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EVALUATION OF THE EFFECT OF BREVIS PRODUCT ON THE CHEMICAL THINNING OF FRUITS IN THE PINK LADY APPLE PLANTATION

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Abstract

The study subject of the experience was Pink Lady apple variety, grafted on M26. The trees were trained as slender spindle system. The distance of plantation is 4.0 x 1.5 m. The aim was to determine the efficacy of different agents on the chemical thinning of apple fruits. To investigate thinning effect of apple fruits proposed to study the following variants: 1. Control – without treatment; 2. Geramid New, 1.3 l/ha; 3. Brevis, 1.1 kg/ha; 4. Brevis, 1.65 kg/ha; 5. Brevis, 2.2 kg/ha. The treatment with the product Geramid New was carried out by spraying, at the fall of 80% of the petals, + 2-3 days, and with Brevis et development stage 10-12 mm fruitlet diameter. During the research, it was studied the number of blossom clusters after thinning, mean fruit weight, yield, average fruit diameter and size classes based on their diameter. It was established that, the good effect of thinning was noticed after application of Brevis, 1.65 kg/ha.

Key words*: apple, fruit production, growth regulator, quality, thinning.*

INTRODUCTION

During the productive period apple varieties frequently produce an excessive number of fruitlets but this can be insufficient to guarantee fruit of good marketable size at harvest (Babuc et al., 2013; Balan & Vămășescu, 2011; Cimpoieş, 2012; Peşteanu, 2013). Furthermore, an unwanted excessive number of fruit per tree during that period can reduce the growth and photosynthetic trees activity (Babuc, 2012; Peşteanu, 2013).

Because of this, trees require adequate thinning to reach marketable fruit sizes and regular yields by preventing alternate bearing (Maas & Meland, 2016; Peşteanu & Calestru, 2020).

The apple varieties have a high ability to setting a lot of fruit organs and can produce an excessive number of fruits (Brunner, 2016; Peşteanu, 2015).

In order to obtain high, constant and qualitative productions, it is intervened by crop loading in the apple plantation (Babuc et al., 2013; Vămășescu, 2012). In mature orchards chemical fruit thinning is a major cultural practice (Bound, 2006; Dorigoni & Lezzer, 2007; Greene, 2014).

Plant growth regulators such as auxins have become essential in commercial apple production (Brunner, 2014; Peşteanu & Calestru, 2020; Stern, 2015).

One of the new chemical thinners is the triazinone herbicide metamitron, which at a low dosage reduces photosynthesis by blocking electron transport in photosystem and consequently enhances fruit drop (Basak, 2011; Botton et al., 2020; Dorigoni & Lezzer, 2007; Lafer, 2010; Stern, 2014).

Its application to apple trees can result in transient carbohydrate stress that may increase the sensitivity of the fruit to a chemical thinner application (McArtney et al., 2012).

The normal time for application of thinning chemicals in apples extends from bloom until 3 weeks after bloom, when the fruit reach a mean diameter of ≈16 mm (McArtney & Obermiller, 2012). During that period single metamitron treatments, regardless of application time, when the fruit diameter reached 6-9 mm or 12-15 mm, showed inconsistent action in the different experimental years.

In other thinning activity metamitron demonstrate positive results when applied to apple fruitlets 10 to 12 mm in diameter (Lafer,

2010) or even later at 20 mm (Brunner, 2014; Gabardo et al., 2017; McArtney et al., 2012).
Research conducted in Serbia (Radivojevic et al., 2020) has shown that a successful thinning effect was achieved in single metamitron treatments during the normal application time (5-15 mm in fruit diameter) at concentrations of 250 mg L^{-1} ('Gala') and 300 mg L^{-1} ('Golden Delicious') only under favorable weather conditions (minimum night temperature 10^0C, maximum daily temperature >25^0C).
If a single application is made, just a few hours after treating the leaves, the product reduces their capacity for photosynthesis by up to 50% depending on the dose administered. The wider inhibition of the photosynthesis process takes place gradually and maximum values are recorded from the fourth day after treatment, but the trees recover their complete photosynthetic activity at 25-45 days after the first application. (Gonzalez et al., 2015; Stern, 2015).
The objective of the present study was to evaluate the thinning efficacy of metamitron applied in single application in 'Pink Lady' apple plantation.

