THE INFLUENCE OF PRUNING ON FRUIT PRODUCTION AND QUALITY OF SOME RASPBERRY VARIETIES

STUDIUL PRIVIND INFLUENȚA TĂIERILOR DE FRUCTIFICARE ASUPRA PRODUCȚIEI ȘI CALITĂȚII FRUCTELOR LA UNELE SOIURI DE ZMEUR

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Abstract. In the climatic conditions of the Covurlui Plain, it was observed that the '*Przehyba'* variety starts vegetation the earliest, being followed at an interval of 2-4 days by '*Laszka'*, '*Sokolica'* and '*Polka'*. '*Glen Ample*' variety is the latest. Raspberry fruits ripen usually 30-34 days after the appearance of the first flowers, '*Przehyba'* being the first variety to start harvesting, followed shortly by '*Laszka*' and '*Sokolica*', then by '*Polka*'. '*Glen Ample*' is the last to be harvested, the difference between it and the earliest variety existing in the plantation being 15 days. Significant differences between the varieties are observed in terms of the length of the harvest period, which varies for each one separately. The shortest harvesting period was recorded for the '*Laszka*' variety, of only 20-21 days, and the longest for '*Glen Ample*', being approximately 28-30 days. In terms of productivity, the '*Laszka*' raspberry variety stands out (14.5 t/ha), being followed by '*Sokolica*' (12.7 t/h) and '*Polka*' (11.2 t/ha), and the lowest productions being recorded at '*Glen Ample*', with an average of 10.7 t/ha. Among the four variants of densities taken into account, V_4 with 20 suckers shoots per linear meter is the most productive, registering the highest productions in the case of all varieties.
Key words: raspberry, variety, production, quality

Rezumat. În condițiile climatice din Câmpia Covurlui s-a observat că cel mai timpuriu pornește în vegetație soiul *Przehyba*, fiind urmat la un interval de 2-4 zile de către *Laszka, Sokolica* și *Polka*, iar cel mai târziu soiul *Glen Ample*
Maturarea fructelor de zmeur are loc la 30-34 de zile de la apariția primelor flori, *Laszka* fiind primul soi la care se începe recoltarea, fiind urmat la interval scurt de timp de *Sokolica* și apoi de *Polka*. *Glen Ample* se recoltează ultimul, diferența dintre acesta și cel mai timpuriu soi existent în plantație fiind de 15 zile. Diferențe semnificative între soiuri se observă în ceea ce privește durata perioadei de recoltare, aceasta variind pentru fiecare în parte. Cea mai scurtă perioadă s-a înregistrat la soiul *Laska* de doar 20-21 de zile, iar cea mai lungă la *Glen Ample* fiind de aproximativ 28-30 de zile. Sub aspectul productivității soiul de zmeur *Laszka* (14,5 t/ha), fiind urmat de *Sokolica* (12,7 t/h), de *Polka* (11,2 t/ha), iar cele mai mici cantități fiind înregistrate la *Glen Ample* cu o medie de 10,7 t/ha.
Dintre cele patru variante de densități luate în calcul, V_4 cu 20 de tulpini anuale pe metru linear de bandă (20-30 cm), lăsate la tăierile de fructificare de fructificare,la distanța de 15-20 cm una de alta, a fost cea mai productivă înregistrând cele mai mari cantități în cazul tuturor soiurilor.
Cuvinte cheie: zmeur, tăieri de fructificare, soi, calitatea fructelor, productie.

INTRODUCTION

Raspberry is a widespread crop worldwide due to the fact that it bears fruit quickly and it is possible to obtain productions up to 8-16 t/ha. Fruits are of high quality and can be selled at an advantageous price.

The fruits are highly appreciated for their excellent taste, particularly strong and pleasant aroma. They contain 6.3-8.1% sugars, 1.2-3% organic acids, 0.4-0.8% mineral substances, 1.2-1.4% protein substances, vitamins (A, B1, B2, B9, C, E, K, PP). The energy value is 40 kcal/100 g of fresh fruit (Cimpoieș, 2018).

