Crop Load Regulation in 'Conference' Pears

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Abstract

To achieve target yields, crop regulation measures in 'Conference' pears may vary from year to year and may embrace measures to stimulate flower bud development and enhance fruit set, but often also chemical thinning of excess fruit. In 'Conference' the value of the crop at harvest strongly depends on the size distribution of the fruit. The aim is to harvest as many pears as possible with fruit diameters of 65 mm or more, since these sizes provide better economic returns than do smaller fruit. In years with ample flowering and good conditions for pollination, fruit set frequently becomes excessive and thinning is needed to realize the target crop load and the desired fruit size. Hand thinning is labor intensive and thus expensive. Therefore, chemical thinning is being examined as a cheaper alternative. Brevis, a new and specially formulated thinning agent containing metamitron, proved to an effective thinning agent. Depending on orchard conditions, desirable levels of thinning were obtained by the use of single or repeated applications of 175 to 350 mg/L metamitron at the 8 to 12 mm fruit diameter stage of development. Higher dosages were needed to thin well-pollinated 'Conference' trees compared to trees in orchards without pollinators. Thinning was also achieved by the use of benzyladenine (BA), tank mixes of BA and naphthalene acetic acid (NAA), and ethephon. Optimum thinning by BA was established at concentrations of 150 mg/L. Thinning efficacy of BA was increased by the addition of 5 to 10 mg/L NAA. The extent of thinning increased with the concentration of NAA in the tank mix. Ethephon applied at 12 to 14 mm fruit diameter also thinned 'Conference' pears, but was somewhat less effective than the combination of BA and NAA. The percentages of fruit having a diameter >65 mm were significantly increased up to 80 to 90% of the yield for those treatments that thinned the trees to the target fruit load of about 110 fruit per tree.

INTRODUCTION

In The Netherlands the pear production area is about 8000 ha. The most important cultivar is 'Conference', which makes up almost 80% of the total production area. To achieve regular yields of high quality pears, growers have to control the crop load of the trees. Several cultural practices are being used. Firstly, shoot growth of the trees needs to be controlled to obtain a desired balance between shoot development, fruit set and fruit growth. Although 'Conference' is grown on dwarfing quince rootstocks like quince MC or quince Adams, shoot growth generally requires further control. Since the ban on the use of the chemical growth retardant chlormequat (CCC) in 2000, mechanical root pruning is used by the growers to control the vigour of the trees (Maas, 2008). Secondly, flowers have to be protected from spring frost to enable them to set fruit. Overhead sprinkler irrigation is used and may, depending on the development stage of the flowers during the frost, successfully protect the flowers against spring frost down to -6°C (Gerber, 1970). Thirdly, gibberellins (GA_3 or GA_{4+7}) may be applied to enhance parthenocarpic fruit set after spring frost or in orchards without pollinizers (Sansavini, 1986). Fourthly, fruit thinning is necessary in instances of ample fruit set to reduce crop load to the target level and to achieve the desired fruit size of 65 mm in diameter or more.

Hand thinning is the only possible method for Dutch pear growers, as no chemical agents are registered in The Netherlands at present. For an average pear orchard planted at 3.0×1.1 (3000 trees/ha) the thinning requirement may be as high as 50 to 100 fruit per tree to obtain the target level of ca. 100 to 110 fruit per tree and to obtain a good yield and a high percentage of fruit >65 mm in diameter (Maas, 2008; Maas et al., 2010).

As manual thinning is costly and labor is increasingly difficult to come by, the possibilities to chemically thin 'Conference' pears were studied. In this study we report on two different approaches for thinning 'Conference'. First, plant growth regulators like NAA, BA and Ethephon with known thinning activity in apples (Yuan and Greene, 2000; Maas, 2006) and pears (Dussi et al., 2008; Maas et al., 2010) were tested. The second approach was to test the use of Brevis developed by Makhtashim Agan, a specially formulated thinning agent containing the photosynthesis inhibitor metamitron as active ingredient. Studies with an herbicide-formulation of metamitron have shown the potential use of metamitron for thinning apples (Clever, 2007; Dorigoni and Lezzer, 2007; Köpcke, 2005).

