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EFFECT OF AUXIGER GROWTH REGULATOR ON FRUITS DEVELOPMENT, PRODUCTION AND CHRACING INDEX OF 'REGINA' CHERRY VARIETY

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Abstract

Fruit size and yield can be improved with the application of growth regulators, such as synthetic auxins and may be effective in enhancing fruit growth, when applied during the second stage of fruit development. The aim was to evaluate the influence of Auxiger growth regulator on average weight of fruits, fruit production, fruit size, period of maturation and cracking index. The study subject of the experience was 'Regina' cherry variety, grafted on Gisela 6. The trees were trained as spindle system. The distance of plantation is 4.0 x 2.0 m. The experimental plot it was placed in the orchard „Vindex-Agro" Ltd. founded in 2012 year. The research was conducted during the period of 2016 year. To study average weight of fruits, fruit production, fruit size, period of maturation and cracking index were experimented the following variants of treatment: 1.Control – without treatment; 2. Auxiger, 0.5 l/ha; 3. Auxiger, 0.7 l/ha. Active ingredient of Auxiger is NAD – 1.5 g/l + ANA – 0.6 g/l. Growth regulator Auxiger were sprayed one time, during the period of intensive fruit growing, when the fruits diameter was 12-13 mm (26.05.16). During the research, it was studied the average of fruits, tree production and their quality, period of maturation and cracking index. During the analyzed period, it was established that the average weight of fruits, the plantation productivity, fruit size, period of maturation increase when treating with Auxiger growth regulators in dose of 0.7 l/ha and reduced the cracking index when the diameter of the fruits was 12 - 13 mm.

Key words: *growth regulator, fruit size, production, quality, maturation*.

INTRODUCTION

Cherries are the first fresh fruit of the year. Cherry fruits have a significant food value (Asanică, 2012; Cimpoieș, 2002). The food value, as well as other qualities of the fruits, such as size, color and firmness of flesh, are generally the main criteria by which the destination to exploit the cherries is determined (Asanică et al., 2013; Balan, 2015).

Small fruit size is one of the limiting factors in marketing cherry fruit (Sansavini and Lugli, 2005; Whiting and Ophardt, 2005).

As consumers prefer large cherries, fruit size is a very important marketing consideration, and the economic benefits of treatments capable of improving average fruit size are potentially very high.

Several techniques have been used to improve fruit production and fruit size of cherry (Balan, 2012; Budan and Grădinăriu, 2000; Long et al., 2014; Whiting and Lang, 2004). Fruit size can be improved with the application of growth regulators, such as synthetic auxins and gibberellins (Zeman et al., 2013).

Synthetic auxins may be effective in enhancing fruit growth, when applied during the second stage of fruit development (Faust, 1989).

The effectiveness of synthetic auxins in increasing fruit size is affected by the type of auxins, its concentration and the fruit crop. Some synthetic auxins are effective in increasing fruit production and fruit size of sweet cherry (Stern et al., 2007), though others, such as CPA, showed no effect (Zhang and Whiting, 2011).

In the fruit growing practice, the growth regulators are used in small amounts, but their effect is quite striking, if applied in recommended phases in active physiological concentrations, allowing be easily absorbing and transporting to the reaction.

NAA applied alone or in combination 30 - 35 days before the harvest decrease cracking index (Demirsoy and Bilgener, 1998). Pre-harvest spray of NAA has also been reported to reduce

the field cracking and cracking index and increase the firmness of two cherry varieties (Anonymous, 1994; Yamamoto et al., 1992).
A combination of auxins gives better results than the application of single compound (Long et al., 2014; Stern et al., 2007; Zeman et al., 2013).
The objective of this study was to evaluate the effect of growth regulator Auxiger (NAD and NAA) on fruit development, fruit size, cracking, maturation, quality and yield in Regina sweet cherry.

