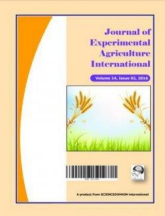

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Thinning of 'Eva' Apple with Plant Growth Regulators

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Authors' contributions

This work was carried out in collaboration between all authors. Authors CG and MBM designed the study and wrote the first draft of the manuscript. Author CG performed the experiments. Author GAA participated in fieldwork and laboratory analysis. Authors FSL and SBA managed the analyses of the study. Author PCMF managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Aims: The aim of this research was to evaluate the effects that cause the plant growth regulators, namely naphthalene acetic acid (NAA), 6-Benzyladenine (BA) and Promalin® (6- benzyladenine (BA) with the gibberellic acid GA 4+7), on thinning efficacy and return bloom of 'Eva' apple trees.
Study Design: The experimental design used was a randomized complete block design, with four replications, with two plants per treatment in each block, following a one-step scheme with 13 treatments for the thinning factor. Obtained results were submitted to analysis of variance, and means were compared by Tukey test with a 5% probability of error.
Place and Duration of Study: The experiment was carried out during the agricultural cicles 2012/2013 and 2013/2014 in a commercial orchard located in the municipality of Morro Redondo, RS, Brazil.
Methodology: Plant growth regulators were applied in both cicles as follows: Promalin® was sprayed at the full bloom (80%) period at doses of 0.5, 1.0, 1.5 and 2.0 mL L^{-1}; NAA and BA were

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sprayed in fruits with 5-7 mm diameter, at doses of 5, 10 and 15 mg L^{-1} and 50, 75, 100 and 125 mg L^{-1}, respectively, and hand fruit thinning was performed after full bloom.
Results: Number of fruit per plant, the density of fruits by the trunk cross-sectional, yield per plant and the return of bloom in the second cycle were evaluated in the field. Fruit flesh firmness, total soluble solids, fruit diameter, fruit length and mean fruit mass were evaluated at Laboratório de Agronomia (LabAgro), Universidade Federal de Pelotas. With Promalin® at different concentrations, the results were statistically similar to the hand fruit thinning, so this procedure can be another alternative for thinning.
Conclusion: The plant growth regulator NAA reduced the harvesting load but caused a negative response and the plants formated of fruits small. The BA-based treatments were more efficacy for reducing fruits load, increased fruit size and accelerated the flowering return.

Keywords: Malus x domestica (Borkh.) Borkh; crop load; 6-Benzyladenine; naphthalene acetic acid; Promalin®.

1. INTRODUCTION

Thinning is an important cultural practice which influences fruit production and quality. Fruit tree thinning is justified by two main reasons, according to physiological aspects of the plant: to reduce the risks of alternation of production, common in the following cycle in years of excessive load in which the plants were not thinned or the process was inadequately; and to have fruits with increased quality (bigger, more colorful, higher sugar content and more aromatic) [1].

Thinning can be performed manually or chemically, however, hand fruit thinning has some limitations such as the time of execution, labor availability and its cost, so the search for new technologies in chemical thinning becomes important.

In fact, the use of chemical thinning in pomiculture reduces considerably the need of labor and consequently its cost. Besides the economic aspects, orchards treated with chemical thinning tend to produce fruits with increased quality, increased mean fruit mass and more regular production avoiding the alternation of production [2]. The chemical thinning as a viable alternative to the hand fruit thinning in pomiculture, as it requires less time of execution and reduced labor [3,4].

Naphthaleneacetic acid (NAA), carbaryl and, more recently, 6-benzyladenine (BA) are among the chemical thinners used in apple tree culture [4,5]. Another product also used is Promalin® formed by the mixture of two natural plant growth regulators, cytokine 6-BA (benzyladenine) and gibberellins GA4 + 7 [6]. The aim of this research was to evaluate the effect that causes the plant growth regulators naphthaleneacetic acid (NAA), 6-benzyladenine (BA) and Promalin® (6-benzyladenine (BA) + gibberellins GA4 + 7) in fruits thinning and in the return of bloom of 'Eva' apple trees.