MATERIAL AND METHODS

Plant Material and Trial Setup

1. Trial 1. This trial comprised 5 treatments and was carried out in 2009 at three sites. The first site was a pear orchard of the fruit research station at Randwijk, The Netherlands (5°42'08.23"E; 51°56'20.06"N). 'Conference' trees on rootstock quince MC and interstem 'Doyenné du Comice' were planted in 1999 in single rows in a soil consisting of river clay with 30% silt. Planting distances were 3.0×1.09 m. Row orientation was north-south. The trees were trained as a Y-hedge made out of trees with four slanting upward-growing leader branches per tree (mini-tatura or V-quad system). 'Verdi' trees (2 trees in between every 9 'Conference' trees) were planted within the rows for pollination.

The second site was a commercial orchard in Ravenswaaij, The Netherlands (5°19'32.01"E; 51°57'01.96"N). 'Conference' trees on rootstock quince MC were planted in a river-clay soil (30% silt) in 2004 at planting distances of 3.25×1.0 m. The trees were trained as a Y-hedge as described for the orchard in Randwijk. Row orientation was north-south. Ornamental pears 'Pollinya® 1' and 'Pollinya® 3' (Kemp et al., 2008) were planted as pollinizers at regular intervals in each row.

The third site was a commercial pear orchard in Waardenburg, The Netherlands (5°15'38.51"E; 51°50'30.89"N). 'Conference' trees on rootstock quince MC were planted in a river-clay soil in 2000 at planting distances of 3.0×1.0 m. Row orientation was north-south. The trees were trained as a Y-hedge as described for the orchard in Randwijk. No pollinizers were planted in this orchard. Trees at all three sites were pruned, fertilized, irrigated and protected from pests and diseases according to local commercial practice.

2. Trial 2. This trial comprised 10 treatments and was carried out in 2010 in the same orchards in Randwijk and Waardenburg as used in trial 1.

3. Trial 3. This trial was carried out in 2010 in the experimental orchard of the fruit research station at Randwijk in the same orchard as used in trial 1. The thinning trial comprised 29 treatments, including an untreated control and a hand thinning treatment.

Chemical Thinning Compounds

The chemicals used in trials 1 to 3, the timing of their application, the concentrations of the active ingredients and the conditions during application are summarized in Tables 1-6. Application of chemical thinning agents was performed using a knapsack sprayer. Trees were sprayed till runoff. Each treatment was replicated 8 times, using a single tree per plot.

Observations and Statistical Analysis

Trees used for the experiment were selected for uniformity of flowering and representing the average blooming intensity and tree size of the orchard. At the beginning

of the experiment the number of flower clusters per tree was counted. The layout of the trial was complete randomized block design. Each treatment was repeated 8 times with 1 tree per plot. At the time of application of the thinning compounds, the average fruit diameter of all untreated control trees was determined. Fruit diameter of 25 randomly chosen fruit per tree was measured at the widest point of the fruit using digital callipers. At harvest the number of fruit and kg of fruit per tree was determined and used to calculate average fruit weight. Fruit size distribution was made in 5-mm diameter classes from 45 mm upward. Fruit quality was determined on samples of 25 randomly collected fruit per plot. Skin colour was assessed by a Minolta colorimeter, rusetting was graded visually on a scale of 1 (no rusetting) to 6 (100% rusetting), firmness was determined with an Instron penetrometer equipped with an 8-mm diameter plunger, and sugar content was determined refractometrically.

Statistical analysis was carried out using the Anova variance analysis of the Genstat statistical program (VSN International Ltd., Hemel Hempstead, United Kingdom). In case of significant differences ($p<0.05$), LSD values were calculated and used for comparing treatment means in pairs.

RESULTS AND DISCUSSION

Trial 1

The average numbers of flower cluster per tree were 105, 155 and 141 for orchards Randwijk, Ravenswaaij and Waardenburg, respectively. In orchard Randwijk the untreated trees produced 211 fruit and 29 kg per tree, in orchard Ravenswaaij 166 fruit and 24 kg, and in orchard Waardenburg 144 fruit and 21 kg. Fruit load decreased linearly with increasing concentrations of metamitron between 175 and 700 mg/L in all three orchards (Tables 7-9, Fig. 1). Mean fruit weight and percentage of fruit >65 mm in diameter increased linearly with the decrease in number of fruit per tree (Tables 7-9, Fig. 2). Remarkably, the thinning efficacy of metamitron and the concomitant increase in fruit weight was less in orchard Randwijk than in the orchards Ravenswaaij and Waardenburg. In orchard Randwijk the target fruit load of 110 fruit per tree was even not achieved by the highest concentration of metamitron, whereas it was already reached at half this concentration in both other orchards. In orchards Ravenswaaij and Waardenburg trees were greatly overthinned by the highest concentration of metamitron. Return bloom in 2010 was not affected by any of the treatments (data not shown).