MATERIALS AND METHODS

The research was conducted during the year of 2016, in the cherry orchard founded near the village Malaesti, Orhei district, during the spring of 2012 in the „Vindex-Agro" Ltd., with one-year-old trees shaped as a rod. The subject of the experience was 'Regina' cherry variety grafted on rootstock Gisela 6. The crowns it conducted by thin spindle system. The planting distance was 4.0 x 2.0 m.
To establish the influence of Auxiger growth regulator on the plantation production, cherry fruits quality and they cracking were tested the following variants (Table 1).

Table 1. Scheme experiments to determine the effectiveness of Auxiger growth regulator on tree production and their quality

Variants	Active ingredient	Application
Control	-	-
Auxiger, 0.5 l/ha	NAD - 1.5 g/l + NAA - 0.6 g/l	Spraying during the period of intensive fruit growing
Auxiger, 0.7 l/ha		

In the second and third variant the treatment date was 26.05.16, when was registered an intensive cherry growing. Location of plots made into blocks, each variant having four replicates. Each replication has 7 trees. At the border between the rehearsals and experimental plots were left one untreated tree to avoid the duplication of variants or repetitions while performing treatments.
Trees treatment was performed with portable sprinklers in the morning hours. The amount of the solution was 0.8 liters tree, based on the number of trees per unit area and the amount of water recommended of 1000 l/ha.
The number of fruits, the average weight of a fruit, the production from a tree and a unit area were settled during the harvest. The establishment of harvest for each variant was performed by individual weighing of the fruits on 28 trees. The average weight of the fruits was determined by weighing a sample of 1 kg of cherries from each repetition and counting them.
The fruit diameter was determined during the harvesting period using the template recommended for sorting cherries by holes of 26, 28, 30, 32, 34 and 36 mm.
The height of the fruits was determined by the measuring and it is the distance between the base and the top. The large and small diameter of a fruit was measured at the equatorial area. The evaluation of mentioned parameters was carried out using calipers at time of harvest gathering 20 fruits in the row from each repetition.
The average weight of the seed was determined by the method of weighing, an indicator which was obtained as a result of removing the pulp from the seed. The ratio of the seed in the fruit is the ratio between the weight of 20 seeds and the weight of these fruits in each repetition reported in percent.
To have a more real index of cracking of cherry fruits, it resorted to setting cracking index of cracking natural and artificial. Natural cracking index was determined by the counting method at harvest time. After collecting 100 fruits in a row from the tree crown, it was counted the number of cracked fruits, then, using the correlation was established the index of cracking. Theoretically, the cracking index was determined by the method described by Christensen (1972).
Fruit harvesting was carried out in two rounds based on their maturation. The share of fruits harvested in the first half and the second one was determined by the method of weighing and counting on specific trees out of each variant.
The significance of differences men values of investigated parameters was determined by using the LSD test for the likelihood of 0.05.
The soil between the rows consisted of grass silage, and the strips between the trees per row with a width of 1.2 m are worked with the mechanical milling FA 086. The irrigation in the plantation is carried out by drip irrigation. The fertilization system calculated according to soil fertility and scheduled crop.

RESULTS AND DISCUSSIONS

The fruit production is the final index which indicates how all agro-technical measures were performed in the cherry plantation 'Regina' variety.

Investigations conducted proved that the number of fruit in the trees crown included in the research were not different in the studied variants (Table 2). This is explained by the fact that to create identical conditions for fruit development was necessary to leave a constant number of fruits in the trees crown. To maintain this number of fruit in the trees crown after the fall of ovaries in June, the load of fruit was corrected by manual thinning, leaving a number as precisely as possible of fruits.

