raspberry plantation depends not only on the choice of variety, but also, crucially, on the adopted cultivation system. Cultivation technology directly influences the main production indicators, such as quantity, quality and harvest timing. (Sumedrea, D. Chițu, et al., 2009,). (Spasojevic, S.., Maksimovic. V, et al., 2024)

Remontant raspberries with fruiting on annual stems (autumn harvest) require less work than raspberries with summer fruiting (on 2-year-old stems), offering the possibility of extending the harvest season from late summer to late autumn. While the early summer harvest lasts around 6 weeks, autumn fruiting can last 12 weeks or more into the season (Balan V. et al, 2018, Popar, R-G., et al. (2024).

Research by Wright and Waister (1982a,b) examined the impact of selective cane removal on raspberry production, comparing two main scenarios. Exclusive cultivation on biennial canes (no annual canes) demonstrated an increase in fruit production, attributed to increased productivity of the "fruiting nodes" on the biennial canes. Cultivation of remontant raspberries exclusively on annual fruiting canes initially led to the development of a higher number of annual canes per linear meter. Morphologically, these canes were shorter due to reduced internodes and had a reduced leaf area. However, the following year, yield increased significant, due to

the accumulation of factors: a larger number of stems, a greater number and weight of raspberry fruits per plant.

Researcher Piter Waister et al. 1980, concluded that the usefulness of the double-cycle cultivation system (which combines fruiting on annual and biennial stems) for obtaining a high yield depends entirely on three essential factors: the selected cultivar, the geographical region of production and the training system used.

When obtaining a harvest on 2 production cycles, the degree of winter resistance of biennial stems and sufficient vigor to support the leaf apparatus and fruit harvest must be taken into account, similar to annual fruiting stems. (Sava P 2016 Hanson E.,2023). The objective of the research is to evaluate the performance and advantages of the remontant raspberry varieties Polana, Polonez and Enrosadira cultivated for autumn fruiting on annual stems, by reporting to the system traditional double-cycle fruiting (on biennial and annual stems).

MATERIAL AND METHODS

The research was conducted in the raspberry plantation planted in the spring of 2021 with the remontant varieties Enrosadira, Polonez and Polana, planted at a distance of 2.5 m between rows and 0.5 m between plants in a row. The Enrosadira variety is early, with high-quality fruits, resistant to transportation, with strong growth, but which requires abundant fertilization and scheduled fertilization for an optimal harvest. The Polana variety is an example of a variety that responds well to both cropping systems, but the yield and quality of the fruits differ depending on the pruning regime applied. (Trader, W.& Zurawicz.E. 2021). The Polonez variety can be grown in a system with two harvests per year, but the main harvest remains the autumn one. (Zurawicz,E., Levandowski,M., 2018).

The density of annual and biennial stems varied between 8 and 10 plants per linear meter, on a strip 0.5 meters wide, with plants spaced about 8-10 cm apart. The following experimental variants were analyzed: V1 - 10 annual stems per linear meter; V2 - 10 biennial stems per linear meter; V3 - 8 annual stems and 8 biennial stems per linear meter (Control). The research was carried out according to the general methodology for field and laboratory experiments, monitoring growth parameters, productivity, fruiting period and fruit quality.

Plants of the Enrosadira and Polonez varieties were trained on simple trellis, in a strip, palisade on 3 rows of double wire, and plants of the Polana variety, having a weaker stem growth vigor, do not need a support and palisade system. Each repetition had a length of 5 linear meters. The management and maintenance technology of the plantation were at a high level, ensuring optimal conditions for plant development in all studied variants. Fruit harvesting was carried out vertically, downwards, along the length of the stems, as the fruits reached maturity. Finally, the amount of fruits harvested per stem, and respectively per hectare, was calculated for each variant.

The plantation is irrigated by drip irrigation, and the plantation maintenance management is at a high level.

The dry tip shortening of the stems of biennial stems was carried out at the end of March. In V 2, all shoots at ground level were suppressed every 20 calendar days, during the period April – September, in both research years.

During the white bud period and after the fall of the ovaries, at the beginning of July, observations were made regarding the degree of flowering of annual stems. The cutting of excess drajoni was carried out twice a season, at the beginning and end of

May, when the drajoni were 25 – 30 cm high from the ground. The period of budding, flowering and harvesting was investigated for the years 2023 and 2024.

The fruit harvest was carried out in two batches, as the fruits reached maturity, the harvest being carried out vertically downwards, along the length of the stems. To assess the quality of the fruits, 100 fruits were harvested in two batches of 50 fruits each, and the differences between the variants were compared with a significance level of 5 %. (Доспехов, 1985).