2. MATERIALS AND METHODS

The study was performed during the agricultural cycles 2012/2013 and 2013/2014 in a commercial orchard located in Morro Redondo municipality, RS, Brasil (31º 40' 60" South and 52º 34' 50" West). Seven years old apple trees of the cultivar 'Eva', grafted on a 'Marubakaido' rootstock and conducted in the central leader system with a density of 2500 plants ha^{-1} were used.

Table 1. Treatments and doses used in apple orchards during the agricultural cycles 2012-2013 and 2013-2014

Treatments	Doses	Treatments	Doses
Control (hand fruit thinning)	----------	NAA	15 mg L^{-1}
Promalin®	1.25 ml L^{-1}	NAA	20 mg L^{-1}
Promalin®	1.50 ml L^{-1}	BA	50 mg L^{-1}
Promalin®	1.75 ml L^{-1}	BA	75 mg L^{-1}
Promalin®	2.00 ml L^{-1}	BA	100 mg L^{-1}
NAA	5 mg L^{-1}	BA	125 mg L^{-1}
NAA	10 mg L^{-1}	----------	----------

The commercial products ANA Técnico (9.5% active ingredient) and MAxCel® (2% active ingredient) were used as source of NAA and BA, respectively. Promalin® was also used and it is composed by gibberellins GA4 + 7 (1.8%) and cytokine 6-benzyladenine (1.8%) [6]. The mineral oil Assist® (0.2%) was added to all treatments. The applications were carried out by spraying with a backpack sprayer using spray medium volume corresponding to 1000 L ha^{-1}. Promalin® was applied when 80% of the flowers were opened (FA), NAA and BA were applied when the larger fruits reached 5 to 7 mm in diameter (Table 1).

Number of fruits per trunk cross-sectional area (cm^{-2}) (TCSA), trunk diameter at 20 cm from the ground, number of fruits per plant, yield per plant (kg) and mean fruit mass (g) were the parameters evaluated in the field. Fruit flesh firmness (N) (FFF), was performed by removing the peel on two opposite sides of the equatorial region of the fruit, and measured using a Turoni 53205 digital penetrometer, with an 11 mm diameter probe. Fruit diameter (mm), fruit length (mm), length/diameter (L/D) ratio and total soluble solids (ºBrix), were evaluated in all treatments in the two years of the experiment.

The return bloom was evaluated for the second agricultural year (2013/2014), estimated using a scale of 1-10, where 1= without flowers and 10= intense flowering, this evaluation was made considering three branches marked in the plant. The experimental design used was a randomized complete block design, with four replications, with two plants per treatment in each block, following a one-step scheme with 13 treatments for the thinning factor. Obtained results were submitted to analysis of variance, and means were compared by Tukey test with a 5% probability of error.

3. RESULTS AND DISCUSSION

A significant influence was observed for the number of fruits per plant for the cicle 2012/2013 harvesting when comparing the chemical treatments with the hand fruit thinning (82.75). Treatments with Promalin® were not statistically different from each other and from the ma hand fruit thinning. A significant reduction in fruits per plant was observed with NAA 15 mg L^{-1} (51.25) comparatively to the hand fruit thinning. Treatments with BA also reduced number of fruits per plant (40.50, 50.25 and 43.75) for dosages of 50, 100 and 125 mg L^{-1}, respectively, with consequent lower fruits load (Table 2).

Results obtained by [5], where BA was applied at 120 mg L^{-1} in 'Fuji Suprema' fruits with 5 to 8.92 mm diameter, also showed a significant reduction on number of fruits per plant compared to the hand fruit thinning. In addition, [7] also reported a reduction in the number of fruits per plant in 'Summerred' cultivar treated with BA and NAA. The application of BA increases the competition for carbohydrates between larger fruits in relation to smaller fruits, reducing the number of fruits per plant [8]. The mechanism of action of BA in respect to apple thinning is still theme of discussion on the literature; one of the evidences is the action of BA on the reduction of polar transport of indolacetic acid, resulting in an increase on cells sensibility in the ethylene abscission area [9,10,11].