The raspberry culture is one of the most widespread among fruit bushes. The world production of raspberries is about 300,000 t, of which 50% produced by Europe, the world's largest producer of raspberries, where 115.2 thousand tones are harvested annually. 10% of world production is obtained in the USA and Oceania. The largest areas are cultivated with raspberries in Poland, England, USA, Canada, Russia (Sava, 2016). Among the largest raspberry producers are: Russia – 90.0 thousand t, Poland – 40.0 thousand t, Germany – 20.0 thousand t, Hungary – 18.0 thousand t, Great Britain – 11.0 thousand t and France – 8.0 thousand t.

Raspberry culture can be carried out in the open field and in protected spaces and can be conducted in different support systems as a result, the culture technology is also differentiated (Iftimie, 2009; Sava, 2014).

The present work presents the results obtained regarding the influence of pruning on the productivity of some raspberry varieties grown in Câmpia Covurlui.

MATERIAL AND METHODS

The main objective of the study was to evaluate the behaviour of some raspberry varieties in the pedoclimatic conditions from Galati area. The study was carried out in the raspberry plantation of the Rediu family fruit farm, the unit being located in the administrative territory of Rediu commune, in Galaţi County.

The plantation was established in 2017, with five raspberry varieties: 'Przehyba', 'Laszka', 'Polka', 'Glen Ample', and 'Sokolica', with planting distances: 3 m between rows and 0.5 m between plants per row, with a support system installed, respective trellises with three wires.

The prunings are carried out in two stages, the first taking place in autumn when the stems that have fruited are removed and a number of root shoots are chosen from the respective year that will ensure the production for the following year, depending on the variety, these being tied to wires. The second stage takes place in the spring and consists in removing the stems that are extra and replacing the ones chosen in autumn with new ones in case they have dried up over the winter. Also, during this period, the stems are shortened to 10-15 cm above the second wire, and in the case of primocane varieties, the dry part of the plant that bore fruit in the previous year is removed.

The experimental variants are represented by the number of annual stems per linear meter of strip (of 20-30 cm), left at the pruning, at a distance of 15-20 cm from each other:

V1– 8 annual stems/m.l. of fruiting band.

V2 – 12 annual stems/m.l. of fruiting band.

V3 – 16 annual stems / m.l. of fruiting band.

V4 – 20 annual stems / m.l. of fruiting band.

In order to achieve the objectives established in the study, certain observations, measurements, determinations and analyzes were carried out regarding the way of growth and fruiting, depending on the factors taken into the study, as it follows: the development of growth and fruiting phenophases; the density and height of the root stems; the productive potential of the varieties; the fruit quality.

In order to apreciate fruit quality there was conducted a survey and the answers were primarily grouped in: positive taste apreciation (fruits have a balanced taste, sweet and pleasantly expressive, without astringency) and negative taste apreciation (fruits with a bland, inexpressive taste, too sharp or lack of acidity, astringent taste).

Taste grades were: 1-3 unsatisfactory, 4-6 good, 7-9 very good.

RESULTS AND DISCUSSIONS

1. Growth and fruiting phenophases of studied raspberry varieties

The biginning and development of the raspberry growth and fruiting phenophases are different from one year to another depending on the climatic conditions (tab. 1).

The temperature is a limiting factor in terms of the good development of all the phenophases, the start of vegetation of the raspberry varieties is realized when the biological threshold of 5° C is reached (Tudor, 1980).

The research carried out during the two years showed the influence that the temperature exerts on the beginning of the phenophases, they highlighted a delay regarding the start of vegetation by approximately two weeks in the year 2021 compared to the year 2020.

In the case of raspberry the swelling of the buds occurs when the sum of the active temperatures reaches 40-50°C, for budding 67-76°C is needed, while for the flowers appearance phenophase it must reach 586-775°C.

In the case of the five raspberry varieties analyzed in the climatic conditions of the Covurlui Plane area, it was observed that ‘Przehyba’ is the earliest to start vegetation, being followed at an interval of 2-4 days by ‘Laszka’, ‘Sokolica’ and ‘Polka’. The latest of all is ‘Glen Ample’ where the bud swelling phenophase started a week after ‘Przehyba’.