MATERIALS AND METHODS

The experiment was conducted on 'Pink Lady' apple variety, trees in the commercial plantation "Terra Vitis" Ltd, Burlacu village, Cahul district. The trees grafted on a M26 rootstock, were planted in 2013, in single rows at a distance of 4.0 × 1.5 m (1666 trees per hectare).
The trees were trained as a slender spindle system. The experiment was conducted during the period of 2018 year.
In accordance with the endowment growth regulators intended for the chemical thinning of the fruits, the following scheme of experiments was elaborated: 1. Without thinning (control); 2. Geramid New, 1.3 l/ha; 3. Brevis, 1.1 kg/ha; 4. Brevis, 1.65 kg/ha; 5. Brevis, 2.2 kg/ha.
The following commercial products containing a different active ingredient were applied "Geramid New" (L. Gobbi S.R.L., Italy) containing 44.8 g L^{-1} alpha-naphthylacetamide acid (NAD) as the active ingredient and "Brevis" (Adama Agan Ltd., Israel) containing 150 g kg^{-1} metamitron as the active ingredient.
In the first variant, no intervention was performed on the reproductive organs in the crown of the trees.
In the second variant, according to the scheme of experience, a single treatment was performed (30.04.2018) with the growth regulator Geramid New at a dose of 1.3 l/ha, when 80% of the petals fell plus 2-3 days, et development stage 4-5 mm fruitlet diameter.
In third, fourth and fifth variants, according to the experiment scheme, a single treatment were performed (06.05.2018) with the Brevis product, in dose 1.1; 1.65 and 2.2 kg/ha, respectively, et development stage 10.4 mm fruitlet diameter.
The amount of solution administered to a tree was 0.6 liters, based on the number of trees per unit area and the recommended amount of water of 1000 l/ha.
The experimental design was randomised block with four replicates, whereby every replication consisted of eight trees.
The research was performed in the field and laboratory conditions according to the accepted method of carrying out experiments on fruit crops with growth regulators.
During the research the following indices were studied: the number of blossom clusters after thinning and the share of fruits in the inflorescence.
The apples were harvested in beginning of November in a single pass-through and afterwards, based on their diameter, they were graded into six classes by hand calibrator at intervals of 5 mm (from 50 mm to >80 mm). Total yield per tree was calculated as a total of the mass of all classes. Average fruit weight (g) was obtained from a ratio of total yield and total number of harvested fruit.
The statistical processing of the main data was determined by the dispersion analysis method.

RESULTS AND DISCUSSIONS

The results presented in Table 1 show that the Geramid New growth regulator did not influence the number of inflorescences related to the 'Pink Lady' variety. In the case of treatment with the growth regulator Geramid New at a dose of 1.3 l/ha, the number of inflorescences related to the 'Pink Lady' trees

was 181 pcs/tree, ie a decrease of 1.7% less compared to the control variant.
In the case of variants where the treatment was performed with the Brevis growth regulator, these indicators registered essential deviations in comparison with the Geramid New variant in the 1.3 l/ha dose and the control variant.
Treatment with Brevis at a dose of 1.1 kg/ha decreased the index in the study by 44.9% compared to the control variant. Increasing the dose to 1.65 and 2.2 kg/ha of the studied product, respectively, decreased the number of tied inflorescences, constituting 101 and 41 pcs/tree, respectively.
In the control variant, where the thinning of the fruit organs was not performed at 29.9% of the inflorescences, one fruit was registered, at 26.6% three fruits, at 29.4% two fruits, 28.8% each three fruits, at 10.9% four fruits each and only within 1.0% of the inflorescences were five fruits each.

