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INFLUENCE OF REGALIS PLUS PRODUCT ON THE GROWTH AND FRUITING OF APPLE TREES

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ABSTRACT

The study subject of the experience was 'Florina' apple cultivar grafted on 'M9' rootstock. The distance of plantation is 3.5 x 0.8 m. The research was conducted during the period of 2020 year. The tested agent was Prohexadion - calcium (product Regalis Plus), which was sprayed in different period. The first application of Regalis Plus at 2.5 and 1.25 kg/ha was apply at the end of flowering, when terminal shoots are 2 to 5 cm in length. Apply a second application of 1.25 and 0.75 kg/ha after the first an interval of 3-4 weeks. The third treatment was executed 3 weeks after the previous one in dose of 0.5 kg/ha, depending on growth conditions. During the research, it was studied the degree of fruit setting, their number in the crown, mean fruit weight, yield, the number of fruits formation and theirs type. It was established that, Regalis Plus at 2.5 kg/ha, 1.25+1.25 kg/ha and 1.25+0.75+0.50 kg/ha influence on the degree of fruit setting, their number in the crown, the mean fruit weight, yield and number of fruits formation on the 'Florina' apple cultivar.

INTRODUCTION

Worldwide, apple culture in the last decade has undergone great transformations regarding cultivation technology. Today, countries such as Italy, Poland, Germany, the Netherlands, the USA, etc. have achieved remarkable performances. (Babuc et al. 2013, Cimpoieş 2012).

One of the main elements of the modern apple plantation cultivation technology is the maintenance of the physiological balance between growth and fruiting (Cimpoieş 2012).

In recent decades, in modern fruit growing, growth regulators with retardant action are used to maintain the bio constructive parameters and more rational structuring of the crown of apple trees. To reduce vigor, the products Alar, Cultar etc. are recommended as a growth regulator with retardant action. However, these products were banned due to the high percentage of residues detected in the fruits (Basak, 2004, Byers et al., 2004).

Currently, the growth vigor of apple trees is influenced by products whose active substance is prohexadion - calcium, produced by the German concern "BASF SE" (Peşteanu & Marandici 2013).

In the Republic of Moldova, the growth regulator with retardant action based on Ca prohexadione - Regalis Plus, was registered for apple in 2015, with a

consumption rate of 1.25 kg/ha for cultivars with moderate growth and 2.5 kg/ha in varieties with vigorous growth (Marandici & Peşteanu 2015).

Ca prohexadione-based growth regulators inhibit the production of gibberellic acid in the plant, reducing the vigor of shoot growth by forming shorter internodes, forming a greater amount of short fruit formations. It also increases fruit production per unit area. The fruits are more intensely colored due to the smaller amount of annual growth in the crown of the trees, and the flowering of the trees in the following year is more uniform. Through this, constant productions of a competitive quality are obtained both on the internal and external markets (Peşteanu & Marandici 2014, Wang et ai. 2021).

Favorable results can be recorded when the pH of the solution used for treatment is 5.5-6.0. If the pH of the water used for treatment is higher than 8.0-8.5 and to have the desired biological efficiency, products with a retardant action based on prohexadione of Ca are necessary by means of orthophosphoric acid, nitric acid, or citric acid to reduce the value of the given index in accordance with the requirements in force. The Regalis Plus product, in the composition of which, apart from calcium prohexadione, citric acid is also included, which in turn adjusts the pH of the solution recommended for treatment between 5.5-7.0, depending on the water quality (Marandici & Peşteanu, 2015).

MATERIAL AND METHODS

The research was carried out during 2020, in the superintensive apple orchard founded near the village of Rudi, Soroca district, in the fall of 2008 at the enterprise SC "Getodava" SRL, with trees in the form of rods.

The objects of study in the investigations carried out were the trees of the ‘Florina’ cultivar grafted on the ‘M9’ rootstock. The planting distance 3.5 x 0.8 m.

To study the Regalis Plus product, the following scheme of the experience was developed (tab. 1).

Table 1

Scheme of the experience for determining the efficiency of the Regalis Plus growth regulator regarding the maintenance of the physiological balance between growth and fruiting in apple trees

Variant	Active ingredient	Mode of application
Control, no treatment	-	-
Regalis Plus, 2.5 kg/ha	Prohexadion - calcium, 100 g/kg + citric acid	One treatment of the trees after flowering (the length of the annual shoots was 2.0-5.0 cm)
Regalis Plus, 1.25 + 1.25 kg/ha		Two treatments: 1st – the end of flowering, when the length of the annual shoots was 2-5 cm; II - at – 3-6 weeks after the first treatment.
Regalis Plus, 1,25 + 0.75+ 0.5 kg/ha		Three treatments: 1st – the end of flowering, when the length of the annual shoots was 2-5 cm; II - at – 3 weeks after the first treatment; of the III - at – 3 weeks after the second treatment.

