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The Effects of the Summer Pruning Operations on the Winter Buds Productivity of cv. Vranec (*Vitis vinifera* L.)

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Abstract

The study presents the analysis of the influence of summer pruning operations (defoliation, cluster thinning) on the parameters of a potential productivity of winter buds at the vine variety Vranec grown near Veles in the period 2013-2015. For this research, four treatments were set: control, defoliation and two types of cluster thinning: 10 and 6 clusters per vine. From the obtained results it is found that there are no injuries in the main winter buds during the vegetation period and the potential fruitfulness is determined by higher coefficient, 1.38, which depends on the location along the cane. The yield at this variety will be formed mainly by clusters with size of 350-550 μm, followed by those with the length of 550-750 μm. The application of defoliation and regulation of the vine yield has a beneficial effect on increasing the rate of potential fruitfulness of winter buds, the number of buds with 2 and 3 clusters, increasing the inflorescences with a length of 350-550 μm and the appearance of those longer than 750 μm.

Key words: Vranec, defoliation, cluster thinning, potential fruitfulness, winter buds, yield

Introduction

Defined indicators for vine variety yield are potential fertility rates based on the total number of healthy winter buds. Varieties react different to the environmental conditions of growth and fruitfulness. The pruning system as a major agricultural factor has a significant impact on the potential rate of fertility of buds and the accumulation of more effective temperature sum with a good fertilization regime, which favors the formation of larger rudimentary organs in the buds on the vine (Braykov, 1975; Stoychev, 2005). There are a number of studies related to the terms of forming, development and differentiation of inflorescences in winter buds of various wine and table grape varieties (Zembery, 1974; Dikany, 1978; Pratt 1971; Hegedus, 1977; Bindra, 1980; Braikov and Roichev 2002; Braykov and Roytchev 2003). It is very important to approach the information related to the potential fertility of winter buds of the local varieties, which are of great economic importance for the region. The purpose of this study is to establish a climate effect on agro-biological parameters influencing the formation of the yield at the vine variety Vranec widespread in the Republic of Macedonia.

Material and Methods

Studies were carried out in a vineyard planted with the variety Vranec in the town of Veles - Republic of Macedonia. The plant density in the vineyard was 2.6 x 1.2 m and the vineyard was located at altitude of 280 m. The vine pruning system was double Guyot loaded with two canes with 8 winter buds and two spurs with two winter buds. All experimental vines were with good health and grow force conditions. The following treatments were applied: *control* – C: without application of summer pruning operations; *defoliation* – D: from the base of the fruiting shoots to the grape bunches area made in mid-August at nearly 80% of veraison; two cluster thinning treatments performed at the end of July: the first one by leaving *6 clusters per vine* – CT 6, and the second one by *leaving 10 clusters per vine* – CT 10 (one cluster on one fruiting shoot). The samples were collected during the autumn-winter period of three experimental years (2013-2015) and consist of 40 randomly picked canes developed from the previous growing season with a length of 15 winter buds for each treatment. All winter buds from the base to the tip of the canes were separated from the canes by chip budding and placed in 70% ethyl alcohol (Braykov 1972, 1981).

The following indicators of winter bud cross sections on spectroscopic binocular were observed: percentage of dead major buds; coefficient of potential fruitfulness (CPF) - calculated on the basis of the number of total buds - healthy

and dead, percentage of fruitless and fruitfulness winter buds - only from healthy buds, percentage of fruitful winter buds with 1, 2 and 3 inflorescences, length of inflorescences divided into four groups: I - 350 μm; II - from 350 to 550 μm; III – from 550 to 750 μm and IV - over 750 μm.

The data for the studied indicators from the even winter buds were obtained by interpolation of the values of the adjacent two buds, summarized for each bud and an average for the whole cane for a period of three years.

For the analysis of the experimental data considering the average for the fruiting cane for a period 2013-2015, modules for Duncan's criteria found in the SPSS 17.0 statistical software were used (Mokreva, 2007).