Table 1. Number of setting inflorescences (NSI) in the crown of 'Pink Lady' apple trees and the share of fruits in an inflorescence according to the growth regulators used to thin the fruit organs

Variants	NSI, pcs/tree	The share of fruits in an inflorescence, %				
		1 pcs	2 pcs	3 pcs	4 pcs	5 pcs
Without thinning, (control)	184	29.9	29.4	28.8	10.9	1.0
Geramid New, 1.3 l/ha	181	30.4	38.2	18.8	12.7	-
Brevis, 1.1 kg/ha	127	55.9	25.2	11.1	7.1	0.7
Brevis, 1.65 kg/ha	101	52.5	22.8	18.9	5.8	-
Brevis, 2.2 kg/ha	41	65.9	19.6	14.5	-	-

In the variant with the use of the growth regulator Geramid New in the dose of 1.3 l/ha, the index in the study did not increase the share of inflorescences with a smaller number of fruits, constituting 31.4%, 38.2%, 18.8% and respectively 12.7%.
Among the variants exposed to chemical thinning, an increase in the share with a higher number of fruits in one inflorescence was recorded when treating the trees with Brevis product at a dose of 2.2 kg/ha, where 65.8% of the inflorescences formed a fruit, at 19.6% two fruits each, and at 14.5% three fruits each.
In the case of treating the trees with the Brevis product in the dose of 1.1 and 1.65 kg/ha, large deviations regarding the location of the fruits in an inflorescence were not obvious. A more rational location of the fruits in an inflorescence of the 'Pink Lady' trees was registered in the version treated with Brevis at a dose of 1.65 kg/ha, where 52.5% of the fruits are one in the inflorescence, at 22.8% two fruits each, and at 18.9 and 5.8% three and four fruits, respectively.
The study performed on the number of fruits reported per 100 inflorescences (Figure 1), showed higher values in the control variant, without thinning, where the index in question constituted 227 pcs.
In the variants treated with the growth regulator Geramid New and Brevis, the mentioned index varied from 151 to 218 pieces per 100 inflorescences. In the variant treated with the Geramid New growth regulator at a dose of 1.3 l/ha, the studied index registered practically identical values with the control variant, where it constituted 218 pieces per 100 inflorescences.

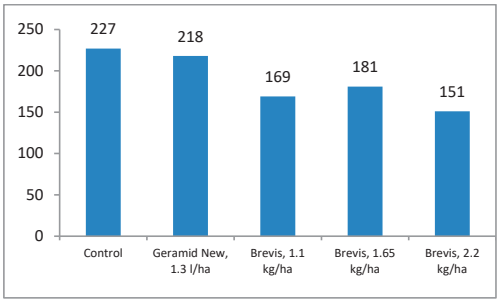

Figure 1. The influence of the growth regulators and the treatment dose on the number of fruits per 100 inflorescences, pcs

When thinned with Brevis 1.1 in the dose; 1.65 and 2.2 kg/ha, the number of fruits per 100 inflorescences was lower compared to the previous variants and amounted to 169; 181 and 151 pieces, respectively.
The number of fruits in the crown of the trees of the 'Pink Lady' variety is in turn influenced by the method of thinning and the dose administered during treatment.
The investigations carried out show that a higher number of fruits (Table 2) in the trees of the 'Pink Lady' variety were registered in the variant where the thinning was not performed - 411 pcs/tree. Next, an insignificant decrease in the number of fruits was observed in the variant

treated with the growth regulator Geramid New in the dose of 1.3 l/ha - 395 pcs/tree.
Treatment with Brevis at a dose of 1.1 kg/ha decreased the index in the study by 91.1% compared to the control variant. Increasing the dose to 1.65 and 2.2 kg/ha of the studied product, decreased the number of fruits formed in the trees, amounting to 183 and 62 pcs/tree, respectively.
If, in the control variant, without thinning, the average weight of a fruit in the 'Pink Lady' variety was 111 g, then in the variants with chemical thinning it ranged from 115 to 165 g. Lower weight of the fruits were recorded when treating the trees with Geramid New at a dose of 1.3 l/ha - 115 g, and the highest average fruit weight was achieved by treatments with Brevis at a dose of 2.2 kg/ha -165 g.