Table 2. The influence of the Auxiger growth regulator on the amount of fruits, the average weight of fruits and the production of 'Regina' cherries variety

Variants	Number of fruits, pcs/tree	Average weight, g	The production of fruit		In %, compared to control variant
			kg /tree	t/ha	
Control	495	10.07	4.98	6.23	100.0
Auxiger, 0.5 l/ha	491	10.68	5.24	6.55	105.1
Auxiger, 0.7 l/ha	498	10.83	5.39	6.74	108.2
LDS 0.05	18.4	0.33	0.14	0.18	-

The lowest average weight of fruits was recorded in the control variant, without treatment being 10.07 g. Followed, in the ascendant order by the variant treated with Auxiger in dose of 0.5 l/ha with an average fruit weight of 10.68 g and the variant treated with Auxiger in dose of 0.7 l/ha, where the studied index was 10.83 g, or an increase of 0.76 g compared with the control variant. This difference in average weight between control variant and variants 2 and 3 was recorded due to treatment with growth regulator Auxiger.

Analyzing the influence of the dose treatment, it was recorded that with the increase of the dose quantity from 0.5 to 0.7 l/ha, the average fruit weight increased, but not as much as it increased between the control variant and the treated variants. If the difference between the variant treated with Auxiger in dose of 0.5 l/ha and 0.7 l/ha was 0.15 g, then between the control variant and the treated variant with the growth regulator Auxiger in dose of 0.5 l/ha was 0.61g. This results were proven statistically too.

The production of fruits on a tree and a surface unit is in direct correlation with the number of fruits and their average weight. The lowest fruit production was recorded in the control variant being 4.98 kg/tree or 6.23 t/ha.

In the variant treated with Auxiger in dose of 0.5 l/ha, the fruit production was 5.24 kg/tree or 6.55 t/ha, or it increased with 5.1% compared with the control variant.

The highest fruit production was registered in the variant treated with Auxiger in dose of 0.7 l/ha being 5.39 kg/tree or 6.74 t/ha, or and increase with 8.2% compared with the control variant.

Studying the influence of treatment dose on fruit production showed that with increasing the amount of product administered from 0.5 to 0.7 l/ha, the studied index increased, but not as essentially as between control variant and tested variants. If the difference between the treated variant with Auxiger in dose of 0.5 l/ha and 0.7 l/ha was 3.1%, then between the control variant and the variant treated with Auxiger in dose of 0.5 l/ha was 5.1%.

The insignificant difference between the variant treated with Auxiger in dose of 0.5 l/ha and Auxiger 0.7 l/ha was proven statistically too.

Statistical data about the production of fruit from a tree and a unit area showed a statistical difference between the control variant and variants treated with Auxiger.

Currently, in the modern research conducted on cherry plantations in order to increase the average weight of the fruits and their quality parameters (height, width, thickness, seed weight) are widely used treatments with growth regulators from auxin group.

While studying the fruit size 'Regina' cherry variety, we recorded higher values on their large diameter (d_1), and then in descendent order was the height and lastly the small diameter (d_2). If the large diameter during the research was 30.7 - 31.5 mm, then the height index and the small diameter was respectively 28.0 - 29.0 and 27.1 - 28.3 mm (Table 3).

Between the studied variants, the lowest height of a fruit was recorded in control variant, being 28.0 mm. In ascendant order is placed the variant treated with Auxiger in dose of 0.5 l/ha, with the studied index being 28.7 mm. Followed by the variant treated with Auxiger in dose of 0.7 l/ha, where the height of a fruit was

29.0 mm, or it increased with 3.6% compared with the control variant.

Table 3. Influence of Auxiger growth regulator on the quality of cherry fruits of 'Regina' variety

Variants	Size , mm			H/D	Average seed weight, g	% of seed
	Height (h)	Large diameter (d_1)	Small diameter (d_2)			
Control	28.0	30.7	27.1	0.91	0.58	5.7
Auxiger, 0.5 l/ha	28.7	3.3	27.9	0.92	0.59	5.5
Auxiger, 0.7 l/ha	29.0	3.5	28.3	0.92	0.59	5.4

Analyzing the influence of the treatment dose on the fruit height, it was noticed that once the treatment dose increased the height of the fruit increased too. If the difference between the variant treated with Auxiger in dose of 0.5 l/ha and dose of 0.7 l/ha was 1.1%, then between control variant and the variant treated with the Auxiger in dose of 0.5 l/ha was 2.5%.

