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EFFECT OF AUXIGER GROW REGULATOR ON DEVELOPMENT AND FRUCTIFICATION OF REGINA CHERRY VARIETY

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ABSTRACT

Cherry presented and continues to present an economic importance, both worldwide and in Moldova. The growth regulators manage the growth and development process of cherry trees, enable to increase the plant resistance to stress, increase fruit setting, fruit weight gaining and reduce damage caused by physiological diseases during storage. The aim was to evaluate the influence of growth regulator Auxiger on physiological processes, development of trees, fruit production, fruit size, its quality, cracking index and period of maturation. 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 4.0×2.0 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 physiological processes, fruit production, and they quality 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 analyzed period, it was established that the physiological processes, development of trees, average weight of fruits, the 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.

Keywords: Cherry, growth regulator, production, quality, cracking

INTRODUCTION

Cherry presented and continues to present an economic importance, both worldwide and in Moldova [3]. Cherries are the first fresh fruit of the year. Cherry fruits have a significant food value [1, 6].

Small fruit size is one of the limiting factors in marketing cherry fruit [9, 13]. 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 [3, 4, 8, 12].

Along with the modern techniques and technologies used to increase fruit production, both quantitatively and qualitatively in the cherry crop, a major role plays the growth regulators [1, 5, 8].

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 [10, 14].

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 [10], though others, such as CPA, showed no effect [14].

NAA applied alone or in combination 30–35 days before the harvest decrease cracking index [7]. 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 [11].

A combination of auxins gives better results than the application of single compound [8, 10, 14].

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.

MATERIAL AND METHOD

The research was conducted during the year of 2016, in the super intensive cherry orchard founded 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 4.0×2.0 m.

To establish the influence of the growth regulator Auxiger on the processes of growth and fruiting of cherry trees, not to upset the physiological processes inside the plant and get consistent and qualitative production in the plantation were tested the following variants (Tab. 1).

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.

Treatment of trees was performed with portable sprinklers in the windless 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.

Determination of chlorophyll and carotenoid pigments in leafs was conducted using the method developed by Wettstein D. [15].

The foliar area of leafs was determined using the method described by V. Balan [3]. The length of trunk circumference was measured at the end of the growing season to all the trees in the experience being 20 cm below the lower roof structure. The average length and summed of the annual growth was determined by the measuring method on one tree out of rehearsal.

The number of fruits, the average weight of a fruit, the production from a tree and a unit area settled during the harvest. The harvest established for each variant 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 [5].

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.

Table 1. Experiments scheme to determine the effectiveness of biological growth regulator Auxiger on growth and fruit bearing on cherry trees

Variants	Active ingredient	Application
Control–without treatment	–	–
Auxiger–0.5 l/ha	NAD–1.5 g/l + ANA–0.6 g/l	Spraying during the period of intensive fruit growing
Auxiger–0.7 l/ha		

RESULTS AND DISCUSSIONS

The growth regulators, which in its composition have products based on NAD and NAA actively participates in the synthesis of chlorophyll, photosynthesis and plant vegetation tree.

Investigations conducted, demonstrate, that treatment with Auxiger positively influenced on the content of chlorophyll “a” and “b” and their sum, and the content of carotenoids, which were determined to end the phase of intensive growth of shoots.

In the control variant the content of chlorophyll "a" was 2.77 mg/dm² and of chlorophyll, “b” was 0.83 mg/dm². The amount of chlorophyll "a" and "b" in this variant was 3.60 mg/dm² and carotenoids 0.99 mg/dm² (tab. 2).

After applying the growth regulator Auxiger during the intensive fruit growth, the content of chlorophyll and carotenoids in leaves has increased.

When treated with the growth regulator Auxiger in dose of 0.5 l/ha, the content of chlorophyll “a” was 2.96 mg/dm² being practically higher by 6.9% compared to the control variant. When treatment was made with the growth regulator Auxiger in dose of 0.7 l/ha, the content of chlorophyll “a” increased by 9.7% compared to the control variant.

Studying the influence of the dose treatment on the content of chlorophyll "a" in the leaves, it was recorded that once the dose of Auxiger increased from 0.5 l/ha to 0.7 l/ha, the studied index increased by 2.7%. The same thing happened with the content of chlorophyll “b”. When treated with Auxiger in dose of 0.5 l/ha, the content of chlorophyll "b" in the leaves was 0.89 mg/dm² and when the dose of Auxiger increased to 0.7 l/ha, the above index increased to 0.94 mg/dm², or an increase with 5.6% compared with the previous variant or with 13.2% compared with the control variant.

