

Effect of chemical and hand thinning young apple tree on yield and fruit quality

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Abstract

The aim of this study was to evaluate the effectiveness of two thinning agents in relation to hand thinning in reducing fruit set in 'Gala' and 'Granny Smith' young apple trees. The agents tested were NAA (two concentrations) and carbaryl. Chemical and hand thinning showed greater influence on reduction fruit set in cv. 'Granny Smith' than in cv. 'Gala'. Fruit thinning significantly increased the average fruit size, especially in cv. 'Granny Smith'. In cv. 'Gala', similar effect was only observed in treatment with higher concentration of NAA. Fruit thinning did not influence on other fruit quality parameters for both cultivars. A high return bloom was recorded in treatments with thinning fruit in comparison to unsprayed treatment. It was higher in cv. 'Granny Smith' than cv. 'Gala'

Key words: chemical thinning, hand thinning, 'Gala', 'Granny Smith'

Introduction

Apple trees often form too many blossoms and set too many fruits to bear marketable crops year after year (Stopar, 2006). In fruit trees, the competition among fruits reduces their size if there is excessive fruit set (Dusi et al., 2006). Fruit thinning of apples (*Malus domestica* Borkh.) is an important cultural practice (Fallahi and Fallahi, 2004; Bound, 2006) that is used to prevent excessive fruit set, improve fruit quality and minimize biennial bearing (Janoudi and Flore, 2005). When apple orchard has been established by using feathered nursery tree excessive crop load can be obtained in first years. In young apple orchards thinning apple fruitlets can be done by hand, however that work is often impossible, especially in large areas, because of labor costs and the limited supply of available labor. Therefore, chemical thinning has to be carried out to ensure profitable apple production (Stopar, 2006). For a successful high density planting, cropping should not be too high in the first years. This is important in order to avoid biennial cropping, insufficient growth and having the allotted space filled in a timely manner (Wertheim et al., 2000). It is particular important for 'Gala' apples, that is difficult to thin properly because of its high fertility and extended bloom period (Costa et al., 2004).

The objective of this work was to evaluate possibility of reducing fruit set with two chemical thinners for the young apple tree cvs. 'Gala' and 'Granny Smith'. Secondly, this work aimed does different concentration of NAA offer alternatives in view of changing of Carbaryl as a thinning agent.

Material and methods

This trial was conducted in the 2009 season on 3-year-old apple trees of cv. 'Brookfield Gala' and 4-year-old apple trees of cv. Granny Smith, both on M9 rootstock. The experimental plot was located in a commercial orchard in Bela Crkva ("Južni Banat" company) located in northeastern Serbia. Planting spacing was 3.3 m x 0.8 m (3.787 trees/ha). For each treatment, five replicates (with two different trees of homogenous size and fruit load per replicate) were selected in a completely randomized design. The treatments applied were the following:

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1. NAA: 7 mg L⁻¹ for both cultivars when the mean fruit diameter was 12 mm
2. NAA: 10 mg L⁻¹ for cultivar 'Granny Smith' when the mean fruit diameter was 12 mm
3. NAA: 14 mg L⁻¹ for cultivar 'Gala' when the mean fruit diameter was 12 mm
4. Carbaryl 500 mg L⁻¹ for both cultivars when the mean fruit diameter was 12 mm
5. Hand thinning after June drop for both cultivars
6. Control: Unsprayed

The spray volume applied was 800 L ha⁻¹. Fruit was harvested in August for cultivar 'Gala' and in September for cultivar 'Granny Smith'. Number and weight of fruit recorded for each tree. Fruit was graded by size into four groups. Samples of 10 randomly selected fruit from each replicate were examined for diameter of fruit, fruit firmness, soluble solids content and total acidity. Fruit diameters were measured using callipers. Fruit flesh firmness was measured with a penetrometer using a tip with a diameter of 11 mm. Juice expressed from the apples during the firmness measurements was collected and soluble solids concentration assessed with an Atago PR-1 digital refractometer. The return bloom was estimated next year at full bloom with the scale 1 - 10 (1 = no flowers, 10 = abundant flowering). Data were analyzed using analysis of variance. Mean separation was done by Tukey's HSD test at 1% and 5% level of significance.