Results and Discussion

While growing Vranec variety near the town of Veles, the parameters of potential fertility in treatment C - without application of summer pruning operations were changing within certain limits (Tab. 1). The information about the percentage of dead major buds during the growing season in winter buds is important when determining the load with winter buds before any pruning operations. There were no dead major buds among the winter buds along the entire length on the fruitful canes. The coefficient of potential fertility gradually increases from 0.80 for the first bud to 1.75 at the 11^{th} bud, after which its values decreased slightly, and its average value was 1.38 / 1.38. The percentage of fruitful first buds was 60%, and the percentage of fruitful second buds was 67.5%, after which the value of this indicator increased significantly by 100% in 9^{th} and 13^{th} -15^{th} bud, with an average of 90.59%.

Fruit buds with 3 inflorescences were reported in the section from 6^{th}-15^{th} bud of the cane - an average of 2.56%. The fruiting buds with two inflorescences (60.80%) are twice as representative as the ones with one inflorescences (36.64%). The yield is formed mainly from inflorescences with a length of 350-550 μm - group II (50.97%) and 550-750 μm - group III (33.71%). In the control treatment 5.53% of the inflorescences belong to the IV group, longer than 750 μm. The germinal shoot lenght slightly increased from 0.53 mm in the middle of the cane to 0.74mm in the 9^{th} bud. The D treatment lacks dead major buds along the entire length of the fruitful cane (Tab. 2).

The potential factor, based on all buds including healthy ones in the study, had increased values till the fifth bud, 1.60 / 1.60, then the values slightly decreased till the section from 9^{th} to 11^{th} bud where it reached its maximum level of 1.75 / 1.75. To the end of the fruiting cane, at the 15^{th} bud, these values were in the range from 1.50 to 1.65. Compared with the C treatment, this ratio has higher average values - 1.49 / 1.49.

Tab. 1. Parameters of potential buds fertility in Vranec variety grown in the region of Veles – control treatment (C), for 2013 - 2015
Параметри плодности потенцијалних пупољака сорте Вранац у региону Велеса – контрола (С), за период 2013-2015

Indicators	winter buds along the fruiting cane															Avg.
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
1. Dead major buds (%)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2. CPF* based on the number of healthy buds	0.8	0.92	1.05	1.22	1.4	1.38	1.35	1.38	1.4	1.58	1.75	1.7	1.65	1.6	1.56	1.38
3. CPF based on the number of all buds	0.8	0.92	1.05	1.22	1.4	1.38	1.35	1.38	1.4	1.58	1.75	1.7	1.65	1.58	1.5	1.38
4. Fruitless major buds (%)	40	32.5	25	15	5	5.28	5.56	2.78	0	2.5	5	2.5	0	0	0	9.41
5. Fruitful major buds (%)	60	67.5	75	85	95	94.72	94.44	97.22	100	97.5	95	97.5	100	100	100	90.59
6. Fruitful buds with:																
1 inflorenscence (%)	7.14	13.84	20.53	37	53.47	47.23	45	52.17	66.33	48.22	31.11	30.56	29	33	35	36.64
2 inflorenscence (%)	92.86	86.16	79.47	63	46.53	50.77	50	43.33	31.67	48.28	65.39	67.44	66	61	60	60.8
3 inflorenscence (%)	0	0	0	0	0	2	5	4.5	2	3.5	3.5	2	5	6	3	2.56
7. Inflorenscences with length:																
to 350 μm	40	28.33	16.67	14.1	11.54	9.94	8.33	5.83	3.33	3.45	3.57	1.79	0	0	0	9.79
from 350 – 550 μm	60	68.9	77.78	69.14	62.11	51.94	42.39	36.19	28.73	33.47	40.17	39.32	41.8	51.28	61.25	50.97
from 550 – 750 μm	0	2.77	5.55	14.31	23.08	33.56	44.05	52.32	60.59	52.86	45.13	47.56	50	41.28	32.57	33.71
over 750 μm	0	0	0	2.45	3.27	4.56	5.23	5.66	7.35	10.22	11.13	11.33	8.2	7.44	6.18	5.53
8. Length of the germinal shoot mm	0.53	0.58	0.62	0.62	0.62	0.65	0.68	0.71	0.74	0.73	0.7	0.7	0.71	0.72	0.73	0.67