The first treatment of the trees on all three variants was carried out after flowering (25.04.2020), when the length of the annual shoots was 2.0-5.0 cm.

In variants three and four, the second treatment was carried out 3 weeks after the first treatment (15.05.2020), and in variant four, the third application coincided with the date of 06.06.2020.

The location of the plots was in blocks, in each variant there were 4 repetitions. Each repetition included 7 trees, because at the boundary between the plots and the repetitions, one tree was left untreated. This allowed to avoid overlapping during the treatments.

It was used to treat trees. The treatment was carried out in the windless hours, in the morning, with the portable sprinkler, when the temperature reached the threshold of +15 - 18°C and was increasing.

For the treatment of one tree, 0.28 liters were consumed, resulting from the number of trees per surface unit and the amount of water recommended for one surface unit.

The research was carried out in field and laboratory conditions according to accepted methods of working with growth regulators in fruit crops.

RESULTS AND DISCUSSIONS

The research carried out shows us that the trees of the 'Florina' apple cultivar differentiated an average amount of fruit buds, which at flowering formed from 620 to 645 pcs/tree (table 2).

In fruit growing practice, the treatments carried out during the flowering period with products whose active ingredient is calcium prohexadione, block the formation of ethylene in the plant, which in turn increases the proportion of tied ovaries and the resistance of flowers to the influence of low temperatures.

Table 2

The influence of Regalis Plus growth regulators on the number of flowers, fruits and the degree of their binding in trees of the 'Florina' cultivar

Variant	Number of flowers, pcs/tree	The degree of fruit binding,%	Number of fruits, pcs/tree
Control, no treatment	640	8.5	54
Regalis Plus, 2.5 kg/ha	620	13.5	84
Regalis Plus, 1.25 + 1.25 kg/ha	645	11.7	75
Regalis Plus, 1.25+0.75+0.50 kg/ha	635	11.6	74
LDS 5%	29,5	-	3.4

Higher values of the degree of fruit binding were recorded in the Regalis Plus variant at the dose of 2.5 kg/ha, where the index under study constituted 13.5%, or an increase of 5.0% compared to the control variant. In the Regalis Plus version in the dose of 1.25+1.25 kg/ha, the degree of fruit set was 11.7%, or an increase of 3.2% compared to the control version and a decrease of 1.8% when the treatment was carried out with the preparation Regalis Plus in a dose of 2.5 kg/ha.

When treated with the growth regulator Regalis Plus in a dose of 1.25+0.75+0.5 kg/ha, the degree of fruit set was 11.6%, or an increase of 3.1% compared to the control variant. So, the degree of fruit set in the case of treatment with the Regalis Plus growth regulator in the dose of 1.25+1.25 kg/ha is identical to

the values recorded in the Regalis Plus version in the dose of 1.25+0.75+0.5 kg/ha.

A smaller number of fruits, 54 pcs/tree, were recorded in the control variant, where the trees were not treated. Higher values of the number of fruits were recorded in the variant treated with the preparation Regalis Plus in a dose of 2.5 kg/ha - 84 pieces/tree. In the case of treating the trees with the growth regulator Regalis Plus in a dose of 1.25+1.25 kg/ha, we record that the number of fruits formed was 75 pcs/tree, and in the version treated with Regalis Plus in a dose of 1.25+ 0.75+0.50 kg/ha – 74 pcs/tree.

Due to the smaller number of fruits (table 2) in the control variant, the average weight recorded maximum values – 199 g (table 3). When using Regalis Plus retardant growth regulators, the number of fruits increased and their average weight decreased from 173 to 157 g.

The lowest average weight on the varieties treated with growth regulators with retardant action was recorded in the Regalis Plus variant in the dose of 2.5 kg/ha - 157 g, and the highest values, in the case when the standard preparation Regalis Plus in the dose was used 1.25+0.75+0.5 kg/ha – 173 g. The variant treated with the growth regulator Regalis Plus in the dose of 1.25 +1.25 kg/ha recorded average values regarding the study index and constituted 169 g.

Table 3

The influence of the Regalis Plus growth regulator on the average weight and fruit production in the 'Florina' apple orchard

Variant	Average weight, g	Fruit production		The difference compared with control variant, t/ha	In % compared to control
		kg/tree	t/ha		
Control, no treatment	191	10.3	36,8	-	-
Regalis Plus, 2.5 kg/ha	157	13.2	47.1	+10.3	128.0
Regalis Plus, 1.25+1.25 kg/ha	169	12.7	45.4	+8.6	123.4
Regalis Plus, 1.25+0.75+0.50 kg/ha	173	12.8	45.7	+8.9	124.2
LDS 5%	7.3	0.38	1.51	-	-

The average weight of a fruit obtained in the variants treated with growth regulators with retardant action decreased by 9.4-17.2% compared to the control variant, but most of the fruits were of high quality.