Table 2. The influence of the growth regulators on the fruits production in the crown of the apple trees of the 'Pink Lady' variety

Variants	The number of fruits, pcs/tree	Average weight, g	The fruits production	
			kg/tree	t/ha
Without thinning, (control)	411	111	45.62	76.00
Geramid New, 1.3 l/ha	395	115	45.42	75.67
Brevis, 1.1 kg/ha	215	131	28.16	46.91
Brevis, 1.65 kg/ha	183	138	25.25	42.07
Brevis, 2.2 kg/ha	62	165	10.23	17.04
LDS 5%	18.7	6.1	2.4	3.2

As the treatment dose decreases, the average weight of the fruits decreased too being in the variant treated with Brevis in the dose 1.1 kg/ha - 131 g, and in the variant Brevis in the dose 1.65 kg/ha - 138 g.
Higher fruit productions per tree and per unit area were registered in the control variant, without thinning where the mentioned indices constituted respectively 45.62 kg/tree and 76.00 t/ha. Similar values with the control variant were registered in the variant treated with Geramid New in the dose of 1.3 l/ha, where the fruit production registered, 45.42 kg/tree and, respectively, 75.67 t/ha. On the side of the respective variant, it can be observed that the treatment with NAD-based products of the trees of the Pink Lady variety did not influence as a growth regulator for crop loading.
In the case of the variant thinned with Brevis at a dose of 1.1 kg/ha, the productivity of a tree was 28.16 kg, and at one area unit 46.91 t/ha was obtained, or it was 61.8% compared to the control variant. Variants treated with the Brevis product in doses of 1.65 and 2.2 kg/ha, the fruit production constituted 46.91 and, respectively 42.07 t/ha.
In the study carried out on how the growth regulator influences the treatment dose on the number of Pink Lady fruits in one kilogram of apples, we register a more rational redistribution in the variants treated with the Brevis product, compared to the control variant, without treatment and the variant treated with Geramid New at a dose of 1.3 l/ha (Figure 2).
If, in the control variant and the one treated with the Geramid New product in the dose of 1.3 l/ha, we register a higher number of fruits within one kilogram of apples (9.01 and 8.7 pieces, respectively), then in the variants treated with Brevis, a decrease in the index under study was obtained.

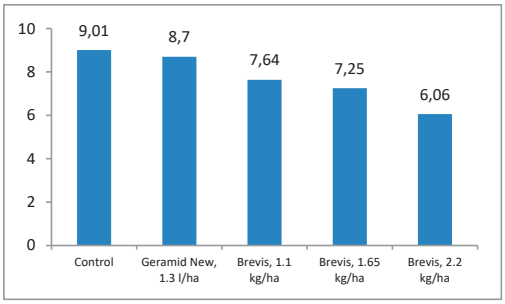

Figure 2. The influence of the growth regulators and the treatment dose on the number of fruits per one kg, pcs

If, in the variant treated with the Brevis growth regulator in the dose of 1.1 kg/ha, we register a value of 7.64 fruits/kg, then with the increase the dose to 1.65 and 2.2 kg/ha the number of fruits of the variety 'Pink Lady' within one kilogram of apples decreased, and amounted to 7.25 and 6.06 fruits/kg, respectively (Figure 3).

Figure 3. The influence of the growth regulators and the treatment dose on the quality of fruits from 'Pink Lady' variety

The study performed as it influences the growth regulator on the fruits quality of the 'Pink Lady' trees, we register a more rational redistribution in the variants treated with the Brevis product, compared to the control variant, without treatment and the variant treated with Geramid New in the dose 1.3 l/ha (Table 3).

Among the trees of the 'Pink Lady' variety, lower quality productions were obtained in the control variant, where the share of fruits with a diameter of less than 55 mm is 0.9%, with a diameter of 55-60 mm - 5.4%, with a diameter of 60-65 mm - 62.1%, with a diameter of 65-70 mm - 24.9% and only 6.7% have a diameter greater than 70 mm.