* CPF – Coefficient of potential fruitfulness / *Коефицијент потенцијлне плодности*

Table 2. Parameters of potential buds fertility in Vranec variety grown in the region of Veles, defoliation treatment - D, 2013 - 2015

Параметри плодности потенцијалних пупољака сорте Вранац у региону Велеса – дефолијација - D, 2013 – 2015

Indicators	winter buds along the fruiting cane															Avg.
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
1. Dead major buds (%)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2. CPF* based on the number of healthy buds	0.75	1.08	1.4	1.5	1.6	1.5	1.4	1.58	1.75	1.75	1.75	1.65	1.55	1.52	1.5	1.49
3. CPF based on the number of all buds	0.75	1.08	1.4	1.5	1.6	1.5	1.4	1.58	1.75	1.75	1.75	1.65	1.55	1.52	1.5	1.49
4. Fruitless major buds (%)	35	20	5	5	5	7.5	10	5	0	2.5	5	2.5	0	2.5	5	7.33
5. Fruitful major buds (%)	65	80	95	95	95	92.5	90	95	100	97.5	95	97.5	100	97.5	95	92.67
6. Fruitful buds with:																
1 inflorenscence (%)	85.71	68.97	52.22	41.94	31.67	35.28	38.89	31.94	25	25.56	26.11	38.06	50	49.17	48.33	43.26
2 inflorenscence (%)	14.29	31.03	47.78	58.06	68.33	64.72	61.11	68.06	75	69.44	63.89	54.44	45	45.83	46.67	54.24
3 inflorenscence (%)	0	0	0	0	0	0	0	0	0	5	10	7.5	5	5	5	2.5
7. Inflorenscences with length:																
to 350 μm	33.33	18.45	3.57	1.79	0	0	0	0	0	1.56	3.12	1.56	0	0	0	4.22
from 350 – 550 μm	61.11	69.84	78.58	71.54	64.51	62.9	61.3	62.02	62.75	60.98	59.21	59.73	60.26	67.62	75	65.16
from 550 – 750 μm	5.56	11.71	17.85	26.67	35.49	33.97	32.45	33.38	34.31	35.99	37.67	38.71	39.74	32.38	25	29.39
over 750 μm	0	0	0	0	0	3.13	6.25	4.6	2.94	1.47	0	0	0	0	0	1.23
8. Length of the germinal shoot mm	0.54	0.6	0.63	0.68	0.7	0.7	0.71	0.7	0.69	0.68	0.67	0.65	0.7	0.71	0.71	0.62

* CPF – Coefficient of potential fruitfulness / *Коефицијент потенцијлне плодности*

According to the results, the defoliation has a beneficial effect on increasing the number of inflorescences in the winter buds, most likely due to the improvement of nutrition, light and air regime of the plants. There are no significant differences in the percentage of fruitful and fruitless major buds between two treatments. The percentage of fruit buds is high: 92.67%. Certain differences were observed in the percentage of fruitful buds with 1, 2 and 3 inflorescences.

The yield in this case is determined mainly by the buds with 2 clusters - 54.24% and those with 1 inflorescence - 43.26%.

The dynamics of percentile change in the buds with 2 inflorescences have two high points at the 5th bud (68.33%) and the 9th bud (75.00%), which correspond to the changes in the coefficient of potential fruitfulness. Buds with 3 inflorescences appear and are established after the 9th bud and they reach 10% in the 11th bud, an average of 2.50 %.

At this treatment, similar to the C, the inflorescences of Group II dominated (65.16%) with the length of 350-550 μm, which will clearly define the quantity of yield. The percentages of this indicator vary in nodes in the range from 59.21% in the 11th bud to 78.58% in the 3rd bud. The number of buds with length of inflorescences of 550-750 μm in group III with 29.39% is twice less abundant. Unlike the C treatment, between the 6th and the 10th bud, inflorescences of the group IV (longer than 750μm) are detected, which are mostly found at the 7th bud - 6.25%; average of 1.23%. The length of the germinal shoot has nearly equal values as those in the C control treatment.