RESULTS AND DISCUSSIONS

In the case of raspberry cultivation only on annual stems (V1), a higher growth in height of annual stems was observed in all raspberry varieties compared to V raspberry cultivation on annual and biennial stems during one growing season (V3). The highest height of biennial stems was found in Polonez and Enrosadira varieties (185cm), year 2024 and 180 cm in Polonez variety in 2024. In V control, the height of fruit stems was fixed at 160 cm in Polana variety, 175 cm in V Polonez and 185 cm in Enrosadira variety. In Polana variety, due to the average growth vigor of the variety, annual fruit stems have a lower growth compared to Polonez and Enrosadira varieties. In V2, the suppression of root suckers requires a lot of physical effort and high economic costs during the growing season, necessary for the total suppression of root suckers 5 times per season compared to the selective suppression of root suckers 2 times per growing season, carried out in V1 and V3. The most difficult process of suppressing root suckers is observed in varieties with strong root suckers, such as the Polonez and Enrosadira varieties. In control V, the height of annual and biennial stems is lower, compared to V1 and V2, which is explained by the presence of plant competition for nutritional space, water, light, and growth of the leaf apparatus.

The same pattern was also recorded in the case of the diameter of the fruit stems. The smallest diameter of the fruit stems was obtained in V3 in all varieties in his research where the diameter of the annual fruit stems was 0.8-1.0 cm compared to V1 and V2 where the stem diameter was obtained between 1.1-1.3 cm. The thickness of the biennial stems is greater (13 mm) in the Enrosadira variety, in V 2 compared to the Polana and Polonez varieties.

In remontant varieties, the length of the fruiting branches is biologically smaller than in biennial varieties. Thus, the length of the fruiting branches is influenced by the density of the stems and the climatic conditions during the period of fruit formation (in the period April - May). The length of the fruiting branches in remontant varieties is biologically smaller in varieties with a smaller plant growth, such as the "Polana" variety, which means fewer fruits on fruiting branches (Table 1). In 2023, in V2, due to the fact that all the shoots at ground level were cut, it was not possible to demonstrate the repeated harvest in 2024, on biennial stems.

The research conducted aimed to compare production indicators in the traditional cultivation variant (on annual and biennial stems), and only on annual stems V1 and V2. In 2023, in V1, on average, 8 fruits were obtained per inflorescence, and the least was obtained in V3, i.e. 7 fruits per inflorescence. In 2024, adverse weather conditions during the summer months influenced the pollination of flowers and the formation of fruits on annual stems, which ultimately led to a decrease in the autumn harvest. It most influenced the production of raspberries in the variety "Polana", in which the autumn harvest in 2024 was compromised, by the partial drying of the fruits on the plant in August. This fact led to a reduction in the harvest per fruit stem and total per ha.

The other varieties were less affected, only that the cessation of fruiting was observed in August, and the restart of pollination, the appearance of lateral fruit branches at the end of August in the variety Enrosadira. In the varieties Polonez and Enrosadira, in 2023, in V1, 2 more inforescences were obtained on the lateral fruit branches (10 pcs) compared to V1 in the Polana variety (8 pcs), and respectively more fruit branches per plant. In the control variants in the varieties Enrosadira and Polonez, we obtained 8 inforescences, compared to 7 inforescences obtained in the control variant in the Polana variety.

The same pattern was also recorded in 2024, in the sense that the number of inflorescences in the varieties Enrosadira and Polonez is higher by 2 units per fruit branch, compared to the variety Polana. Thus, the varieties "Polonez" and "Enrosadira" recorded not only greater growth vigor and the number of inforescences, but also the number of fruits is higher.

In 2023, in the case of the control variant, the yield per linear meter of the Polana variety is 69.70 % lower than the Polonez variety and 81.81 % lower than the "Enrosadira" variety. The highest yield of the Polana variety in the experience was obtained in V2, and the lowest yield was obtained in the control variant in both years of research. Even though the highest yield was obtained in V3, the quality of the harvested fruits leaves much to be desired, the drajoni are poorly developed (which influences the harvest for the following year), the fruits are smaller than in V1 and V2. One of the causes is the excessive thickening of the plants per linear meter in V3, the competition of biennial stems and drajoni for light, development space and nutrients. Cultivating plants on 2 production cycles can be recommended in a protected space, where environmental factors are regulated, and the vegetative growth of the plants, less so in the open field.