Table 3. The influence of the growth regulators on the redistribution of fruits according to their diameter in the apple trees of the 'Pink Lady' variety

Variants	The share of fruits (%) according to their diameter (mm)					
	50-55	55-60	60-65	65-70	70-75	75-80
Without thinning, (control)	0.9	5.4	62.1	24.9	6.7	-
Geramid New, 1.3 l/ha	0.3	4.6	55.0	36.1	4.0	-
Brevis, 1,1 kg/ha	-	2.6	27.9	23.3	32.9	13.3
Brevis, 1,65 kg/ha	-	4.0	9.9	26.0	41.3	18.8
Brevis, 2,2 kg/ha	-	0.7	3.6	13.5	37.9	44.3

In the variant treated with the product Geramid New, 1.3 l/ha, we register a redistribution of the fruits on the studied diameters as in the control variant with small deviations within the fruits with a diameter of 60-65 mm (55.0%) and diameter of 65-70 mm (36.1%). Thus, in the control variant, the share of fruits with a diameter greater than 65 mm was 31.6%, and in the Geramid New version, 1.3 l/ha - 40.1%. This proves once again that the NAD product cannot be recommended for the standardization of the fruits load in the 'Pink Lady' variety.

The use of the Brevis growth regulator in the regulation of the fruits load positively influenced the quality of the obtained fruits. If, for example, in the variant treated with the Brevis growth regulator at a dose of 1.1 kg/ha, we register a higher weight for fruits with a diameter of 60-70 mm, increasing the treatment dose of Brevis to 1.65 and 2.2 kg/ha, decreased the share of fruits with a diameter of 60-70 mm, but increased the index in question for fruits with a diameter of 70-80 mm (Figure 4).

Figure 4. The influence of treatment dose of Brevis product on the quality of fruits from 'Pink Lady' variety

More convincing results regarding the production ratio and the diameter of the fruits were registered during the researches at the 'Pink Lady' variety in the variant of using the Brevis growth regulator at a dose of 1.65 kg/ha. The average diameter of the fruits is an indicator that has a direct tangent with the average weight of the obtained production.

Lower values of the average diameter of the fruits in the trees of the 'Pink Lady' variety were registered in the control variant - 64.4 mm, where the trees were without thinning, and higher values were registered in the variant treated with the Brevis product in the dose 2.2 kg/ha - 73.3 mm. The variant treated with the Geramid New growth regulator at a dose of 1.3 l/ha registered practically identical values with the control variant, where it constituted 64.6 mm (Figure 5).

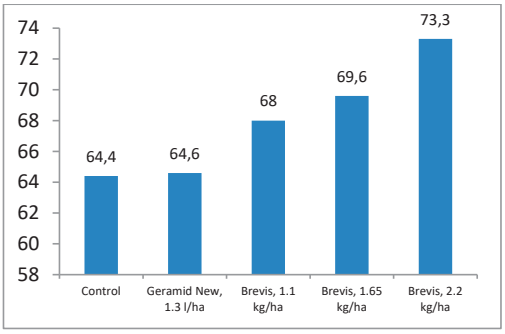

Figure 5. The influence of the growth regulators on the diameter of the 'Pink Lady' apple variety fruits, mm

In the variants treated with the Brevis product in the dose of 1.1 and 1.65 kg/ha, the average diameter of a fruit registered average values of the index under study, which constituted 68.0 and 69.6 mm, respectively.

CONCLUSIONS

The number of fruits, their average weight and the recorded production differ depending on the active ingredient taken in the study of crop loading and the dose of the product used to thin the fruit.

The active ingredient taken in the study to normalize the crop loading influenced the weight of fruits of different diameters.

In commercial industrial plantations for crop loading of apple fruits, the treatment of 'Pink Lady' trees to be carried out with the Brevis growth regulator at a dose of 1.65 kg/ha, et 10-12 mm fruitlet diameter.

The sky should be clear, the air temperature in the atmosphere should vary from +10 to 25^{0}C and without atmospheric precipitation during 2-3 days after treatment.

The 'Pink Lady' variety is not prone to fruit load regulation with the Geramid New growth regulator.

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REFERENCES

Babuc, V. (2012). Pomicultura. Chişinău.

Babuc, V., Peşteanu, A. Gudumac, E., Cumpanici A. (2013). Producerea merelor. Chişinău.

Balan, V., Vămăşescu, S. (2011). Increase quantity and quality of apple fruit by normalization of load by different methods of thinning. *Lucrări ştiinţifice Seria B - LV. UŞAMV, Bucureşti, Seria Horticultură*, 352 - 357.