A similar behavior was observed for hand fruit thinning and treatments with Promalin® in respect to the number of fruits for the TCSA, both treatments showing the highest values. Nevertheless, treatments with NAA and BA showed a significant decrease in this parameter compared to hand fruit thinning, as well as a reduction in the number of fruits per plant.

Regarding fruit flesh firmness (Table 2), with the hand fruit thinning was obtained the lowest mean (59.21N) and with the dose of BA 100 mg L^{-1} the highest average (73.16N). The BA was the that caused an increase of fruit size and also the highest fruit flesh firmness, perhaps because the first parameter is related to the number and size of cells, and the second (fruit flesh firmness) with the cell wall [12].

In respect to mean fruit mass, it was verified that BA (125 mg L^{-1}), the highest dosage of the cytokine plant growth regulator, presented a mean value of 160.5 g not differing from the hand fruit thinning (Table 2). Once again it was verified that BA influences the fruits size and weight through the increase of number of cells per fruit due to the stimulation of cell division [13].

The application of BA increased fruit weight as a result of the reduction of harvest load [14,15]. [16] Also related the increase in the number of fruits with the acceleration of cell division when BA was applied. Treatments with different doses of NAA were those with the lowest mean fruit mass, being the NAA 15 mg L^{-1} that with the lowest result (115.95 grams) (Table 2).

Different results are reported in the literature for the efficiency of NAA in both the thinning and the fruit weight and size since the chemical thinning should consider the local climatic conditions as well as the cultivar. reports the NAA as a common compound used for apple thinning, although there are different data on their effectiveness, which can be partly explained by the climatic conditions, mainly the temperature and sensitivity of the variety [17]. The application of high concentrations of NAA provided a negative effect on fruit size [18].

The evaluation of fruit shape represented by fruit diameter, length and their ratio (L/D) are presented in Table 3. Both diameter and L/D values were statistically different among treatments, while length was not. Lower diameters were found for apples under NAA treatment, all less than 60 mm, however, it presented a high L/D ratio due to the length, resulting in slightly deformed fruits with consequent lower commercial value.

Table 2. Number of fruits per plant, fruits per trunk cross-sectional area, production per plant, mean fruit mass and fruit flesh firmness in different thinning treatments for the first experiment cycle (2012/2013) on 'Eva' cultivar

Treatments	Number of fruits plant^{-1}	Fruits cm^{-2} TCSA	Yield plant^{-1} (kg)	Mean fruit mass (g)	FFF (N)
Control (hand fruit thinning)	82.75 ac	7.51 a	13.41 a	162.20 a	59.21 b
Promalin® (1.25 ml L^{-1})	82.00 ac	7.69 a	10.04 a	122.50 ef	67.97ab
Promalin® (1.50 ml L^{-1})	83.50 ac	7.68 a	11.14 a	133.50 cd	71.93 ab
Promalin® (1.75 ml L^{-1})	91.25 ab	8.27 a	12.13 ab	133.12 c	69.20 ab
Promalin® (2.00 ml L^{-1})	96.25 a	7.93 a	12.51 ab	130.00 c	70.77 ab
NAA (5 mg L^{-1})	55.75 cd	4.54 b	7.56 ce	135.72 cd	65.66 ab
NAA (10 mg L^{-1})	66.5 ad	5.42 ab	8.88 be	133.75 cd	66.31 ab
NAA (15 mg L^{-1})	51.25 d	5.47 ab	5.94 de	115.95 f	68.09 ab
NAA (20 mg L^{-1})	56.25 cd	4.40 b	7.19 ce	127.92 de	61.15 ab
BA (50 mg L^{-1})	40.50 d	3.76 b	5.44 e	134.25 cd	68.20 ab
BA (75 mg L^{-1})	61.75 bd	5.50 ab	8.55 be	138.75 c	71.82 ab
BA (100 mg L^{-1})	50.25 d	4.49 b	7.45 ce	147.75 b	73.16 a
BA (125 mg L^{-1})	43.75 d	4.01 b	6.99 ce	160.50 a	71.83 ab
CV (%)	17.98	19.94	18.78	3.15	7.92