If we refer to the level of production obtained, we note that for the Polana variety, in V1 we obtained the lowest harvest of 5.6 t/ha in 2023, and 5.2 t/ha in 2024.The highest harvest of 12 t/ha was obtained for the Enrosadira variety in V3, or 0.8 t/ha more than in V2 and 1.2 t/ha more than in V1, in 2023. In 2024, the same regularity was recorded in the harvest obtained by variants (table 2). In 2023, the yield of the “Polonez" variety is higher than that of the Polana variety by 64.28 % in V1, by 60 % higher in V2 and by 69.7 % higher in V3, and in 2024 the production level obtained for the “Polonez" variety is 69.23 % higher in V1, compared to the “Polana” variety and by 69.64 % higher in V3. The number of fruits harvested from the fruiting stems of the “Polonez” variety is higher compared to the Enrosadira variety, but because the fruits of the Enrosadira variety are larger in weight, the total yield per ha is practically equal for both varieties.

The quality of raspberry fruits harvested in the control variant, in the Polana variety, is lower, that is, if in V 1 quality I fruits were obtained, in a ratio of 92 %, then in V 3 it is only 80 %, which indirectly influences the marketing price and the volume of discarded fruits obtained. Raspberry fruits in the "Polana" variety are less suitable for long-distance transportation, which makes it difficult to preserve them for a longer time. The fruits obtained in V3, in the Polana variety are the smallest 2.4 g (2023) and 2.5 g (2024), compared to the Polonez variety, where fruits with an average weight in the control V of 3g were obtained, in V2 they were obtained 3.2 g, and respectively 2.8 g in V3, in 2023 and 2.7g in 2024. So we find that the weight of the fruits is strongly influenced by the number of stems per linear meter of strip and by the capacity of the fruiting stems to form large fruits, under the conditions of competition between annual and biennial plants. In V3, a clear influence is observed at the vegetative and generative level on the development of annual stems and

generative organs in both years of research. The market for raspberry production dictates the required quality, which de facto ultimately requires us to use one or another cultivation system. The highest quality fruits, in terms of weight and visual appearance, were obtained in V1 and V2 for the variety "Enrosadira" and the variety "Polonez", and the smallest fruits were obtained in V3.

Table 1

Production indicators of remontant raspberry varieties depending on the cultivation system

Indicators	Polana			Polonez			Enrosadira		
	V1	V2	V3	V1	V2	V3	V1	V2	V3
Year 2023									
Number of fruits per inflorescence, pcs.	8	9	7	10	11	8	10	11	8
Average fruit weight, g	2,6	2,7	2,4	3,0	3,2	2,8	3,4	3,5	3,1
Harvest per linear meter of tape, kg	1,4	1,5	1,65	2,3	2,4	2,8	2,7	2,8	3,0
Total harvest per ha, t	5,6	6,0	6,6	9,2	9,6	11,2	10,8	11,2	12,0
Fruits of quality I, %	92	94	80	96	97	90	97	97	90
Fruits of quality II, %	8	6	20	4	3	10	3	3	10
Year 2024									
Number of fruits per inflorescence, pcs.	7	-	7	10	-	8	10	-	8
Average fruit weight, g	2,5	2,6	2,5	3,0	-	2,7	3,4	-	3,0
Harvest per linear meter of tape, kg	1,3	-	1,68	2,2	-	2,7	2,7	-	3,0
Total harvest per ha, t	5,2	-	6,72	8,8	-	11,4	10,8	-	12,0
Fruits of quality I, %	90	-	78	96	-	88	95	-	90
Fruits of quality II, %	10	-	22	4	-	12	5	-	10

From an economic point of view, the most effective cultivation system for the Polana and Enrosadira varieties is the cultivation of raspberries on annual stems (V1), and for the Polonez variety, in a double production cycle by alternation (one year cultivation on annual and biennial stems, and the following year, cultivation only on annual fruiting ones), in the open field. The permanent cultivation of the Polonez variety in dry years, in two production cycles, will exhaust the vigor of the plant's root system over time, and the economic period of exploitation of the plants. The use of the cultivation variant for obtaining 2 harvests per season (on annual and biennial stems) for the Polonez variety is welcome, unless there are long-term extreme temperatures during the pre-harvest period and during the harvest, such as the summer of 2024, where the harvest on annual fruiting stems was significantly reduced.

CONCLUSIONS

Raspberry cultivation with autumn fruiting on annual stems has demonstrated higher economic efficiency compared to the traditional cultivation method involving fruiting on both biennial and annual stems in the same growing season. The quality and weight of raspberry fruits obtained in two production cycles in a season was lower on annual and biennial stems in the Enrosadira and Polana varieties, being strongly influenced by the density of fruiting stems per linear meter of strip, and by climatic conditions. The highest productivity in two growing seasons

was obtained in the Polonez variety, with fruiting on annual and biennial stems in the same growing season, followed by the Enrosadira variety, with fruiting on annual stems. The open field system remains a viable option for small producers or those with limited investment, being mainly oriented towards local markets or processing. However, climatic risks can be a major limiting factor.

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