The variety Vranec with yield regulation by leaving 6 clusters per vine showed almost the same characteristics as the treatment C (Tab. 3). There are no dead major buds, and the coefficient of potential fertility is higher when compared to previous two treatments (C and D). The percentage of major fruit buds is high, with an average of 91.61% and in the area between the 5th and 9th bud it is 100%. The yield of grapes is determined mainly by the buds with 2 inflorescences - 55.76% and 1 inflorescence - 43.20%. Between the 12th and the 15th bud there were also buds with 3 inflorescences with an average of 1.04%.

Similar to the treatment C, the highest number of inflorescences were from Group II with a length of 350-550 μm – 49.13 %, followed by Group III - 550-750 μm – 38.08%. The largest inflorescences were missing only in the first bud, as their average amount was 7.71%. The size of the germinal shoot did not differ from the one of the C treatment.

After cluster thinning with leaving 10 clusters per vine, some important parameters of potential fertility significantly changed when compared to the C treatment (Tab. 4).

Table 3. Parameters of potential buds fertility in Vranec variety grown in the region of Veles, CT 6 treatment, 2013 – 2015

Параметри плодности потенцијалних пупољака сорте Вранац у региону Велеса – третман CT 6, *2013 – 2015*

Indicators	winter buds along the fruiting cane															Avg.
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
1. Dead major buds (%)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2. CPF* based on the number of healthy buds	0.79	1.02	1.27	1.39	1.71	1.75	1.79	1.7	1.6	1.5	1.47	1.55	1.63	1.72	1.9	1.52
3. CPF based on the number of all buds	0.79	1.02	1.27	1.39	1.71	1.75	1.79	1.7	1.6	1.5	1.47	1.55	1.63	1.72	1.9	1.52
4. Fruitless major buds (%)	45	30	15	7.5	0	0	0	0	0	2.5	5	5	5	5.28	5.56	8.39
5. Fruitful major buds (%)	55	70	85	92.5	100	100	100	100	100	97.5	95	95	95	94.72	94.44	91.61
6. Fruitful buds with:																
1 inflorenscence (%)	0	20.14	40.28	52.64	65	67.5	70	55	40	45	50	40.83	31.67	34.58	35.5	43.2
2 inflorenscence (%)	100	79.86	59.72	47.36	35	32.5	30	45	60	55	50	56.39	62.78	62.64	60	55.76
3 inflorenscence (%)	0	0	0	0	0	0	0	0	0	0	0	2.78	5.55	2.78	4.5	1.04
7. Inflorenscences with length:																
to 350 μm	50	23.89	2.37	0	0	0	0	0	0	0	0	0	0	0	0	5.08
from 350 – 550 μm	6.25	22.41	38.57	46.51	52.44	58.73	60.01	60.97	62.92	59.71	52.5	52.07	51.65	51.32	60.8	49.13
from 550 – 750 μm	43.75	48.3	52.86	48.83	42.22	36.04	26.86	25.8	29.74	35.62	37.5	39.93	34.35	34.38	35	38.08
over 750 μm	0	5.4	6.2	4.66	5.34	5.23	13.13	13.23	7.34	4.67	10	8	14	14.3	4.2	7.71
8. Length of the germinal shoot mm	0.54	0.57	0.6	0.66	0.71	0.72	0.74	0.75	0.77	0.74	0.71	0.7	0.7	0.72	0.75	0.69

* CPF – Coefficient of potential fruitfulness / *Коефицијент потенцијлне плодности*

Table 4. Parameters of potential buds fertility in Vranec variety grown in the region of Veles, CT 10 treatment, 2013 - 2015

Параметри плодности потенцијалних пупољака сорте Вранац у региону Велеса – третман CT 10*, 2013 – 2015*