'Conference' showed only minor symptoms of phytoxicity after treatment with Brevis. Only the leaves present at the time of treatment showed minor and temporary symptoms of leaf chlorosis.

Trial 2

The average numbers of flower clusters per tree were 161 and 171 for orchards Randwijk and Waardenburg, respectively. The untreated control trees of the Randwijk and Waardenburg orchards produced 215 fruit and 32 kg per tree (Table 10) and 156 fruit and 22 kg per tree (Table 11), respectively. Except for the single applications of 175 (Randwijk and Waardenburg) and 350 mg/L of metamitron (Randwijk) at 6-8 mm fruit size only, all other chemical treatments significantly reduced fruit set. The extent of reduction in fruit set increased with the number of applications of metamitron. In orchard Randwijk, only the three-fold application of 350 mg/L metamitron (treatment 10) thinned the trees to the target fruit load of the hand-thinned trees and resulted in a similar high average fruit weight and high percentage of fruit >65 mm (Table 10). In orchard Waardenburg, the target level of thinning of the hand-thinned trees was already achieved by the two-fold applications of metamitron (treatments 5 and 8). In orchard Randwijk the final thinning response did not depend on the concentration of metamitron used in the first application at 6-8 mm, while in orchard Waardenburg thinning was slightly stronger when 350 mg/L instead of 175 mg/L was used in the first application. The tank mix application of 100 mg/L BA and 10 mg/L NAA gave similar results as the three-fold

applications of metamitron with 175 mg/L. As in trial 1, similar concentrations of chemical thinning agents caused more thinning in orchard Waardenburg than in orchard Randwijk. In orchard Waardenburg, the orchard without pollinizers, overthinning occurred at the highest dosages of metamitron, while in orchard Randwijk even a three-fold application of 350 mg/L of metamitron did not overthin the trees. The difference in thinning response is attributed to the presence of pollinizers in orchard Randwijk, which resulted in fruit with more seeds. Fruit of orchard Randwijk contained 2.9 mature and 5.8 empty seeds on average while fruit of orchard Waardenburg contained only 0.5 mature and 4 empty seeds on average. Fruit with seeds are less prone to abscise than fruit without seeds because of growth regulators produced by the seeds (Yuda et al., 1984). Apparently, the presence of seeds also enhances the sink activity of the fruit for assimilates and makes it more difficult to promote their abscission by the inhibition of photosynthesis.

Trial 3

The average number of flower clusters was 133 per tree. The untreated control trees produced 178 fruit and 28 kg per tree with a mean fruit weight of 161 g and 50% fruit >65 mm. Hand thinning after June drop increased average fruit weight to 202 g and the percentage of fruit >65 mm to 79%. To reach the target fruit load of about 110 fruit per tree ca. 80 fruit had to be removed in the pure hand thinning treatment. This need for hand thinning was significantly reduced by 19 of the 27 chemical thinning treatments (Table 12). NAA alone did not reduce the need for hand thinning, but BA alone at a concentration of 150 or 200 mg/L and ethephon alone at 400 mg/L reduced the need for hand thinning by 60 and 66%, respectively. A tank mix application of NAA+BA resulted in more thinning than either BA or NAA alone. The strongest thinning was achieved by the combination of 10 mg/L NAA with either 150 or 200 mg/L BA. Both treatments reduced the requirement for hand thinning to only a few fruit per tree. All combinations of NAA+BA+hand thinning significantly increased average fruit weight above that of trees that were thinned by hand only. Combinations of 10 mg/L NAA with 150 mg/L BA and 200 mg/L BA resulted in average fruit weights of 226 and 233 g and percentages fruit >65 mm of 87 and 90%, respectively. Most of the NAA applications followed by an ethephon application also significantly reduced the need for hand thinning, but in general this reduction was not larger than that caused by ethephon alone (Table 12). Manual adjustment of fruit load after chemical thinning improved fruit size compared to that chemical thinning alone, especially in the case of NAA+BA tank mix applications that tended to reduce average fruit size due to the retention of small fruit (Maas et al., 2010). Fruit colour, rusetting, and firmness were not significantly affected by any of the thinning treatments (data not shown). Sugar content of the fruit was only significantly increased by the treatments 400 mg/L ethephon (11.3°Brix), 5 mg/L NAA + 150 mg/L BA (11.0°Brix) and 10 mg/L NAA+150 mg/L BA (11.2°Brix) as compared to that of the untreated control (10.5°Brix).