Lower values of fruit production per tree and per surface unit were recorded in the control version, where it was 10.3 kg and 36.8 t/ha, respectively.

In the case of treating the trees with the growth regulator Regalis Plus in a dose of 2.5 kg/ha, we record that the fruit production increased, constituting 13.2 kg/tree and 47.1 t/ha. The difference between the respective variant and the control variant was 2.9 kg/tree and 10.3 t/ha.

In the case of treating the trees, with the growth regulator Regalis Plus in a dose of 1.25+1.25 kg/ha, we record that fruit production increased compared to the control version by 2.4 kg/tree and 8.6 t/ha, but it was practically at the same level as the variant where it was processed with Regalis Plus in a dose of 1.25+0.75+0.50 kg/ha, where the values obtained were 2.5 kg/tree and, respectively, 8.9 t/ha. The difference between the respective variants and the control variant are also statistically demonstrated.

In sustainable fruit growing, when researching the influence of growth regulators with inhibitory action on the fruiting microstructure, it is necessary to study the number and location of fruit formations in the tree crown, which allows us to

regulate the harvest at the first stage of fruit load regulation, i.e. during cuts.

The research carried out further (table 4), highlights that the lowest number of fruit formations were formed in the control variant, compared to the variants, where it was treated with the growth regulator with retardant action Regalis Plus. If, in the control variant, the number of fruit formations was 143 pcs/tree, then in the variants treated with Regalis Plus in different doses it varied from 170 to 208 pcs/tree, i.e. there was an increase of 21.6 and, respectively, 34.2% compared to the control variant.

A higher number of fruit formations was recorded in the version treated with the Regalis Plus preparation in the dose of 1.25+0.75+0.5 kg/ha - 208 pieces/tree, and lower values in the Regalis Plus version in the dose 2 .5 kg/ha – 174 pcs/tree.

Table 4

The influence of the growth regulator with retardant action Regalis Plus on the amount and type of fruit formations in apple trees of the 'Florina' cultivar

Variant	The number of formations of fruit, pcs/tree	Type of fruit formations,%			
		Spurs ringed	Spears	Rods	Fruit bursae
Control, no treatment	143	37.5	7.6	10.1	44.8
Regalis Plus, 2.5 kg/ha	170	41.7	11.4	15.8	31.1
Regalis Plus, 1.25+1.25 kg/ha	186	43.2	13.7	13.2	29.6
Regalis Plus, 1.25+0.75+0.50 g/ha	208	45.0	15.1	12.5	27.4

Investigating the type of fruit formations, we note that in the variants treated with Regalis Plus, compared to the control variant, the weight of the ringed spurs, spines, and nodules increases and the amount of fruit bursae decreases.

The treatment dose also influences the type of fruit formations. In the Regalis Plus variant at the dose of 2.5 kg/ha, we record a decrease in the weight of ringed spurs and thorns to the detriment of fruiting nodules and bursae. In the Regalis Plus variants in the dose of 1.25+1.25 kg/ha and the dose of 1.25+0.75+0.50 kg/ha, the weight of the ringed spurs and thorns increases to the detriment of the fruit balls and bursae. This is explained by the fact that, at the first treatment with the growth regulators in the Regalis Plus version at a dose of 2.5 kg/ha, the development of the shoots is braked to a greater degree, then it intensifies, which allows to obtain longer formations in comparison Regalis Plus variant in the dosage of 1.25+1.25 kg/ha Regalis Plus variant in the dosage of 1.25+0.75+0.50 kg/ha, when a higher share of short fruit formations is recorded due to monitoring growth processes.

CONCLUSIONS

The administration of the growth regulator Regalis Plus in different doses blocked the formation of ethylene in the plant, increasing the resistance of the flowers to low temperatures, increasing the weight of the tied ovaries, finally registering a greater number of fruits in the crown of the trees.

The treatment with the growth regulator Regalis Plus in various doses, led to a more rational garnishing of the trees by increasing the weight of annual fruit formations in favor of multi-annual ones.

In farmers' orchards and commercial industrial plantations to use a single

treatment with the growth regulator with retardant action Regalis Plus in a dose of 2.5 kg/ha when the amount of inflorescences in the crown of the trees is less.

If a sufficient number of inflorescences are recorded in the crown of the trees, it can be treated twice with Regalis Plus in the dose of 1.25 + 1.25 kg/ha, or three times with Regalis Plus in the dose of 1.25 + 0 .75+0.50 kg/ha.

The first treatment to be carried out when 4-5 leaves have formed on the terminal shoot (shoot length 4 - 5 cm), and the second, at an interval of 4 - 5 weeks from the previous one. When three treatments are carried out, Regalis Plus should be administered 15-20 days after the previous treatment.

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