At harvest time, the smallest value of the large diameter on cherry fruits was recorded in the control variant, being 30.7 mm. When treatment was applied with Auxiger, an increase in the studied index was noticed being 31.3 - 31.5 mm, so it increased with 0.6 - 0.8 mm compared with the control variant. The increase in the treatment dose did not influence significantly the large diameter index on Regina cherry variety. The same thing is valid and for the small diameter perhaps with small deviations between the variants.

The treatments made with Auxiger also influenced on the ratio between the height and the large diameter on the fruits. The smallest value of this ratio was registered in the control variant, being 0.91. In the variants treated with Auxiger, the ratio height/large diameter of fruits was 0.92.

The size of the seed is an important index for the quality of the fruits and productivity. On different varieties of cherries the seed ratio stands around 7.0%, but cherries varieties are quite different (Donica Il et al., 2005).

The conducted researches showed at the average seed weight in the control variant, was the smallest being 0.58g, but when treatment was made with Auxiger, its value was 0.59 g.

The seed ratio in the fruit is influenced by the average seed weight and the average fruit weight. Conducted research highlighted the variants treated with Auxiger where the seed weight was 5.4 to 5.5%. In the control variant, the above index was higher, being 5.7%. Therefore, the treatments made with had a positive influence both on height, width and thickness of the fruit, and also on the fruit and the seed weight.

Effectuated research showed that there is a direct influence between the fruit weight and their diameter. The results from table 4 show that the fruit production obtained in the studied variants differ, registering higher values when treating with the Auxiger growth regulator.

If, in the control variant, the diameter of fruits with 22-26 mm was 24.7%, the fruits with 26-30 mm diameter were 30.1% and the fruits with the diameter larger than 30 mm were 45.2%. Therefore, the fruits with the diameter larger than 26 mm in the control variant were 75.3%.

Table 4. The influence of Auxiger growth regulator on fruits redistribution according to their diameter in the 'Regina' cherry variety

Variants	The share of fruits (%) according to their diameter (mm)		
	22-26	26-30	>30
Control	24.7	30.1	45.2
Auxiger, 0.5 l/ha	14.6	28.7	56.7
Auxiger, 0.7 l/ha	12.8	27.7	59.5

When treatment was made with Auxiger, the cherry fruit quality improved compared to the control variant. When treatment was made with Auxiger growth regulator in dose of 0.5 l/ha, the share of fruits with the diameter 22 - 26 mm decreased in comparison with the control variant being 14.6%, those with diameter 26 - 30 mm were 28.7%. The fruits with a diameter larger than 30 mm increased to 11.5%. This means that the share of fruits with the diameter larger than 26 mm were 85.4% or it increased with 10.1% compared with the control variant.

The same thing was valid and for the variant treated with Auxiger in dose of 0.7 l/ha. The share of fruits with the diameter 22 - 26 mm decreased in comparison with the control variant, being 12.8%, those with diameter 26 - 30 mm were 27.7% and the fruits with a diameter larger than 30 mm - 5.5%. Practically, this variant showed higher values compared with the control variant and the variant treated with Auxiger in dose of 0.5 l/ha.

By studying the influence of the dose treatment on the distribution of cherry fruit by diameter, once the amount of product increased from 0.5 to 0.7 l/ha, the studied index increased too, but

not as much as compared with the control variant. If the difference between the fruits with a diameter larger than 2 mm between the variant treated with Auxiger in dose of 0.5 and 0,7 l/ha was 1,%, then between the control variant and the variant treated with Auxiger in dose of 0.5 l/ha was 20.1%.

Cherry fruit cracking is an inherent characteristic of the species and under certain genetic, physiological, chemical conditions can affect up to 90% of the harvest which influences negatively the financial situation of companies (Demirsoy and Bilgener, 1998).

The factors that may promote the phenomenon of cracking of the cherry fruits can be chemical, technological and genetically. They influence on the maturation of the cherry, the intensity of respiration, the capacity to absorb the water at the root and the skin of fruit, and also the osmotic pressure and turgor potential of the mesocarp cells (Yamamoto et al., 1992).