Results and discussion

Chemical and hand thinning expressed significant influence on decreasing of total fruit number per tree in cv. 'Granny Smith' (table 1). However, lower number of fruit per tree did not affect lower total yield per tree, i.e. per hectare. Both chemical and hand thinning were significantly increased the share of fruits with diameter above 75 mm in total yield. On unsprayed apple trees, the largest amounts of fruits were observed in the class with diameters ranged from 70 to 75 mm, whereas all other treatments had the largest amounts of fruits in class above 80 mm (fig.1). There were not significant differences among the treatments in two other fruit classes. Our results are in agreement with finding of Fallahi and Fallahi (2004).

Table 1. The effect of chemical and hand thinning on productivity of apple cv. 'Granny Smith'

Treatment	Fruit (no. tree ⁻¹)	Yield (kg tree ⁻¹)	Yield (t hectare ⁻¹)	Fruit > 75mm diameter (%)	Bloom index ^a
NAA: 7 mg L ⁻¹	76.8ab	14.9	56.3	79.7a	9.4a
NAA: 10 mg L ⁻¹	79.4ab	15.9	60.4	84.5a	9.3a
Carbaryl	66.6b	13.3	50.3	85.4a	9.0a
Hand-thin	71.0b	13.3	50.3	83.5a	7.3b
Control	99.1a	15.9	60.4	42.4b	4.2c
	**	ns	ns	**	**

* = $P < 0.05$; ** = $P < 0.01$ according to Tukey's test. ^a Scale: 0 = no flowers to 10 = abundant flowering.

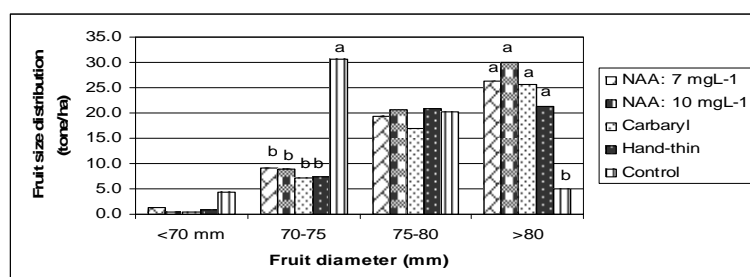


Fig. 1. Effect of chemical and hand thinning on fruit size distribution in 'Granny Smith'

Size classes represent fruit diameters of: < 70, 70-75, 75-80 and > 80 mm. Different letters above column represent statistically significance at 5% level by Tukey's HSD test.

In general, fruit thinning expressed a positive influence on both fruit weight and fruit diameter (table 2). Obtained values were significantly lower in control treatment in comparison to other treatments. The highest fruit firmness was recorded on trees which were subjected to Carbaryl treatment, whereas the lowest one was obtained under NAA (7 mg L⁻¹) treatment. Fruit thinning did not influence other fruit quality parameters of 'Granny Smith'.

Table 2. The effect of chemical and hand thinning on apple fruit quality of cv. ‘Granny Smith’

Treatment	Fruit quality parameters					
	Weight (g)	Diameter (mm)	Firmness (kg cm ⁻²)	Iodine starch index (1-5)	Soluble solids (Brix°)	Total acid (%)
NAA: 7 mg L ⁻¹	190.4a	77.8a	8.4b	2.2	11.1	0.51
NAA: 10 mg L ⁻¹	201.5a	78.8a	8.8ab	1.9	10.5	0.53
Carbaryl	202.6a	78.9a	9.5a	2.1	11.0	0.49
Hand-thin	193.9a	78.3a	9.0ab	2.2	10.3	0.51
Control	166.7b	74.2b	9.3ab	2.1	10.6	0.47
	**	**	**	ns	ns	ns

* = $P < 0.05$; ** = $P < 0.01$ according to Tukey’s test

Apple trees of cv. ‘Gala’, which were subjected to both chemical and hand fruit thinning, showed lower fruit number per tree compare to the control trees, but no significant differences were observed (table 3). Consequently, significant differences between yield per tree as well as yield per hectare were not recorded. It has to be taken into account that ‘Gala’ is considered as a hard to thin cultivar, which is probably the reason for such insignificant thinning (Stopar et al., 2010).

