

## Efficiency of Fruitlet Thinning Apple „Golden Reinders” by use Naphthylacetamide Acid (NAD)

Ananie PESTEANU

Faculty of Horticulture. State Agrarian University of Moldova, Republic of Moldova;  
[a.pesteanu@uasm.md](mailto:a.pesteanu@uasm.md)

**Abstract.** Thinning the apple crop during the post bloom period is absolutely essential to ensure large fruit size, superior fruit quality, and reliable annual cropping. To evaluate the effectiveness of thinning agent on base of naphthylacetamide acid (NAD) in reducing fruit set in Golden Reinders apple trees. The experimental plot is placed in the orchard “Dacfruct” Ltd. founded in 2006 with trees of a „knip boom” canopy type. The study subject of the experience was Golden Reinders apple variety grafted on M 9 weak vigor rootstock. The trees were trained as slender spindles. The distance of plantation is 3,5 x 1,2 m. The agent tested were NAD, (preparation Geramid New). The preparation was sprayed on the trees either one time (when fallen 80% of petals +2-3 days), or twice (the second spraying was repeated at the dimension of central fruits 6 mm in diameter). The research was conducted during the period of 2011 year. During the research, it was studied the number of blossom clusters before thinning degree, fruit at harvest time (number per tree, number per 100 flower clusters and number per cm<sup>2</sup> TCSA), yield, mean fruit weight, average fruit diameter, size classes based on their diameter and the number of pygmy fruits. It was established that, the good effect of thinning was noticed after one spray with preparation Geramid New. The single treatment has a significant affect on yield, mean fruit weight and positively influenced fruit size, the distribution of apples in size classes.

**Keywords:** apple, thinning, NAD, yield, mean fruit weight, fruit diameter, size classes.

### INTRODUCTION

‘Golden Delicious’ is one of the most important cultivars grown in Republic of Moldova. It is also one of the most widely accepted apples on the world market. The ‘Golden Delicious’ apple trees typically produce more flowers and fruit than are needed to produce a full crop of marketable fruit (Ferré, 1979; Laurens, 1989; Stopar, 2000; Robinson, 2006; Wertheim, 2000).

Many of the excess fruitlets will drop shortly after petal fall or later. Intensive thinning during the blossoming period increased fruit size the most, whereas the hand thinning after June drop (Forshey, 1986; Webster, 2002).

The hand thinning of the ‘Golden Delicious’ apple trees is costly because they produce the large number of fruitlets. Heavy crop loads inhibit the ability of the tree to develop blossom buds for the following year, resulting in biennial bearing (Greene, 2002; Tromp, 2000).

Therefore, ‘Golden Delicious’ trees should be first thinned chemically, and only then by hand if needed (Wertheim, 1997). Chemical thinning with bioregulators decreases fruit set and increases average fruit weight of different apple cultivars (Basak, 2004; Greene, 1993; Robinson, 2006; Stern *et al.*, 2006; Stopar, 2000).

Chemical fruit thinning methods were tested by different research in many countries. Generally, plant growth regulators are used such as NAA, NAD, BA and ethephon for fruit thinning. Some of the fruit thinners can reduce fruit quality. In addition, their effects may

change depend on weather temperature in application time (Greene *et al.*, 1990; Robinson, *et al.*, 1998; Wertheim, 1997).

NAD induces early mild thinning, particularly in Golden and Gala, which starts the differentiation process among the flower clusters. This paves the way for a second later treatment, with BA and NAA, which normally hits the weakened fruits, leaving 1 or 2 undisturbed fruitlets per cluster. Additionally, NAD can also improve skin finish on Golden Delicious (Dirigoni, 2005).

One negative aspect of NAD is the shocking effect it has on vegetation and in part on fruit development, particularly on Gala (Basak, 2006).

Time of application of naphthaleneacetamide (NAD) beginning from first petal fall on the king blossom to 6 mm fruit diameter.

Use concentrations depending on variety and growing conditions (Robinson and Lakso 2000). NAD is particularly effective on hard-to-thin varieties such as Golden Delicious, if used at the proper time. Best applied at temperatures between 21°C and 24°C, under slow drying conditions, as NAD is mostly absorbed from the original solution (Ferré, 1979).