CONCLUSIONS AND RECOMMENDATIONS

Brevis, a new and specially formulated thinning agent containing metamitron, proved to be a good chemical thinning compound for thinning ‘Conference’ pears. Further tests are needed to adjust the concentration and application times to the desired level of thinning in orchards differing in vigour or the level of pollination.

Thinning of ‘Conference’ was also achieved by 150 mg/L BA and even more so by a combined application of 150 mg/L BA+10 mg/L NAA. Ethephon applied at 400 mg/L at 12-14 mm also thinned ‘Conference’ pears, but was somewhat less effective than the combination of BA+NAA.

Finally, additional hand thinning is recommended to remove excess fruit, especially small and deformed fruit remaining on the trees after chemical thinning, to further maximize fruit size and the percentage of fruit >65 mm.

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Tables

Table 1. Treatments of thinning trial 1 on 'Conference' in 2009 at Randwijk, Ravenswaaij, and Waardenburg orchards.

1.	Untreated control
2.	Hand thinning after June drop (June 29, Randwijk; July 2, Ravenswaaij; July 3, Waardenburg)
3.	175 mg/L metamitron[1] at 10-12 mm fruit diameter
4.	350 mg/L metamitron at 10-12 mm fruit diameter
5.	700 mg/L metamitron at 10-12 mm fruit diameter

[1] Brevis (Makhteshim-Agan).

Table 2. Spraying conditions of thinning trial 1 on 'Conference' in 2009 at Randwijk, Ravenswaaij, and Waardenburg orchards.

Site[1] treatment	Date	Stage[2] (mm)	Time (h)	Temp. (°C)	R.H. (%)	Wind direction, Speed (m/s)	Sky cloudiness (%)	L/tree
S1 3, 4, 5	May 7	11.3	10-12	13	78	South-west 3-4	80	0.38
S2 3, 4, 5	May 2	10.7	8-10	13	90	West 2	10	0.38
S3 3, 4, 5	May 7	11.3	16-18	17	60	South-west 2	20	0.38

[1] S1 = Orchard Randwijk; S2 = Orchard Ravenswaaij; S3 = Orchard Waardenburg.
[2] Average diameter of the fruit of the untreated control trees determined on day of treatment (25 fruit/tree).

Table 3. Treatments of thinning trial 2 on 'Conference' in 2010 at Randwijk and Waardenburg orchards.

1.	Untreated control
2.	Hand thinning after June drop[1]
3.	100 mg/L BA[2]+10 ml/L NAA[3] at 10-12 mm fruit diameter (FD)
4.	175 mg/L metamitron[4] at 6-8 mm FD
5.	175 mg/L metamitron at 6-8 mm+175 mg/L at 10-12 mm FD
6.	175 mg/L metamitron at 6-8 mm+175 mg/L at 10-12 mm+175 mg/L at 14-16 mm FD
7.	350 mg/L metamitron at 6-8 mm FD
8.	350 mg/L metamitron at 6-8 mm+175 mg/L at 10-12 mm FD
9.	350 mg/L metamitron at 6-8 mm+175 mg/L at 10-12 mm+175 mg/L at 14-16 mm FD
10.	350 mg/L metamitron at 6-8 mm+350 mg/L at 10-12 mm+350 mg/L at 14-16 mm FD

[1] Carried out on July 15 at Randwijk and July 6 at Waardenburg.
[2] Benzyladenine (MaxCel, Certis Europe b.v.).
[3] 1-naphtalene-acetic acid (Late-val vloeibaar at Certis Europe b.v.).
[4] Brevis (Makhteshim-Agan).

Table 4. Spraying conditions of thinning trial 2 on 'Conference' in 2010 at Randwijk and Waardenburg orchards.