Cherry fruits are more prone to cracking during the period when they move from the yellow - purple color until they become black which is considered the full maturation and they are ready for consume. During the reference period (10-29.06.2016), the quantity of atmospheric precipitation was 85.9 mm.

These rainfalls affected the natural fruit cracking index on Regina cherry variety. The high'est value of the natural fruit cracking index on 'Regina' cherry variety was recorded after precipitation fallen during their maturation were in the control variant was 2.0%. In the variants treated with growth regulators Auxiger, it did not register fruits cracked naturally despite the precipitation fallen during fruit ripening.

To have a more real value of the theoretical fruit cracking index on 'Regina' cherry variety, it was used the method described by Christensen (1972).

Conducted research after two hours of cherries fruits immersion in water, it demonstrated that in the control variant, only one fruit cracked. The number of fruits cracked in the same variant after being immersed in water for four hours was 2 pcs, and after 6 hours - 7 pcs. The obtained results showed that the theoretical index of artificial cracking was 7.2% (Table 5).

In the variants treated with Auxiger, after the fruits were immersed in water for 2 and 4 hours, don't were registered the cracked fruits. If, the period of time that the fruits where in the water increased to 6 hours, it was recorded the quality of cherries improved compared to the control variant. In the variant treated with Auxiger in dose of 0.5 l/ha, the number of fruits artificially cracked was 4 pcs, or it decrease of 5.6% compared with the control variant.

Table 5. The influence of the growth regulator Auxiger on the fruit cracking on cherries of 'Regina' variety

Variants	Index of natural cracking, %	Fruits cracked artificially, psc.			Index of theoretical cracking, %
		After 2 hours	After 4 hours	After 6 hours	
Control	2.0	1	2	7	7.2
Auxiger, 0.5 l/ha	-	-		4	1.6
Auxiger, 0.7 l/ha	-	-	-	3	1.2

The same thing happened and in the variant treated with Auxiger in dose of 0.7 l/ha where the number of cracked fruit artificially was 3 psc, or it decreased by 6.0% compared with the control variant.

Analyzing the influence of the treatment dose on the artificially fruit cracking, it was noticed that once the dose treatment increased for 0.5 to 0.7 l/ha, the studied index didn't change as much as it did in the control variant. If the difference between the artificially cracked fruits in the variant treated with Auxiger in dose of 0.5 and 0.7 l/ha was 0.4%, then between the control variant and the variant treated with Auxiger in dose of 0.5 l/ha was 5.6%.

Optimal harvest time is determined by the fruit capitalization way. In this context, it should be borne in mind the gradual maturation of cherries and that after their separation from the tree no longer occur physiological processes to improve quality, as happens in other species. Therefore, cherry fruits are collected in two phases, during the time when they have the highest food value and good taste. The best harvesting time is determined usually empirically based on experience taking into account the color of the fruit, since there is no other index more accurately. Thus, the cherries are harvested when they got the color typical of the variety, the flesh softens and releases easily from the stalk branch.

Conducted research proved that treatments made with growth regulators Auxiger

intensified fruit coloring. 'Regina' cherry variety is a late maturing variety which requires for the fruits to be collected in two stages.

The most important index is the share of fruits picked in the first and second stage of harvest. The research showed that in the control variant in the first picking stage (27.06.2016) were collected 48.8% of fruits from the trees crown and in the second stage (30.06.206) were picked the rest 51.2% (Table 6).

The treatments performed with the growth regulator Auxiger which is based on active ingredients NAD and NAA increased the share of fruits pick in the first stage of harvest.

Table 6. The influence of Auxiger growth regulator on the maturation of fruits of 'Regina' cherry variety, %

Variants	Harvest time	
	27.06.2016	30.06.2016
Control	48.8	51.2
Auxiger, 0.5 l/ha	67.5	32.5
Auxiger, 0.7 l/ha	70.4	28.6

When treatments were made with Auxiger in dose of 0.5 l/ha, the share of fruits picked in the first stage of harvest was 67.5% or it increased with 18.7% compared with the control variant. Once, the treatment dose increased to 0.7 l/ha, the studied index increased to 70.4%, which increased by 21.6% compared with the control variant and a 2.9% increase compare with the variant where the treatment dose was 0.5 l/ha.