The amount of chlorophyll "a" and "b" in variants treated with growth regulator Auxiger was 3.85–3.98 mg/dm², or an increase of 6.7 to 10.5% compared to the control variant. In the variant treated with Auxiger in dose of 0.5 l/ha, the amount of chlorophyll “a” and “b” was 3.85 mg/dm², or increased by 8.9%, compared with the control variant. In the variant where the treatment in dose of 0.7 l/ha, the amount of chlorophyll “a” and “b” was 3.98 mg/dm², or it increased by 10.5% compared with the control variant.

Treating the plants with the growth regulator Auxiger increased the content of carotenoids in plants registering an increase of up to 1.07 to 1.12 mg/dm². This increase occurred is a result of improving the physiological processes activity after treatment with growth regulator Auxiger. When the treatment it effected with Auxiger in dose of 0.5 l/ha, the content of carotenoids in plants was 1.07 mg/dm², then when the dose of Auxiger increased to 0.7 l/ha, the above index increased to 1.12 mg/dm². Increasing the treatment dose from 0.5 l/ha to 0.7 l/ha increased by 4.6% the weight content of carotenoids in leaves.

The fruit production is the final index, which indicates how all agro–technical measures 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 (tab. 3). This 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 growth regulator Auxiger on the content of chlorophyll and carotenoid in the leaves of trees cherry Regina

Variants	Chlorophyll pigment content (mg/dm²)			The content of carotenoids (mg/dm²)
	“a”	“b”	“a” + “b”	
Control	2.77	0.83	3.60	0.99
Auxiger, 0.5 l/ha	2.96	089	3.85	1.07
Auxiger, 0.7 l/ha	3.04	0.94	3.98	1.12
$LSD_{0.05}$	0.14	0.03	0.18	0.04

Even though the number of fruit is practically identical in the studied variants, the average weight of a fruit has seen big changes under the influence of treatment with growth regulator Auxiger conducted during the intensive fruit growth when the fruit were 12–13 mm in diameter.

During investigations, in the control variant without treatment, cherry trees have formed 495 pcs. In the variant treated with the growth regulator Auxiger in dose of 0.5 l/ha, the number of fruits was 491 pcs/tree, but in the variant with the treatment in dose of 0.7 l/ha, the studied index was 498 pcs/tree.

The lowest average weight of a fruit 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. 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 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 l/ha 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 0,61 g. 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 the growth regulator 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, without treatment.

The highest fruit production was registered in the variant treated with the growth regulator 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 l/ha to 0.7 l/ha, the studied index increased, but not as essentially as between control variant and variants tested. If the difference between the treated variant with the growth regulator 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 difference insignificant between the variant treated with the growth regulator 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 in dose of 0.5 l/ha and Auxiger in dose of 0.7 l/ha.

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 (Tab. 4).

Table 3. The influence of the growth regulator Auxiger on the amount of fruits, the average weight of fruits and the production of cherries of Regina 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
$LSD_{0.05}$	23.44	0.43	0.27	0.31	–

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.

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%.

Table 4. 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	31.3	27.9	0.92	0.59	5.5
Auxiger, 0.7 l/ha	29.0	31.5	28.3	0.92	0.59	5.4
$LSD_{0.05}$	0.45	0.54	0.43	–	0.023	0.25

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 [4, 6].

The conducted researches showed at the average seed weight in the control variant, was the smallest being 0.58 g, 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 5. 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
$LSD_{0.05}$	0.85	1.22	2.54

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 05 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 26 mm between the variant treated with Auxiger in dose of 0.5 and 0.7 l/ha was 1.8%, then between the control variant and the variant treated with Auxiger in dose of 0.5 l/ha was 10.3%.

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 [7].

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 [11].

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 highest 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 [5].

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.

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

Table 6. 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
$LSD_{0.05}$	–	–	–	–	0.32

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 (tab. 7).

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%.

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.

When treatments were made with Auxiger in dose of 0.5 l/ha, the share of fruits picked in the first stage of harvest were 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.

Table 7. 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

CONCLUSIONS

The highest values of the content of chlorophyll "a", "b", "a" + "b" and the carotenoids were recorded in the variants treated with the growth regulator Auxiger in dose of 0.7 l/ha.

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.

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