Site[1] treatment	Date	Stage[2] (mm)	Time (h)	Temp. (°C)	R.H. (%)	Wind direction, Speed (m/s)	Sky cloudiness (%)	L/ tree
S1 4-10	May 5	6.5	14-18	12-14	55	North 2	60	0.36
S2 4-10	May 10	7.2	15-17	12-13	46	West 2	10	0.35
S1 3,5,6,8,9,10	May 20	10.6	18-21	17-22	45	North-West 3	0	0.38
S2 3,5,6,8,9,10	May 21	9.5	8-11	11-18	79	North-West 2	50	0.34
S1 9,10	June 1	14.9	13-15	17-21	67	North-West <1	95	0.41
S2 9,10	June 3	14.8	7-9	10-13	86	North 2	0	0.37

[1] S1 = Orchard Randwijk; S2 = Orchard Waardenburg.
[2] Average diameter of the fruit of the untreated control trees determined on day of treatment (25 fruit/tree).

Table 5. Spraying conditions of thinning trial 3 on 'Conference' in 2010 at Randwijk orchards.

Treatment	Date	Stage[1] (mm)	Time (h)	Temp. (°C)	R.H. (%)	Wind direction, speed (m/s)	Sky Cloudiness (%)	L/ tree
3-8; 12-20	May 20	10.6	9-17	15-22	39-62	North West 2-3	0	0.36
9-11; 21-29	May 25	12.7	10-12	17-19	47-49	North <1	0	0.35

[1] Average diameter of the fruit of the untreated control trees determined on day of treatment.

Table 6. Treatments of thinning trial 3 on 'Conference' in 2010 at Randwijk orchard.

1.	Untreated control
2.	Hand thinning after June drop (July 15)
3.	5 mg/L NAA[1] at 8-10 mm fruit diameter
4.	7.5 mg/L NAA at 8-10 mm fruit diameter
5.	10 mg/L NAA at 8-10 mm fruit diameter
6.	100 mg/L BA[2] at 8-10 mm fruit diameter
7.	150 mg/L BA at 8-10 mm fruit diameter
8.	200 mg/L BA at 8-10 mm fruit diameter
9.	200 mg/L Ethephon[3] at 12-14 mm fruit diameter
10.	300 mg/L Ethephon at 12-14 mm fruit diameter
11.	400 mg/L Ethephon at 12-14 mm fruit diameter
12.	5 mg/L NAA+100 mg/L BA at 8-10 mm fruit diameter
13.	5 mg/L NAA+150 mg/L BA at 8-10 mm fruit diameter
14.	5 mg/L NAA+200 mg/L BA at 8-10 mm fruit diameter
15.	7.5 mg/L NAA+100 mg/L BA at 8-10 mm fruit diameter
16.	7.5 mg/L NAA+150 mg/L BA at 8-10 mm fruit diameter
17.	7.5 mg/L NAA+200 mg/L BA at 8-10 mm fruit diameter
18.	10 mg/L NAA+100 mg/L BA at 8-10 mm fruit diameter
19.	10 mg/L NAA+150 mg/L BA at 8-10 mm fruit diameter
20.	10 mg/L NAA+200 mg/L BA at 8-10 mm fruit diameter
21.	5 mg/L NAA at 8-10 mm fruit diameter+200 mg/L Ethephon at 12-14 mm fruit diameter
22.	5 mg/L NAA at 8-10 mm fruit diameter+300 mg/L Ethephon at 12-14 mm fruit diameter
23.	5 mg/L NAA at 8-10 mm fruit diameter+400 mg/L Ethephon at 12-14 mm fruit diameter
24.	7.5 mg/L NAA at 8-10 mm fruit diameter+200 mg/L Ethephon at 12-14 mm fruit diameter
25.	7.5 mg/L NAA at 8-10 mm fruit diameter+300 mg/L Ethephon at 12-14 mm fruit diameter
25.	7.5 mg/L NAA at 8-10 mm fruit diameter+400 mg/L Ethephon at 12-14 mm fruit diameter
27.	10 mg/L NAA at 8-10 mm fruit diameter+200 mg/L Ethephon at 12-14 mm fruit diameter
28.	10 mg/L NAA at 8-10 mm fruit diameter+300 mg/L Ethephon at 12-14 mm fruit diameter
29.	10 mg/L NAA at 8-10 mm fruit diameter+400 mg/L Ethephon at 12-14 mm fruit diameter

[1] 1-naphtalene-acetic acid (Late-val vloeibaar at Certis Europe b.v.).
[2] 6-benzyladenine (MaxCel, Certis Europe b.v.).
[3] Ethrel-A (Bayer CropScience b.v.).

Table 7. Flower clusters, fruit set (fruit/100 flower clusters), fruit per tree, yield, and average fruit weight of 'Conference' in thinning trial 1 in Orchard Randwijk in 2009.