Means followed by the same letter do not differ from each other, by Tukey test, at 5% probability (p< (0.05). CV– Coefficient of variation

Table 3. Diameter, length, length/diameter ratio and total soluble solids (TSS) in different thinning treatments for the first experiment cycle (2012/2013) on 'Eva' cultivar

Treatments	Diameter (mm)	Length (mm)	L/D	TSS °Brix
Control (hand fruit thinning)	65.75 a	70.50 ns	1.07 ab	13.17 ns
Promalin® (1.25 ml L^{-1})	65.25 ab	71.75	1.09 ab	13.47
Promalin® (1.50 ml L^{-1})	61.5 ad	70.25	1.14 ab	13.05
Promalin® (1.75 ml L^{-1})	62.25 ac	70.75	1.13 ab	13.32
Promalin® (2.00 ml L^{-1})	56.97 ce	70.25	1.22 ab	13.02
NAA (5 mg L^{-1})	59.97 ce	70.50	1.27 a	12.57
NAA (10 mg L^{-1})	55.70 de	67.00	1.19 ab	12.55
NAA (15 mg L^{-1})	59.12 de	66.25	1.11 ab	12.75
NAA (20 mg L^{-1})	53.75 e	67.75	1.26 ab	13.15
BA (50 mg L^{-1})	61.50 ad	68.00	1.10 ab	13.45
BA (75 mg L^{-1})	63.25 ab	69.00	1.08 ab	13.17
BA (100 mg L^{-1})	62.75 ac	67.25	1.06 b	12.95
BA (125 mg L^{-1})	62.62 ac	68.00	1.08 ab	13.20
CV (%)	2,87	6,57	6,91	6,06

Means followed by the same letter do not differ from each other, by Tukey test, at 5% probability. ns- not significant (p< 0.05). CV – Coefficient of variation

Formation of fruits with diameter less than 60 mm occurs due to the stop in growth until harvest after the application of products with auxin, reported in the literature as the formation of pigmy fruits. One disadvantage reported in the literature for NAA is its negative effect on fruit growth, although its thinning and decreasing harvest load effect, this plant growth regulator is not capable of increase fruit size [15,19,7]. [20] Reported that high concentrations and late applications of NAA depress fruit size. The remaining treatments were not statistically different from the hand fruit thinning that showed the lowest diameter (Table 3).

Apples treated with NAA 5 mg L^{-1} and BA 100 mg L^{-1} showed a statistically different L/D ratio. Although values of length were not statistically different, it can be observed that Promalin® resulted in longer fruits, thus with a good L/D ratio. These results are in accordance with those obtained by [21] once authors found that Promalin® treatment increases fruit length, although they were not statistically different. [22] Also obtained an increase in fruit length, with a consequent increase on L/D ratio after the treatment of 'Royal Gala' cultivar with Promalin®. Total soluble solids (º Brix) were not statistically different among treatments, with a mean general value of 13.05 º Brix (Table 3).

A similar behavior was observed when comparing the first (2012/2013) and second (2013/2014) experiment cycles regarding the number of fruits per plant. The hand fruit thinning showed the highest values of this parameter and plants treated with Promalin®, were statistically similar. Nevertheless, a significant reduction was observed for NAA and BA treatment, being the BA treatment at dose 50 and 125 mg L^{-1} those with lower mean of fruits per plant (44.5) (Table 4). [23] Also observed a significant reduction in the number of fruits per plant with NAA 7.5 mg L^{-1} (8 DAPF) for the 'Gala' cultivar. In addition, [24] tested different volumes of NAA (10 mg L^{-1}) and BA (100 mg L^{-1}) and observed the same behavior for 'Jonagold' cultivar. According to [23], optimum fruit load varies from 6 to 9 fruits per cm^{-2} from the TCSA, or 1 to 1.5 kg cm^{-2} TCSA.