Basak, A. (2011). Efficiency of fruitlet thinning in apple 'Gala Must' by use of metamitron and artificial shading. *Journal of Fruit and Ornamental Plant Research*, *19* (1), 51-62.

Botton, A., Rocchi, L., Costa, G. (2020). Modelling metamitron-induced fruit drop as related to photoinhibition stress, dosage and number of applications in Golden Delicious. *Acta Hortic.,* 1295, 21–32.

Bound, S.A. (2006). Comparison of two 6-benzyladenine formulations and carbaryl for post-bloom thinning of apples. *Scientia Horticulturae*, *111*, 30-37.

Brunner, P. (2014). Impact of metamitron as a thinning compound on apple plants. *Acta Horticulturae*, 1042, 173-181.

Brunner, PH. (2016). The thinning opportunities offered by Brevis. *European Fruit growers Magazine*, 25-27.

Gabardo, G. C., Petri, J. L., Hawerroth, F. J., Couto, M., Argenta, L. C., Kretzschmar, A. A. (2017). Use of Metamitron as an apple thinner. *Rev. Bras. Frutic.*, 39,(3) 1-9.

Gonzalez, L., Torres, E., Alegre, S., Bonany, J., Avila, G., Carbo, J., Asin, L. (2015). Brevis, una nueva herramienta para aclareo quimico en manzano. *Revista de Fruticultura*,42, 30-41.

Cimpoieş, GH. (2012). Cultura mărului. *Editura „Bons Offices", Chişinău,* 380.

Dorigoni, A., Lezzer, P. (2007). Chemical thinning of apple with new compounds. *Erwerbs-Obstbau*, 49, 93-96.

Greene, D.W. (2014). Use of metamitron alone and in combination with 6-benzyladenine for thinning apples. *Acta Horticulturae*, 1042, 167-172.

Lafer, G. (2010). Effects of chemical thinning with metamitron on fruit set, yield and fruit quality of 'Elstar'. *Acta Horticulturae*, 884, 531-536.

Maas, F.M., Meland, M. (2016). Thinning responses of 'Summerred' apple to Brevis® in a northern climate. *Acta Horticulturae*, 1138, 53-60.

McArtney, S.J., Obermiller, J.D. (2012). Use of 1-aminocyclopropane carboxylic acid and metamitron for delayed thinning of apple fruit. *HortScience*, 47 (11), 1612-1616.

McArtney, S.J., Obermiller, J.D., Arellano C. (2012). Comparison of the effects of metamitron on chlorophyll fluorescence and fruit set in apple and peach. *HortScience*, 47 (4), 509-514.

Peşteanu, A. (2013). Efficiency of fruitlet thinning apple „Golden Reinders" by use naphthylacetamide Acid (NAD). *Bulletin of University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca*, Horticulture, 70(1), 281-289.

Peşteanu, A. (2015). The influence of thinning agent on base of 6-BA and NAA on productivity and fruit quality of "Gala Must" variety. *Bulletin of University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca*, Horticulture, 72(1), 151-156.

Peşteanu, A., Calestru, O. (2020). Eficacitatea normării încărcăturii de rod la unele soiuri de măr în perioada precoce de dezvoltare a organelor reproductive. *Ştiinţa agricolă*, 1, 46-54.

Radivojevic, D.,Milivojevic, J., Pavlovic M., Stopar M. (2020). Comparison of metamitron efficiency for postbloom thinning of young 'Gala' and 'Golden Delicious' apple trees. *Turk J Agric For.*, 44, 83-94.

Stern, R. (2014). The photosynthesis inhibitor metamitron is an effective fruitlet thinner for 'Gala' apple in the warm climate of Israel. *Scientia Horticulturae*, 178, 163-167.

Stern, R. (2015). The photosynthesis inhibitor metamitron is a highly effective thinner for 'Golden Delicious' apple in a warm climate. *Fruits*, 70 (3), 127-134.

Vămăşescu, S. (2012). Apple harvest based on the variety and the fruit thinning method system. *Annals of the University of Craiova,* XVII (LIII), 437-442.