Treatment	Flower clusters 2009	Fruit/100 flower clusters	Fruit/tree	Yield/tree (kg)	Fruit weight (g)	% kg >65 mm
1. Untreated control	104	204 d	211 c	28.9 c	140 a	22.6 a
2. Hand thinning	106	105 a	109 a	21.1 a	192 c	58.2 bc
3. 175 mg/L metamitron	105	176 c	184 c	27.2 bc	152 ab	28.7 a
4. 350 mg/L metamitron	105	156 b	160 b	27.0 bc	170 bc	47.9 b
5. 700 mg/L metamitron	105	120 a	124 a	23.9 ab	194 c	69.3 c
F-test	NS	P<0.001	P<0.001	P<0.001	P<0.001	P<0.001

NS = not significant. Values within a column followed by the same letter(s) are not statistically different.

Table 8. Flower clusters, fruit set (fruit/100 flower clusters), fruit per tree, yield, and average fruit weight of 'Conference' in thinning trial 1 in Orchard Ravenswaaij in 2009.

Treatment	Flower clusters 2009	Fruit/100 flower clusters	Fruit/tree	Yield/tree (kg)	Fruit weight (g)	% kg >65 mm
1. Untreated control	152	111 d	166 d	24.1 c	146 a	27.1 a
2. Hand thinning	141	86 c	114 bc	21.1 bc	185 bc	52.4 bc
3. 175 mg/L metamitron	149	89 c	130 c	20.9 bc	163 ab	40.2 ab
4. 350 mg/L metamitron	165	64 b	102 b	19.9 b	202 c	69.6 cd
5. 700 mg/L metamitron	168	35 a	61 a	14.4 a	237 d	77.5 d
F-test	NS	P<0.001	P<0.001	P<0.001	P<0.001	P<0.001

NS = not significant. Values within a column followed by the same letter(s) are not statistically different.

Table 9. Flower clusters, fruit set (fruit/100 flower clusters), fruit per tree, yield, and average fruit weight of 'Conference' in thinning trial 1 in Orchard Waardenburg in 2009.

Treatment	Flower clusters 2009	Fruit/100 flower clusters	Fruit/tree	Yield/tree (kg)	Fruit weight (g)	% kg >65 mm
1. Untreated control	139	105 d	144 d	21.2 c	150 a	20.9 a
2. Hand thinning	143	81 bc	110 bc	18.2 bc	167 a	32.1 a
3. 175 mg/L metamitron	141	83 c	116 c	19.3 bc	170 ab	35.6 a
4. 350 mg/L metamitron	141	64 b	89 b	17.5 b	199 b	56.9 b
5. 700 mg/L metamitron	142	32 a	45 a	10.4 a	247 c	78.5 c
F-test	NS	P<0.001	P<0.001	P<0.001	P<0.001	P<0.001

NS = not significant. Values within a column followed by the same letter(s) are not statistically different.

Table 10. Flower clusters, fruit set (fruit/100 flower clusters), fruit per tree, yield, and average fruit weight of 'Conference' in thinning trial 2 in 2010 in Orchard Randwijk.

Treatment	Flower clusters	Fruit/ 100 flower clusters	Fruit/ tree	Yield/ tree (kg)	Fruit weight (g)	% kg >65 mm
1. Untreated control	161	141 f	215 d	31.7 b	150 a	38.8 a
2. Hand thinning	159	69 a	107 a	24.0 a	226 de	93.6 e
3. 100BA[1]+10NAA[2]	163	99 bc	156 b	29.5 b	192 bc	72.7 cd
4. 175MM[3]	155	130 ef	194 c	31.1 b	164 ab	49.6 ab
5. 175MM+175MM	156	113 cde	171 bc	30.5 b	183 bc	63.3 bc
6. 175MM+175MM+175MM	164	96 bc	156 b	29.7 b	198 cde	73.0 cd
7. 350MM	165	126 def	204 cd	31.1 b	162 ab	46.8 ab
8. 350MM+175MM	162	106 bcd	170 bc	29.5 b	178 abc	60.2 bc
9. 350MM+175MM+175MM	165	91 b	151 b	28.7 b	196 cd	72.6 cd
10. 350MM+350MM+350MM	155	70 a	111 a	24.3 a	234 e	87.8 de
F-test	NS	P<0.001	P<0.001	P<0.001	P<0.001	P<0.001

[1] BA=6-benzyl-adenine.
[2] NAA=1-naphtalene-acetic acid.
[3] MM=metamitron. Number in front of thinning compound is concentration used in mg/L. See Tables 3 and 4 for more detailed information of the treatments.
NS=not significant. Values within a column followed by the same letter(s) are not statistically different.