Indicators	winter buds along the fruiting cane															Avg.
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
1. Dead major buds (%)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2. CPF* based on the number of healthy buds	0.59	1.02	1.45	1.53	1.61	1.62	1.63	1.63	1.63	1.69	1.75	1.8	1.85	1.75	1.65	1.55
3. CPF based on the number of all buds	0.59	1.02	1.45	1.53	1.61	1.62	1.63	1.63	1.63	1.69	1.75	1.8	1.85	1.75	1.65	1.55
4. Fruitless major buds (%)	41.25	23.12	5	2.5	0	2.5	5	2.5	0	0	0	2.5	5	2.5	5	6.46
5. Fruitful major buds (%)	58.75	76.88	95	97.5	100	97.5	95	97.5	100	100	100	97.5	95	97.5	95	93.54
6. Fruitful buds with:																
1 inflorenscence (%)	100	74.17	48.33	43.33	38.33	33.06	27.78	32.22	36.67	30.83	25	20.55	16.11	20.55	25	38.13
2 inflorenscence (%)	0	25.83	51.67	56.67	61.67	66.94	72.22	67.78	63.33	69.17	75	73.89	72.78	73.89	75	60.39
3 inflorenscence (%)	0	0	0	0	0	0	0	0	0	0	0	5.56	11.11	5.56	0	1.48
7. Inflorenscences with length:																
to 350 μm	39.58	21.88	4.17	2.09	0	0	0	0	0	1.39	2.78	1.39	0	0	0	4.89
from 350 – 550 μm	18.75	18.81	18.87	35.08	51.31	60.85	70.38	72.27	74.17	67.15	60.12	55.43	50.73	57.03	63.33	51.62
from 550 – 750 μm	41.67	57.23	72.79	60.74	48.69	34.74	20.8	18.63	16.46	23.83	31.21	40.23	49.27	38.8	28.34	38.9
over 750 μm	0	2.08	4.17	2.09	0	4.41	8.82	9.1	9.37	7.63	5.89	2.95	0	4.17	8.33	4.59
8. Length of the germinal shoot mm	0.59	0.64	0.7	0.73	0.76	0.78	0.8	0.82	0.8	0.8	0.81	0.79	0.79	0.79	0.79	0.71

* CPF – Coefficient of potential fruitfulness / *Коефицијент потенцијлне плодности*

Tab. 5 Comparing multivariate analysis of the investigated parameters of the potential buds fruitfulness at the grape variety Vranec compared between treatments, average for the fruiting cane for period 2013-2015
Мултиваријантна анализа испитиваних параметара продуктивности потенцијалних пупољака сорте грожђа Вранац, поређења третмана, просјек за чокот у периоду 2013-2015

Indicators Treatment	K on the base of healthy buds		K on the base		Fruitless major buds		Fruitful buds		Fruitful buds with 1 inflorescence %		Fruitful buds with 2 inflorescence %	
	Duncan		Duncan		Duncan		Duncan		Duncan		Duncan	
C	1.38	b	1.38	b	9.41	a	90.59	c	36.64	c	60.80	a
D	1.49	a	1.49	a	7.33	c	92.67	ab	43.26	a	54.24	b
CT 6	1.52	a	1.52	a	8.39	b	91.61	b	43.2	a	55.76	b
CT 10	1.55	a	1.55	a	6.46	d	93.54	a	38.13	b	60.39	a
a, b, c .. degree of proof according to the Duncan's method at error α = 0.05												
Indicators Treatment	Fruitful buds with 3 inflorescence %		Inflorescences with length till 350 µm %		Inflorescences with length from 350 – 550 µm %		Inflorescences with length from 550 – 750 µm %		Inflorescences with length over 750 µm %		Lenght of leading shoot mm	
	Duncan		Duncan		Duncan		Duncan		Duncan		Duncan	
C	2.56	a	9.79	a	50.97	b	33.71	b	5.53	b	0.67	a
D	2.50	a	4.22	d	65.16	a	29.39	c	1.23	c	0.62	a
CT 6	1.04	c	5.08	b	49.13	b	38.08	a	7.71	a	0.69	a
CT 10	1.48	b	4.89	c	51.62	b	38.9	a	4.59	b	0.71	a
a, b, c .. degree of proof according to the Duncan's method at error α = 0.05												

* CPF – Coefficient of potential fruitfulness / *Коефицијент потенцијлне плодности*