## MATERIALS AND METHODS

The research was conducted during the period of 2011 year in the superintensive apple tree orchard, growing at a village Sirota form district Orhei in the autumn of 2006 year at the Ltd. „Dacfruct” with trees of a „knip boom” canopy type.

The study subject of the experience was Golden Reinders apple variety grafted on M 9 weak vigour rootstock. The trees were trained as slender spindles. The distance of plantation is 3.5 x 1.2 m.

The chemical growth regulator used were Geramid – New, containing 44.8 g/l active ingredient NAD, the preparation by the „L. Gobbi Ltd.” producer from Italy. To optimize the fruit load of the apple trees were experimented the following variants (Tab. 1).

Tab. 1

Scheme of the experiences to determine the efficiency of Geramid-New growth regulator regarding the optimization of apple fruit load

Nr.	Experience variantities	Active ingredient	Mode of application
1.	Control variant – without thinning	-	-
2.	Geramid-New - 150 ml/hl	NAD (44,8 g/l)	Spraying, when fallen 80% of petals +2-3 days.
3.	Geramid-New - 100 ml/hl +100 ml/hl	NAD (44,8 g/l)	Two sprayings: I – when fallen 80% of petals +2-3 days; II – at the dimension of central fruit in diameter of 6 mm.

The soil was maintained with grass on intervals between rows and herbicided field between trees on row with a width of 1.2 m. It was used the drip irrigation system.

The plots placement was made in blocks, each variant having three repetitions. Each repetition consisted of 7 trees. At the boundaries between the plots and the experimental repetitions was left per 1 untreated tree to avoid duplication of some control variants or repetitions on making the treatments.

On the experimental sector, in conformity with the experiences scheme (Tab. 1), in the second variant it was made a single treatment 14.05.11 at a dose of 150 ml/hl. There were made two treatments in variant 3 with a dose 100 ml/hl. The first treatment was made 14.05.11, and the second treatment 18.05.11. The treatment of trees was made with portable watering tools on hours without wind, from morning, starting at the temperature of +20°C.

The amount of solution to a tree was 0.4 to 0.5 liters, based on the number of trees per unit area and the amount of water recommended by the 1000 l/ha. For a more positive grip of the solution with a leaf surface was added Silwet L77 from the ratio of 1 ml to 10 liters of water.

The effects on the fruit set, the yield, fruit quality at harvest and subsequent blooming were recorded and evaluated according to the following measurements: the number of inflorescences and the number of fruitlets on each tree; the fruit yield produced by each tree, and, for 1 ha orchard of apples; weight of 1 apple; the share of fruits (in %) in size classes based on their diameter from 50 mm to 85 mm with the intervals of 5 mm and relative effectiveness of treatments.

Thus, we see that the weather conditions during the surveys differ as between them and to the multiannual average, but it were typical for the area and conducive to grow apple fructification and Geramid-New growth regulator treatment.

## RESULTS AND DISCUSSIONS

During the research of the amount of fruit generative organs, we record that in the year 2010, the trees of the variety Golden Reinders differentiated enough fruit buds, which after cutting in the dormant period in the spring of 2011 year, at the flowering, there were 190-201 inflorescences (Tab. 2). Inflorescences amount obtained demonstrate that trees have a uniform development and can be mounted the research with Geramid-New growth regulator in accordance with scheme of the experiences.

Investigations demonstrate that Geramid - New growth regulator, as prepared for chemical fruit thinning, has an essential influence.

In the control variant where has been no fruit thinning, the difference between the total inflorescences and tied ones number was properly corresponding to 197 and 186pcs/tree, respectively 94.4% of flowers have formed.