Budding normally takes place in the second half of March and until the second decade of April, depending on the variety and climatic conditions.

The optimal temperature requirement for budding phenophase is obtained in the case of all varieties 3-5 days after buds swelling, the only noticeable difference being between the two years in which the studies were carried out.

Unlike other species, raspberries bloom later and escape the negative influence of late spring frosts.

The start of flowering usually occurs in early May to late May, depending on the sum of the accumulated active temperatures.

Flowering and fruit ripening occurs sequentially, starting with the opening of the inflorescences at the tip, from the top of the shoot and descending to the base, lasting 3-4 weeks.

To reach the flowering phase depending on the variety, it is necessary to accumulate 480.3–603.3˚C from the beginning of vegetation. Taking into account the created conditions, the flowering period can take place, starting from the 1st decade of May to the 3rd decade of May. The duration of the mass flowering period is 18-26 days.

The 'Glen Ample' raspberry variety showed late flowering, respectively 20.05.-30 05.

Table 1

Calendar datas on the initiation and development of the raspberry vegetation phenophases during 2020-2021

Variety	Buds swelling	Budding	Inflorescences appearance	The begining of flowering	The end of flowering	Fruit ripening	Harvest period (days)
Glen Ample	09.04-14.04	12.04-17.04	09.03-17.05	21.05-30.05	20.06-27.06	21.06-02.07	28-30
Laszka	25.03-08.04	29.03-12.04	20.04-12.05	06.05-21.05	26.05-11.06	08.06-23.06	20-21
Przehyba	20.03-07.04	24.03-11.04	18.04-10.05	07.05-18.05	01.06-13.06	06.06-21.06	25-26
Sokolica	21.03-10.04	26.03-14.04	22.04-14.05	06.05-22.05	02.06-29.06	08.06-24.06	27-29
Polka	21.03-09.04	25.03-13.04	22.04-19.05	05.05-20.05	25.08-15.09.	08.06-21.06	95

a b c d

Fig. 1. 'Polka' variety phenophases: buds swellingr (a), budding (b), Inflorescences appearance (c) and fruit ripening (d)

Raspberry fruits ripen 30-34 days after the appearance of the first flowers, 'Laszka' being the first variety to start harvesting, followed shortly by 'Sokolica', and then by 'Polka'. 'Glen Ample' is harvested last, the difference between it and the earliest variety in the plantation being 15 days.

Significant differences between the varieties are observed in terms of the length of the harvest period, which varies for each one separately. The shortest period was recorded for the 'Laska' variety of only 20-21 days, and the longest for 'Glen Ample', which was approximately 28-30 days.

'Polka' is a variety with continuous fructification, and in this case the harvesting interval extends from summer to autumn when the second harvest ends (128 days in 2020 and 95 days in 2021).

The raspberry varieties grown in the climatic conditions of Covurlui Plane have duration of the vegetation period between 215 and 243 days.

2. Results obtained regarding the influence of pruning on vegetative growth and fruiting of raspberry stems.

The capacity to produce root shoots (expresed by number of fertile stems per m.l.) of raspberry plants is a characteristic of the variety, which ensures fruiting the following year and is influenced by climate, soil type and fertility, water supply, climatic conditions, applied technology, etc (Mladin *et all, 2008*).

Most of the studied varieties have an average capacity to produce root shoots (fig. 2). The raspberry variety with the highest capacity to produce root shoots is 'Glen Ample', it is followed in order by 'Polka', 'Sokolica', and the fewest root shoots are recorded in the 'Laszka' variety.

From the analysis of the obtained data, it appears that the capacity to produce root shoots of all varieties decreases progressively with the increase in the number of annual stems left after fruiting cuts (fig. 2).