Table 11. Flower clusters, fruit set (fruit/100 flower clusters), yield, and average fruit weight of 'Conference' in thinning trial 2 in 2010 in Orchard Waardenburg.

Treatment	Flower clusters 2010	Fruit/ 100 flower clusters	Fruit /tree	Yield/ Tree (kg)	Fruit weight (g)	% kg >65 mm
1. Untreated control	178	89 d	156 f	21.6 d	141 a	22.4 a
2. Hand thinning	169	64 bc	103 bc	18.4 bc	179 bc	44.8 b
3. 100BA[1]+10NAA[2]	178	49 a	85 ab	17.1 ab	202 d	64.4 cd
4. 175MM[3]	165	89 d	145 ef	21.2 d	148 a	23.7 a
5. 175MM+175MM	167	71 c	117 cd	20.7 cd	180 bc	48.1 bc
6. 175MM+175MM+175MM	169	52 ab	86 ab	16.9 ab	197 cd	57.8 bc
7. 350MM	171	73 c	125 de	20.7 cd	170 b	40.3 ab
8. 350MM+175MM	181	65 c	111 cd	18.7 bc	171 b	43.0 b
9. 350MM+175MM+175MM	168	48 a	81 a	15.6 a	195 cd	55.5 bc
10. 350MM+350MM	166	40 a	69 a	15.6 a	241 e	81.6 d
F-test	NS	P<0.001	P<0.001	P<0.001	P<0.001	P<0.001

[1] BA=6-benzyl-adenine.
[2] NAA=1-naphtalene-acetic acid.
[3] MM=metamitron.
Number in front of thinning compound is concentration used in mg/L. See Tables 3 and 4 for more detailed information of the treatments.
NS=not significant. Values within a column followed by the same letter(s) are not statistically different.

Table 12. Flower clusters, fruit set (fruit/100 flower clusters), yield, average fruit weight, and number of hand-thinned fruit of 'Conference' trees of thinning trial 3 in Randwijk. Trees, except treatment 1, were hand-thinned to approximately 110 fruit/tree on 15 July 2010.