Overall, the results obtained for this variable was similar for the two experiment cycles (Tables 2 and 5), showing that the hand fruit thinning and Promalin® were not statistically different and presented higher values. Treatments with NAA and BA showed the highest reduction, with values lower than those reported by [25] demonstrating the effect of these plant growth regulators. However, [23] reported a high effective fructification when 7.38 fruits cm^{-2} TCSA was obtained.

Results for the production per plant (kg) demonstrated that all dosages of BA were responsible for the highest reduction compared to the hand fruit thinning. Hand fruit thinning showed an average production of 9.23 kg whereas the mean value for BA (50 mg L^{-1}) was 5.06 kg per plant. BA (125 mg L^{-1}) showed the best results concerning the mean fruit mass (130.71 g) while the lowest values were observed for Promalin® 1.75 ml L^{-1} and NAA 20 mg L^{-1} with 83.63 g and 82.76 g, respectively. A small and significant difference was observed for Fruit flesh firmness in the second experiment cycle, being NAA 10 mg L^{-1} that with high value (84.65 N) (Table 4).

Total soluble solids (º Brix) were higher in those fruits with lower mass (g) and diameter (mm); this fact can be due to low rainfall before harvest (Table 5). Comparing cycle 1 and 2, it can be observed that in a general way, fruits from the second cycle presented lower mean fruit mass and consequently higher firmness, higher concentration of total soluble solids and a reduction on plant load. This fact can be due to the different climatic conditions of the two years of production. It was noticed that a cumulative precipitation was below normal in December, the last month of fruit growth, for the second year, different from the first cycle where the cumulative precipitation was above normal for the same period, fact that may have influenced the size and firmness of the fruit.

There are different studies reporting that apple development can be described as expolinear; the first exponential phase corresponds to the cell division, followed by the second phase, a linear growth corresponding to cell expansion until maturation [26]. Nevertheless, normally fruit growth is not affected by cell division, but in the following phase, the fruit growth is more sensitive to hydric stress as it needs to maintain cell swelling to promote cell expansion [27].

Fruit diameter values (Table 5) where significantly higher for BA treatments and BA 100 mg L^{-1} and 125 mg L^{-1}, with fruit diameter of 64.8 mm and 64.57 mm, respectively, where statistically different from the hand fruit thinning (60.5 mm). This increase in diameter reveals the effectiveness of treatment with the cytokine 6-

benzyladenine. Our results are in accordance with those reported by [28] who obtained fruits with diameter higher than 65 mm when BA 100 mg L^{-1} was applied to Golden Delicious cultivar. In addition, fruits with diameter higher than 70 mm were obtained by [29] for Galaxy cultivar; however, their results were not statistically different from the hand fruit thinning.

Fruit length was not significantly different among treatments, however higher values were observed for Promalin® treatment, as it happens for the first cycle. A higher variation on L/D ratio was observed in the second cycle where Promalin® 1.5 ml L^{-1} (L/D=1.12) and Promalin® 1.75 ml L^{-1} (L/D=1.14) differ from NAA 20 mg L^{-1} (L/D=0.95) and BA 100 mg L^{-1} (0.94). The increase in L/D ratio for treatments based on BA + GA_{4+7} has been demonstrated when applied during the flowering period [30,31,32]. [33] Reported an increase in L/D ratio by Promalin® in Fuji and Imperial Gala cultivars, and [34] found the same behavior when using BA in Fuji and McIntosh cultivars. The increase in fruit size is a consequence of cell division induction and cell elongation, increasing, therefore, the length of the fruit [35,36].