Tab. 2

Total inflorescence number (TIN), formed (FIN) in apple trees crown of the variety Golden Reinders and fruit weight in an inflorescence

Nr.	Experience varants	TIN, pcs/tree	FIN, pcs/tree	fruit weight in an inflorescence, %			
				1 pc.	2 pcs.	3 pcs.	>4 pcs.
1.	Control variant without thinning	197	186	58.0	28.0	9.1	4.9
2.	Geramid - New, 150ml/hl	190	87	52.9	35.6	11.5	-
3.	Geramid - New, 100 ml/hl +100 ml/hl	201	94	69.1	27.6	3.3	-

The results with chemical spray, demonstrates us that Geramid - New growth regulator reduces the number of inflorescences formed. In the case when the treatment with Geramid - New growth regulator in dose of 150 ml/hl, the number of inflorescences was about 87 pcs/tree, i.e. decreased by 2.14 times if compared with the control variant. In variant two, with Geramid - New growth regulator in dose of 100 ml/hl+100 ml/hl study indicators was respectively 94 pcs/tree and 1.98 times.

Studying the influence of growth regulators on fruit weight in an inflorescence, we register a more rational location in the variant 3 - Geramid - New 100 ml/hl +100 ml/hl, where 69.1% of fruits are by one fruit in blossom, 27.6% by two fruits and 3.3% by three fruits. In variant two - Geramid - New in dose of 150 ml/hl the index in that study was 52.9%, 35.6% and respectively, 11.5%.

In the control variant, where there was made no thinning process, in 4.9% of inflorescences formed by four fruits, from 9.1% by three fruits, on 28.0% by two fruits and on 58.0% by one fruit.

The largest amount of fruit (Tab. 3) is observed in the control variant - 316 pcs/tree of which 30 pieces/ tree of "pygma" type. Next, in a decreasing order is placed the Geramid - New variants with a dose of 150 ml/hl - 141 pcs/tree and Geramid - New in a dose of 100 ml/hl + 100 ml/hl - 121 pcs/tree.

Studying the number of fruit per 100 inflorescences we record a similar rule to that described above, being of 145, 74 and, respectively, 60 pcs.

A higher production per a tree and ha, was obtained when treating with Geramid - New (05/14/11) 150 ml/hl, when the petals have fallen 80% plus 2-3 days, being respectively 22.13 kg/tree and 52.66 t/ha. In case of having a second time the treatment with Geramid - New of about 100 ml/hl (5/14/11, 5/18/11) we obtained 17.21 kg/tree and 40.95 t/ha.

Tab. 3

Influence of Geramid - New growth regulator on production and fruit quality parameters of apple trees in the crown of apple tree Golden Reinders variety at harvesting

Nr.	Experience variants	Number of fruits, pcs.		Fruit production			Average weight, g	Average diameter, mm
		tree	100 infl.	kg/cm <sup>2</sup> STT	kg/tree	t/ha		
1.	Control variant, without thinning	286/30*	145	1.34	21.43	51.00	75.0	55.0
2.	Geramid - New, 150ml/hl	141	74	1.31	22.13	52.66	156.0	71.0
3.	Geramid - New, 100 ml/hl +100 ml/hl	121	60	1.00	17.21	40.95	142.0	69.0
	LSD 5%	13.03	-	-	1.97	4.68	6.99	-

\* - number of small fruit called "pygma"

Fruit production reported to the transversal section of the trunk in the control variant is 1.34 kg/cm<sup>2</sup>, in variant Geramid - New 150 ml/hl -1.31 kg/cm<sup>2</sup>, and in the Geramid - New variant, 100 ml/hl + 100 ml/hl - 1.0 kg/cm<sup>2</sup> STT.

Fruit quality is tangent to the weight and the average diameter of a fruit. If in the control variant has been no thinning the average weight of a fruit was 75.0 g, then in the variants, where is spray with the Geramid - New growth regulator, it has increased to 142.0-156.0 g.

Studying how the average weight was carried in the variants with a chemical thinning, the we recorded an increase of the investigated index with 9.8% in the case when treating with preparation Geramid New in a dose of 150 ml/hl, if to compare with the variant with two treatments of 100 ml/hl. The smallest average fruit diameter was in control variant - 55.0 mm. In Geramid - New 100 ml/hl +100 ml/hl variant the given index constituted 69.0mm, and in the Geramid - New 150 ml/hl variant - 71.0 mm.

The obtained results demonstrate that the largest fruit production was recorded in the case when using for chemical thinning the preparation Geramid - New with a dose of 150ml/hl. In that version, the fruit quality is higher.