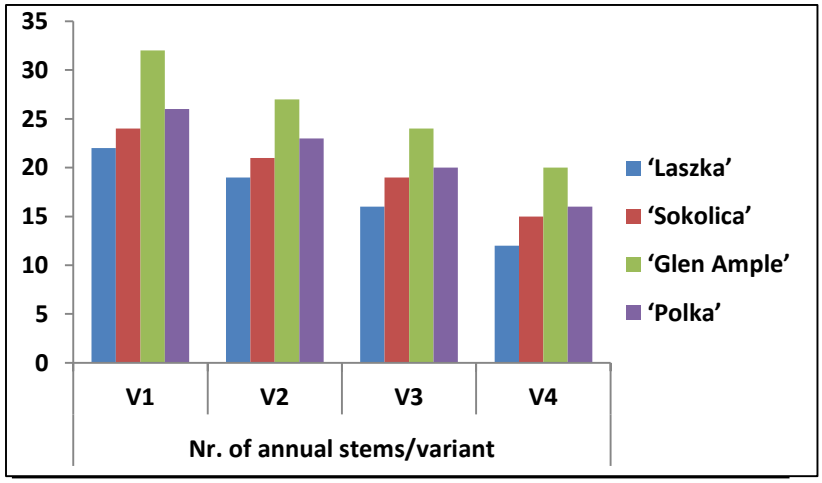

Fig. 2. The capacity to produce root shoots of the studied raspberry varieties, depending on the number of annual stems left at cutting (V1– 8 annual stems per m.l.; V2 – 12 annual stems per m.l.; V3 – 16 annual stems per m.l.; V4 – 20 annual stems per m.l)

The height of the shoots is considered to be an important characteristic, in obtaining a superior production both qualitatively and quantitatively (fig. 3).

From the analysis of the data presented in fig. 3, it can be seen that if more stalks are left per linear meter in the fruit cuttings, the root shoots capacity is decreased.

The raspberry variety with the tallest root shoots was 'Glen Ample', with an average height of 2.61 m in V1 variant, and the shortest ones are found in the 'Polka' variety with an average size of 2.09 m in the same V1 variant.

The average root shoots height of all studied raspberry varieties was higher in 2021 compared to 2020, which was a dry year, with the lack of rain affecting annual shoot growth.

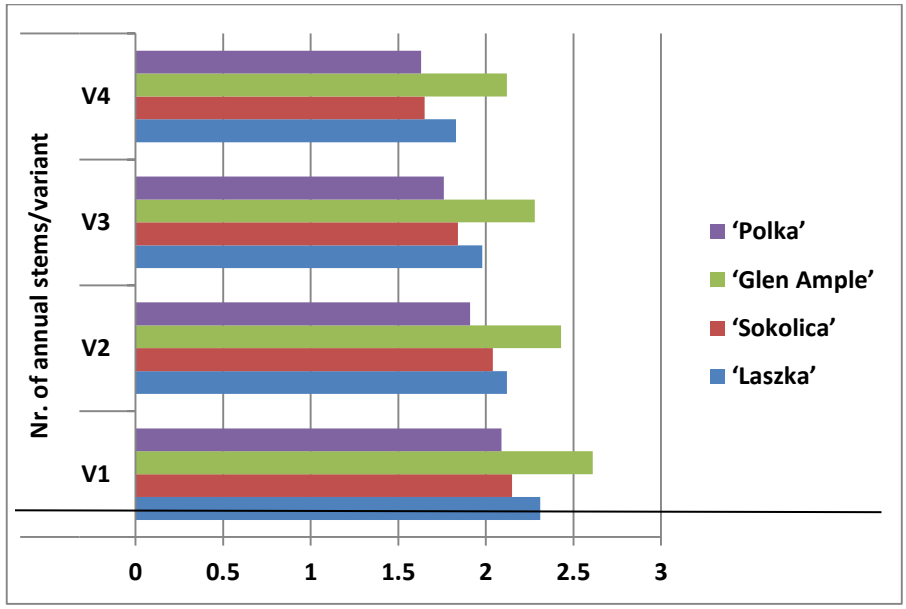

Fig. 3. The height of fertile stems according to the number of annual stems left at cutting, per linear meter (V1– 8 annual stems per m.l.; V2 – 12 annual stems per m.l.; V3 – 16 annual stems per m.l.; V4 – 20 annual stems per m.l)

The increase in the thickness of the shoots of raspberry plants exerts a positive influence on the production and its quality, with vigorous root shoots producing quality fruit.