The highest level in this study reached the coefficient of potential fruitfulness - 1.55 / 1.55, which gradually increased along the length of the cane from the 1st bud – 0.59 to the 13th bud - 1.85. The fruitful buds are the most abundant compared to other control treatments - 93.54%. The yield is determined by the buds with 2 inflorescences - 60.39% and those with 1 inflorescence - 38.13%. In the area from the 12th -14th nodes there were also buds with 3 inflorescences - 1.48%. The amount of smallest inflorescences of group I with a length of 350 μm and Group IV - over 750 μm are almost identical - 4.89% and 4.59%. There are most inflorescences of group II with size from 350-550 μm and average of 51.62%, followed by group III with size of 550-750 μm and average of 38.90%. The average value of the length of the germinal shoot is relatively greater than the one of the C treatment.

The comparative analysis of the examined parameters of the potential fertility of buds for the variety Vranec in the period 2013-2015, for the coefficients (K) on the base of healthy and all examined buds, showed statistically significant differences compared to the C treatment (Table. 5). Same ratios are observed in fruitless and fruitful major buds, but because the absolute values of these indicators are different, several groups of proof are formed. This tendency is characteristic for fruitful buds with 1, 2 and 3 inflorescences, but differences with the C are not characteristic only for CT 10 treatment (major buds with 2 inflorescences) as well as for D (major buds with 3 inflorescences). From the indicators related to the size of the inflorescences, only those with the length of 350-550 μm in the treatments CT 6 and CT 10 have no significant differences compared to the treatment C. The impact of the length of the germinal shoot was not statistically significant.

Conclusion

Under the experimental conditions near the town of Veles, in variety Vranec dead major buds are missing along the cane during the vegetation period, which indicates the productive capability of the variety. Potential fertility is determined by the high odds - 1.38, which differs depending on the location of the bud along the cane. The percentage of fruit winter buds is high - 90.59%. In the major buds, two inflorescences are mainly formed with the average of 60.80%. The yield of this variety will be formed mostly of inflorescences with sizes 350-550 μm – 50.97% of Group II, followed by Inflorescences with the length of 550-750 μm Group III - 33.71%.

The application of defoliation has a beneficial effect on increasing the coefficient of potential fruitfulness of winter buds, the number of buds with 2 and 3 inflorescences, on increasing the inflorescences with the length of 350-550 μm and the appearance of new ones - longer than 750 μm.

After yield reduction by CT 6 and CT 10, higher values of the potential fertility coefficient have also been observed. The yield is determined mainly by the buds with 2 and 1 inflorescences, however, buds with 3 inflorescences are also observed and the largest of them are longer than 750 μm.

The established differences in the absolute values of the examined parameters of the potential fertility of the buds in the treatments (average for the fruit canes for the period 2013-2015) are almost always statistically proven.

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Утицај љетње резидбе на продуктивност зимских пупољака сорте винове лозе (*Vitis vinifera* L.) Вранац

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Сажетак

Ово истраживање представља анализу утицаја љетње резидбе (дефолијација, прорјеђивање гроздова) на параметре потенцијалне продуктивности зимских пупољака сорте вина Вранац, на локалитету близу Велеса у периоду 2013-2015. За ово истраживање су постављена четири третмана: контрола, дефолиација и двије врсте прорјеђивања гроздова: са 10 и са 6 гроздова по чокоту. Према добијеним резултатима утврђено је да у главним зимским пупољцима нема повреда током вегетационог периода, а потенцијална плодност је утврђена према већем коефицијенту од 1,38, што зависи од позиције пупољка на стаблу. У приносу сорте Вранац ће углавном учествовати кластери дужине 350-550 μm, те кластери дужине 550-750 μm. Примена дефолиације и регулисање приноса вина позитивно утиче на повећање стопе потенцијалне плодности зимских пупољака, број пупољака са 2 и 3 кластера, повећање броја цвасти дужине 350-550 μm те присутност цвасти дужих 750 μm.

Кључне ријечи: Вранац, дефолијација, прорјеђивање гроздова, потенцијална продуктивност, зимски пупољци, принос

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