Apple cultivation generally presents biennial production cycle, where in one year there is an excess of flowering and fruit production, affecting the flowering and yield the following year. One hypothesis for the occurrence of this phenomenon is that the production of gibberellins by the seed is the cause of the negative effect. There is a close relationship between the time when the fruit increases the production of gibberellins and the time when the fruit becomes inhibitors of flower buds formation. Gibberellins possible induce the synthesis and transport of auxin, 6 to 8 weeks after full bloom, affecting the formation of flower buds [37].

However, according to [38] 'Gala' and 'Eva' cultivars, in general, do not present problems with alternation of production, usually blooming even when excess production occurs. In the present study the evaluation of flowering return was made in the second cycle of the experiment (2013/2014) and results are displayed in Fig. 1. This evaluation allows verifying the effectiveness of the plant growth regulators on the alternation of production in the apple tree crop. The highest flowering return was observed for BA 100 mg L^{-1} and 125 mg L^{-1} (5 – 7mm). Promalin® (1.25 and 1.50 ml L^{-1}) and NAA (10 and 20 mg L^{-1}) showed the lowest index. [7] Obtained the best return flowering for BA and BA combined with other plant growth regulator for 'Summerred' cultivar.

Conversely to the results obtained herein, 'Golden Delicious' treated with NAA (20 mg L^{-1}) had a return flowering index diameter of 10 mm [39]. [34] One of the main reasons of apple thinning is to assure the return bloom for the next year, he considers that all thinning agents have potential to increase the flowering return once the thinning is made in young fruits as it is a

Table 4. Number of fruits per plant, fruits per trunk cross-sectional area, production per plant, mean fruit mass and fruit flesh firmness (FFF) in different thinning treatments for the first experiment cycle (2013/2014) on 'Eva' cultivar

Treatments	Number of fruits $plant^{-1}$	Fruits cm^{-2} TCSA	Yield $plant^{-1}$ (kg)	Mean fruit mass (g)	FFF (N)
Control (hand fruit thinning)	86.25 ab	8.01 ab	9.23 a	107.04 bc	71.27 ab
Promalin® (1.25 ml L^{-1})	71.00 ac	5.93 ac	7.71 ac	108.72 bc	71.86 ab
Promalin® (1.50 ml L^{-1})	71.75 ac	6.44 ac	6.71 ac	93,63 de	79.25 ab
Promalin® (1.75 ml L^{-1})	93.00 a	8.62 a	8.16 ac	83.63 e	71.46 ab
Promalin® (2.00 ml L^{-1})	89.00 ab	7.83 ab	9.67 a	108.79 bc	76.39 ab
NAA (5 mg L^{-1})	55.50 cd	4.75 bc	6.38 ac	115.38 b	67.71 ab
NAA (10 mg L^{-1})	67.00 bd	6.27 ac	6.27 ac	93.52 de	84.65 a
NAA (15 mg L^{-1})	53.00 cd	5.64 ac	7.28 ac	115.15 bc	77.57 ab
NAA (20 mg L^{-1})	70.25 ac	6.80 ac	6.82 ac	82.76 e	76.90 ab
BA (50 mg L^{-1})	44.5 d	4.21 c	5.06 c	112.13 bc	75.32 ab
BA (75 mg L^{-1})	59.5 cd	5.35 ac	6.11 ac	102.77 cd	78.31 ab
BA (100 mg L^{-1})	59.5 cd	5.22 ac	6.39 ac	107.57 bc	79.46 ab
BA (125 mg L^{-1})	44.5 d	4.19 c	5.97 bc	130.71 a	74.67 ab
CV (%)	14.59	22	20.56	4.78	8.38

Means followed by the same letter do not differ from each other, by Tukey test, at 5% probability ($p< 0.05$). CV– Coefficient of variation

Table 5. Diameter, length, length/diameter ratio and total soluble solids (TSS) in different thinning treatments for the second experiment cycle (2013/2014) on 'Eva' cultivar