The diameter of the root shoots in the raspberry varieties is different, depending on the annual stems left per linear meter at the fruiting cuts (table 2).

Within V2 and V3 variants, the vigor of the root shoots is considered to be good, but the largest diameters of the root shoots were recorded in V2, among all the studied varieties.

Table 2

Shoots diameter in some raspberry varieties, depending on the number of annual stems left per linear meter, at fruiting cuttings (mm)

Variety	Nr. of annual stems/variant			
	V_1	V_2	V_3	V_4
'Laszka'	9.6	11.8	11.4	9.9
'Sokolica'	11.5	12.8	12.2	11.1
'Glen Ample'	10.9	13.0	12.7	10.9
'Polka'	11.5	14.6	12.8	11.2

V1– 8 annual stems per m.l.; V2 – 12 annual stems per m.l.; V3 – 16 annual stems per m.l.; V4 – 20 annual stems per m.l

3. Results on fruit production

Raspberries fruit production obtained is influenced by the variety and directly by the number of fertile stems left on the fruiting cuttings, which ensure the fruit production of the respective year.

The fruit production obtained from raspberries is influenced by the variety and directly by the number of root shoots left after the fruiting cuttings, which ensure the fruit production of the respective year (Milutinovid *et all*, 2008; Pritts, 2008).

Table 3

Raspberry varieties production according to the number of annual stems left per linear meter, after cutting

Variety	Variant	Fruit average weight (g)	Production/ml (kg)	Production (t/ha)
'Laszka'	V_1	11.6	4.8	10.5
	V_2	9.8	5.1	13.8
	V_3	6.4	5.2	14.1
	V_4	4.2	5.3	14.5
'Sokolica'	V_1	9.7	4.0	8.9
	V_2	9.3	3.2	11.5
	V_3	6.6	4.5	12.3
	V_4	4.3	4.7	12.7
'Glen Ample'	V_1	8.9	2.2	6.1
	V_2	7.3	2.9	7.9
	V_3	6.4	3.6	9.8
	V_4	4.1	3.8	10.7
'Polka'	V_1	7.8	2.8	7.7
	V_2	6.3	3.5	9.5
	V_3	4.8	3.7	10.0
	V_4	3.2	4.1	11.2

V1– 8 annual stems per m.l.; V2 – 12 annual stems per m.l.; V3 – 16 annual stems per m.l.; V4 – 20 annual stems per m.l

Among the four studied variants, V4 with 20 annual stems left per linear meter after fruiting cuts, recorded the highest productions in the case of all raspberry varieties (tab. 3).

In terms of productivity, the 'Laszka' variety stood out, with 14.5 t/ha, followed by 'Sokolica' with 12.7 t/ha, 'Polka' with 11.2 t/ha, and the lowest productions being recorded at 'Glen Ample' with an average of 10.7 t/ha in the case of V4 (tab. 3).

Although in terms of average fruit weight, the V1 variant gives the best results (between 7.8 g and 11.6 g), the higher productivity was recorded in the V4 variant where 14.5 t/ha were obtained, being followed by V3 with 14.1 t/ha, then by V2 with 13.8 t/ha and by V1 with 10.5 t/ha (tab. 3).

Analyzing the average fruit weight/productivity ratio, the best variants are V2 – 12 annual stems/m.l. and V3 – 16 annual stems /m.l., left after fruiting cuts, where the average fruit weight was between 6.3 g and 9.8 g and the fruit production varied between 7.9 t/ha and 14.1 t/ha.

Among the studied raspberry varieties, 'Laska' stood out (13.8 t/ha and the average fruit weight of 9.8 g in the V2 variant), followed by 'Sokolica' (11.3 t/ha and the average fruit weight of 9,5 g in the V2 variant), 'Glen Ample' (9.8 t/ha and average fruit weight of 4.4 g in the V3 variant).