Return bloom index showed higher values in all thinning treatments than those obtained in control treatment.

The very high amount of fruit with diameter above 75 mm was obtained under treatment with 14 mg L⁻¹ NAA (94.1%) (Fig. 2).

Table 3. The effect of chemical and hand thinning on productivity of apple cv. ‘Gala’

Treatment	Fruit (no. tree ⁻¹)	Yield (kg tree ⁻¹)	Yield (t hectare ⁻¹)	Fruit > 70mm diameter (%)	Bloom index ^a
NAA: 7 mg L ⁻¹	56.6	8.7	33.1	75.7ab	4.7a
NAA: 14 mg L ⁻¹	49.2	8.6	32.7	94.1a	5.2a
Carbaryl	55.8	8.9	33.6	82.5a	4.9a
Hand-thin	46.6	6.7	25.3	54.8b	4.9a
Control	59.9	8.1	30.8	50.6b	1.7b
	ns	ns	ns	**	*

* = $P < 0.05$; ** = $P < 0.01$ according to Tukey’s test. ^a Scale: 0 = no flowers to 10 = abundant flowering.

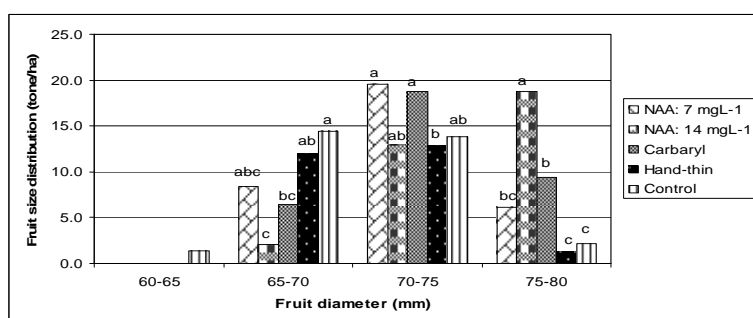


Fig. 2. Effect of chemical and hand thinning on fruit size distribution in ‘Gala’

Size classes represent fruit diameters of: < 65, 65-70, 70-75, and >75 mm. Different letters above column represent statistically significance at 5% level by Tukey’s HSD test

Concerning the fruit weight values obtained for cv. ‘Gala’, unsprayed treatment showed lower value (137 g) in comparison to chemical treatments with NAA (14 mgL⁻¹) and Carbaryl (177 g and 161 g, respectively). Stopar (1999) reported that NAA applied in cv. ‘Gala’ with concentration of 15 ppm increased mean fruit size. However, other fruit quality parameters studied in this work was not differed depending on the thinning treatment.

Table 4. The effect of chemical and hand thinning on apple fruit quality of cv. 'Gala'

Treatment	Fruit quality parameters					
	Weight (g)	Diameter (mm)	Firmness (kg cm ⁻²)	Iodine starch index (1-5)	Soluble solids (Brix°)	Total acid (%)
NAA: 7 mg L ⁻¹	156abc	73.0ab	8.0	3.6	12.3	0.15
NAA: 14 mg L ⁻¹	177a	74.7a	7.7	3.7	12.4	0.17
Carbaryl	161ab	72.7ab	8.0	3.6	12.5	0.17
Hand-thin	145bc	72.6ab	8.1	3.6	12.3	0.16
Control	137c	70.4b	8.3	3.4	11.7	0.15
	**	*	ns	ns	ns	ns

* = $P < 0.05$; ** = $P < 0.01$ according to Tukey's test

Conclusions

Chemical and hand thinning showed greater influence on reduction fruit set in cv. 'Granny Smith' than in cv. 'Gala'. Fruit thinning significantly increased the average fruit size, especially in cv. 'Granny Smith'. In cv. 'Gala', similar effect was only observed in treatment with higher concentration of NAA. A high return bloom was recorded in treatments with thinning fruit in comparison to unsprayed treatment. It was higher in cv. 'Granny Smith' than cv. 'Gala'. Taking into account the achieved results, with chemical thinning should start as soon as possible because of that early application does not harm precocity. NAA completely can replace carbaryl as chemical thinning agent in young apple orchard, due to its utilization is prohibited in many EU countries.

Acknowledgements

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