Treatments	Diameter (mm)	Length (mm)	L/D	TSS ºBrix
Control (hand fruit thinning)	60.5 ce	61.75 ns	1.01 ac	12.95 ac
Promalin® (1.25 ml L^{-1})	58.87 ef	65.00	1.09 ab	13.45 ac
Promalin® (1.50 ml L^{-1})	56.85 fg	63.00	1.10 ab	15.62 a
Promalin® (1.75 ml L^{-1})	54.62 g	61.50	1.12 a	14.65 ab
Promalin® (2.00 ml L^{-1})	54.85 g	63.00	1.14 a	12.95 ac
NAA (5 mg L^{-1})	61.00 ce	64.00	1.04 ac	12.16 bc
NAA (10 mg L^{-1})	57.85 eg	59.00	1.01 ac	12.13 bc
NAA (15 mg L^{-1})	59.97 df	63.25	1.05 ac	13.26 ac
NAA (20 mg L^{-1})	63.75 ac	61.00	0.95 c	11.83 bc
BA (50 mg L^{-1})	61.27 be	62.50	1.01 ac	11.33 c
BA (75 mg L^{-1})	62.95 ad	61.50	0.97 bc	11.33 c
BA (100 mg L^{-1})	64.80 a	61.25	0.94 c	11.56 c
BA (125 mg L^{-1})	64.57 ab	65.5	1.01 ac	11.60 c
CV (%)	2.30	4.96	5.29	9.47

Means followed by the same letter do not differ from each other, by Tukey test, at 5% probability. ns- not significant (p< 0.05). CV – Coefficient of variation

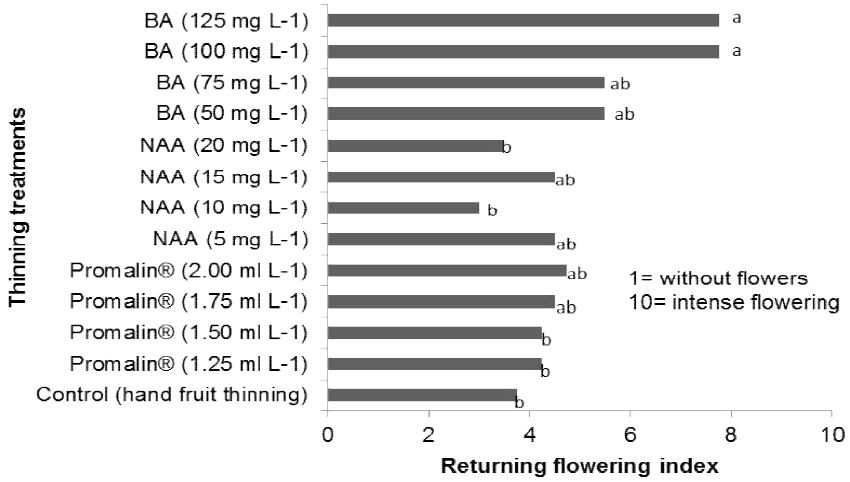

Fig. 1. Return flowering index for different thinning treatments for the second experiment (cycle 2013-2014)

Means followed by the same letter do not differ from each other, by Tukey test, at 5% probability (p< 0.05)

primary source of inhibition of flower buds. [40] Reported that the regulation process for flowering buds is to maintain the balance between the vegetative and reproductive systems, but they stated that an effective thinning program, capable of reducing the number of fruits per plant, increases the probability of the axial terminal meristem of a flower or fruit spurs develop a reproductive structure.

4. CONCLUSION

Overall, results obtained with Promalin® were similar to those that observed where hand fruit thinning was practiced. When used NAA a negative effect was obtained with the formation of small fruits, in addition to low production per plant and poor flowering return. The BA was the that caused the best results in the mean fruit mass and on highest index of the flowering return, but with lower fruit load per plant. Then the use of Promalin® also can be other alternative for fruits thinning.

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COMPETING INTERESTS

Authors have declared that no competing interests exist. The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

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