Tab. 4

Influence of Geramid - New growth regulator on fruit redistribution according to their diameter at Golden Reinders apple tree varieties

Nr.	Experience variants	Fruit weight (%) according to their diameter (mm)						
		55	56-60	61-65	66-70	71-75	76-80	81-85
1.	Control variant, without thinning	47.4	43.2	9.4	-	-	-	-
2.	Geramid - New, 150ml/hl	-	0.5	8.9	19.9	50.3	16.4	4.0
3.	Geramid - New, 100 ml/hl +100 ml/hl	-	0.7	15.3	24.8	50.3	8.9	-

The results obtained on fruit redistribution according to their diameter demonstrate that a lower quality production was obtained in the control variant. The highest fruit weight (47.4%) are with a diameter less than 55 mm, 43.2% with a diameter of 56-60 mm and only 9.4% have a diameter of 61-65 mm. Thus, there were not registered any data in the control variant without fruit thinning of extra category and class I.

Further, studying the influence of growth regulators on fruit quality, we record a more rational redistribution in the variant with a single treatment, Geramid - New with a dose of 150 ml/hl. In that variant the weight of fruit with a diameter less than 65 mm is 9.4%., In class I, the fruit with a diameter of 66-70 mm have 19.9%, and 70.7% is assigned to extra category of fruit. Thus, the fruit weight of extra and class I categories is 90.6%.

In case of treatment with Geramid - New 100 ml/hl +100 ml/hl it was registered an increase of fruit weight in the class with the diameter 56-70 mm (40.8%) and a decrease in the amount of fruit which is attributable to diameter 76 -85 mm (8.9%).

Thus, the more convincing results on fruit diameter were recorded in the variant Geramid – New with a dose of 150 ml/hl.

Diameter index (R) is the ratio of total harvest production to that with the smaller diameter of 70 mm (Tab. 5).

Tab. 5

Relative effectiveness of treatments for chemical thinning with Geramid – New growth regulator in Golden Reinders apple tree variety plantation

Nr.	Experience variants	Fruit production, kg/tree		Index		
		Total	with $\phi < 70$ mm	diameter (R)	production (P)	global (G)
1.	Control ariant, without thinning	21.43	21.43	1.0	1.0	1.0
2.	Geramid - New, 150ml/hl	22.13	6.48	3.41	1.03	3.,51
3.	Geramid - New, 100 ml/hl +100 ml/hl	17.21	7.06	2.44	0.80	1.95

As the fruit weight diameter with a diameter less than 70 mm, so it increases the diameter index represented in the variant Geramid New 100 ml/hl +100 ml/hl - 2.44, and the dose of Geramid New 150 ml/hl – 3.41.

Production index (P) constitutes the production of fruit harvested from the variant in the study reported to the fruit production registered in the control variant. Investigations were made, so the variant Geramid - New 100 ml/hl +100 ml/hl is 0.80 then is placed the control variant - 1.0 and Geramid - New 150 ml/hl with 1.03.

Global Index (G) is the product between the diameter index of production and production index. The lowest values of the global index are recorded in the control variant (1.0). The highest global index was recorded in variant Geramid - New 150 ml/hl - 3.51 and, the lowest, in the dose of 100 ml/hl +100 ml/hl - 1.95, i.e. 1.8 times lower.

The highest values of real efficiency (diameter index, the production index and global index) are registered in Geramid - New variant in a dose of 150 ml/hl.

## CONCLUSION

It was observed in the experiments performed that inadequate thinning was influent on fruit weight in inflorescence, number of fruits on tree, fruit production, average weight and average diameter, fruit redistribution according to their diameter and on the relative effectiveness of treatments.

It was demonstrated that NAA can be active as a thinner for the 'Golden Delicious' cultivar, when are fallen about 80% of flower petals, plus 2-3 days, but not later than the king fruits have in diameter to 5-6 mm.

Based on experimental results obtained the Geramid - New growth regulator may be included in the system of chemical thinning to optimize the apple fruit load on 'Golden Delicious' cultivar, a one treatment in a dose of 150 ml/hl.

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