CONCLUSIONS

Treatments made with Auxiger in dose of 0.7 l/ha increased the average weight of fruits, the plantation productivity, fruit size, period of maturation and reduced the cracking index.

The results presented here, indicate that the effect of the application of plant growth regulator Auxiger in dose of 0.7 l/ha during the intensive cherry growth, when the fruits reach a diameter was 12 - 13 mm, improve the physiological processes of the plant and increase the fruit development, quality and yield of 'Regina' sweet cherries variety.

REFERENCES

Anonymous , 1994. All about cherry cracking. Tree Fruit Leader, 3: 1-11.

Asanică A., 2012. Cireşul în plantaţiile moderne. Bucureşti.

Asanică A., Petre Gh., Petre V., 2013. Înfiinţarea şi exploatarea livezilor de cireş şi vişin. Bucureşti.

Balan V., 2012. Perspective în cultura cireşului. Pomicultura, Viticultura şi Vinificaţia Moldovei. Chişinău, 2: 7.

Balan V., 2015. Tehnologii pentru intensificarea culturii mărului şi cireşului. Akademos, Chişinău, 3: 82-87.

Budan V., Grădinăriu G., 2000. Cireşul. Iaşi.

Christensen J. V., 1972. Cracking in cherries. I. Fluctuation and rate of water absorption in relation to cracking susceptibility. Tidsskr. Planteavl, 76: 1-5.

Cimpoieş Gh., 2002. Pomicultura specială. Chişinau.

Demirsoy L., Bilgener S., 1998. The effect of preharvest chemical applications on cracking and fruit quality in 0900 Zirat, Lambert and Van sweet cherry varieties. Acta Hort., 468: 663-670.

Donica Il., Ceban E., Rapcea M., Donică A., 2005. Cultura cireşului. Chişinău.

Faust M., 1989. Physiology of Temperate Zone Fruit Trees. Wiley, New York, USA, 169-234.

Long L. E., Lond M., Peşteanu A., Gudumac E., 2014. Producerea cireşelor. Manual tehnologic. Chişinău.

Sansavini S., Lugli S., 2005. Trends in sweet cherry cultivars and breeding in Europe and Asia. Proc. 5th Int. Cherry Symposium. Turkey, (Abstract), 1.

Stern R.A., Flaishman M., Applebau, S., Ben-Arie R., 2007. Effect of synthetic auxins on fruit development of "Bing" cherry (Prunus avium L.). Sci. Hortic. Amsterdam, 114: 275-280.

Yamamoto T., Satoh H., Watanabe S., 1992. The effects of calcium and naphthalene acetic acid Sprays on cracking index and natural rain cracking in sweet cherry fruits. J. Japan. Soc. Hort. Sci., 61: 507-511.

Whiting M.D., Lang G.A., 2004. "Bing" sweet cherry on the dwarfing rootstock Gisela 5: thinning affects tree growth and fruit yield and quality but not net CO2 exchange. J. Am. Soc. Hort. Sci., 129: 407-415.

Whiting M.D., Ophardt, D., 2005. Comparing novel sweet cherry crop load management strategies. HortScience, 40; 1271-1275.

Zeman S., Jemrić T., Čmelik Z., Fruk G., Bujan M., Tompić T. 2013. The effect of climatic conditions on sweet cherry fruit treated with plant growth regulators. Journal of Food, Agriculture and Environment, 11(2): 524-528.

Zhang C., Whiting M., 2011. Pre-harvest foliar application of prohexadione-Ca and gibberellins modify canopy source-sink relations and improve quality and shelf-life of "Bing" sweet cherry. Plant Growth Regul., 65: 145-156.