Polka being a variety with continuous fruiting, only autumn production was taken into account, in spring the terminal portions of the annual stems were removed by cutting, and the root shoots were thinned at the beginning of summer when they reached 25-30 cm high.

In the Polka variety, production increases with annual stems left per linear meter and fruit weight decreases as the number of annual stems increases. The best productivity was recorded in V4 variant, of 11.2 t/ha, and the lowestin V 1 with 7.7 t/ha. The average fruit weight decreased from 7.8 g, to 6.3 g, then to 4.8 g and to 3.2 g.

4. Aspects regarding raspery fruit quality

The quality of raspberry production is represented by the weight of the fruits, their length, their color and shape, their firmness and the fruit content in chemical substances (carbohydrates, titratable acidity and ascorbic acid content) (Mladin and Mladin, 2008).

Analyzing the data presented regarding the height of the fruits, it is observed that it decreases with the increase in the number of shoots per linear meter left at the fruiting cuts, in the case of all the varieties taken in the study. So that in the 'Laszk'a variety in V1 the average height was 4.6 cm, then decreasing to 4 cm in V2, than to 3.1 cm. in V3 and respectively 2.6 cm in V4.

As for the shape of the raspberry fruits, this does not depend on the density of the berries, being more a characteristic of each variety, they maintaining the same shape in all four variants, namely: conical, but slightly elongated in 'Polka', conical to spherical in the 'Glen Ample' variety, conical in 'Sokolica' and elongated conical in 'Laszka' (tab. 4; fig. 4).

As in the case of the shape, the color of the fruit is not influenced by the number of fruiting stems, it varies in shades of red depending on the variety (table 4.).

According to all the analyzed characteristics, the V1 and V2 variants have the necessary number of fruiting stems to obtain a quality production, and in the case of the 'Glen Ample' variety, V3 also produces quality fruits, the average fruit high of 2.7 cm placing the fruit in the category of very good quality for that variety.

Table 4

Fruit quality in some raspberry varieties, depending on the number of annual stems per linear meter, left after fruiting cuts

Variety	Variant	Fruit high (cm)	Fruit form	Colour	Taste
'Laszka'	**V1**	4.6	Conical elongated	Intense red	7-9
	V2	4.0			7-9
	V3	3.1			4-6
	V4	2.6			1-3
'Sokolica'	**V1**	3.9	Conical	Bright red	7-9
	V2	3.6			7-9
	V3	2.9			4-6
	V4	2.4			1-3
'Glen Ample'	**V1**	3,4	Conical to spherical	Dark red	7-9
	V2	3.0			7-9
	V3	2.7			7-9
	V4	2.0			1-3
'Polka'	**V1**	2.8	Conical slightly elongated	Dark red towards sour cherry red	7-9
	V2	2.5			7-9
	V3	2.0			4-6
	V4	1.7			1-3

V1– 8 annual stems per m.l.; V2 – 12 annual stems per m.l.; V3 – 16 annual stems per m.l.; V4 – 20 annual stems per m.l
Taste grades 1-3 unsatisfactory, 4-6 good, 7-9 very good

The ability of raspberry varieties to adapt to new growing conditions is different, and the insufficiency or lack of atmospheric precipitation can influence the production quality and quantity, reduce the weight of the fruits.

'Polka' **'Laszka'** ***'Glen Ample'*** ***'Sokolica'***

Fig. 4. Fruit size and shape in the studied raspberry cultivars

CONCLUSIONS

The pedoclimatic conditions in the area of Câmpia Covurlui are favorable for raspberry culture, except for the rainfall regime that can be compensated by applying crop irrigation.

In terms of productivity, the 'Laszka' variety stood out, with 14.5 t/ha, followed by Sokolica with 12.7 t/ha, Polka with 11.2 t/ha, and the lowest productions being recorded at Glen Ample with an average of 10.7 t/ha.

Among the four variants of densities taken into account, V4 with 20 annual stems per linear meter is the most productive, registering the highest productions in the case of all varieties.

Analyzing the productivity/fruit quality ratio, the best variants are V2 – 12 annual stems per m.l. and V3 – 16 annual stems per m.l., left after fruiting cuts.

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