Treatment	Flower clusters 2010	Fruit/ 100 clusters	Fruit/ tree	Yield/ tree (kg)	Fruit weight (g)	# hand-thinned fruit/ tree
1. Untreated control	136	137 j-l	178 f	28.2 d	161 a	-
2. Hand thinning	136	147 l	117 b-e	23.5 ab	202 bc	79 i
3. 5 mg/L NAA[1]	137	114 c-j	113 a-e	24.0 a	215 c-i	52 f-i
4. 7.5 mg/L NAA	136	128 g-l	122 e	25.2 a-c	209 b-f	47 d-i
5. 10 mg/L NAA	135	137 kl	116 b-e	23.9 bc	210 b-f	64 hi
6. 100 mg/L BA[2]	129	126 g-l	116 b-e	24.6 a-c	212 b-h	42 c-h
7. 150 mg/L BA	139	101 a-e	110 a-e	24.2 a-c	221 f-j	31 b-f
8. 200 mg/L BA	133	112 c-h	115 a-e	24.5 a-c	215 b-i	32 b-h
9. 200 mg/L Ethephon	136	134 i-l	119 c-e	23.7 a-c	199 b	63 g-i
10. 300 mg/L Ethephon	135	125 f-k	117 b-e	23.4 ab	201 bc	50 f-i
11. 400 mg/L Ethephon	128	116 c-j	112 a-e	23.4 ab	211 b-g	27 b-h
12. 5 mg/L NAA+100 mg/L BA	139	121 e-k	113 a-e	25.6 c	228 h-j	48 e-i
13. 5 mg/L NAA+150 mg/L BA	131	100 a-e	108 a-d	24.0 a-c	222 f-j	21 a-d
14. 5 mg/L NAA+200 mg/L BA	133	110 b-g	115 a-e	25.1 a-c	221 f-j	25 b-f
15. 7.5 mg/L NAA+100 mg/L BA	132	101 a-e	106 a-c	23.0 a	219 d-j	28 b-f
16. 7.5 mg/L NAA+150 mg/L BA	130	98 a-d	111 a-e	24.2 a-c	220 e-j	15 ab
17. 7.5 mg/L NAA+200 mg/L BA	132	94 a-c	104 ab	23.8 a-c	230 ij	19 a-c
18. 10 mg/L NAA+100 mg/L BA	130	115 c-i	115 a-e	24.3 a-c	213 b-h	31 b-g
19. 10 mg/L NAA+150 mg/L BA	131	89 ab	104 ab	23.3 ab	226 g-j	6 a
20. 10 mg/L NAA+200 mg/L BA	135	81 a	102 a	23.7 a-c	233 f	4 a
21. 5 mg/L NAA → 200 mg/E[3]	131	132 h-l	121 de	24.8 a-c	204 b-e	48 d-i
22. 5 mg/L NAA → 300 mg/E	126	124 f-k	113 a-e	24.2 a-c	214 b-i	42 c-h
23. 5 mg/L NAA → 400 mg/E	131	116 d-k	116 b-e	23.7 a-c	206 b-d	35 b-h
24. 7.5 mg/L NAA → 200 mg/E	134	111 c-g	109 a-d	23.0 a	215 c-i	39 b-h
25. 7.5 mg/L NAA → 300 mg/E	129	116 c-j	113 a-e	24.4 a-c	216 c-i	33 b-h
26. 7.5 mg/L NAA → 400 mg/E	129	102 b-f	113 a-e	24.0 a-c	219 b-h	22 a-e
27. 10 mg/L NAA → 200 mg/E	133	113 c-i	110 a-e	23.7 a-c	220 e-j	35 b-h
28. 10 mg/L NAA → 300 mg/E	129	117 d-k	110 a-e	24.5 a-c	211 b-g	29 b-f
29. 10 mg/L NAA → 400 mg/E	139	120 e-k	116 b-e	24.3 a-c	210 b-g	48 e-i
F-test	NS	P<0.001	P<0.001	P<0.001	P<0.001	P<0.001

[1] NAA=1-naphtalene-acetic acid.
[2] BA=6-benzyl-adenine.
[3)] E=ethephon.
NS=not significant. Values within a column followed by the same letter(s) are not statistically different (a-c=abc, a-d=abcd, etc.).

Figures

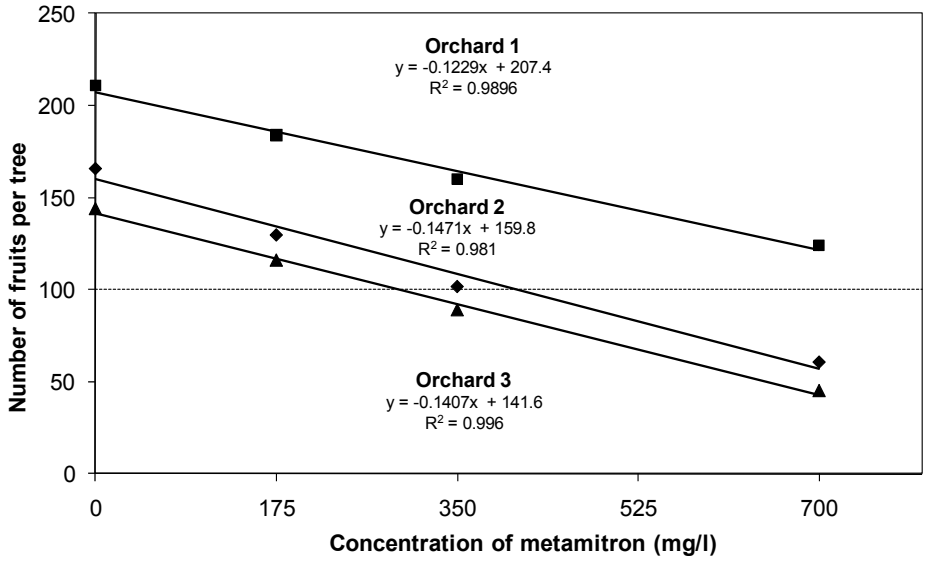

Fig. 1. Relationship between concentrations of metamitron applied at 10-12 mm of fruit diameter and final number of fruit per tree at harvest in trial 1. Orchards 1, 2 and 3 refer to locations Randwijk, Ravenswaaij and Waardenburg, respectively.

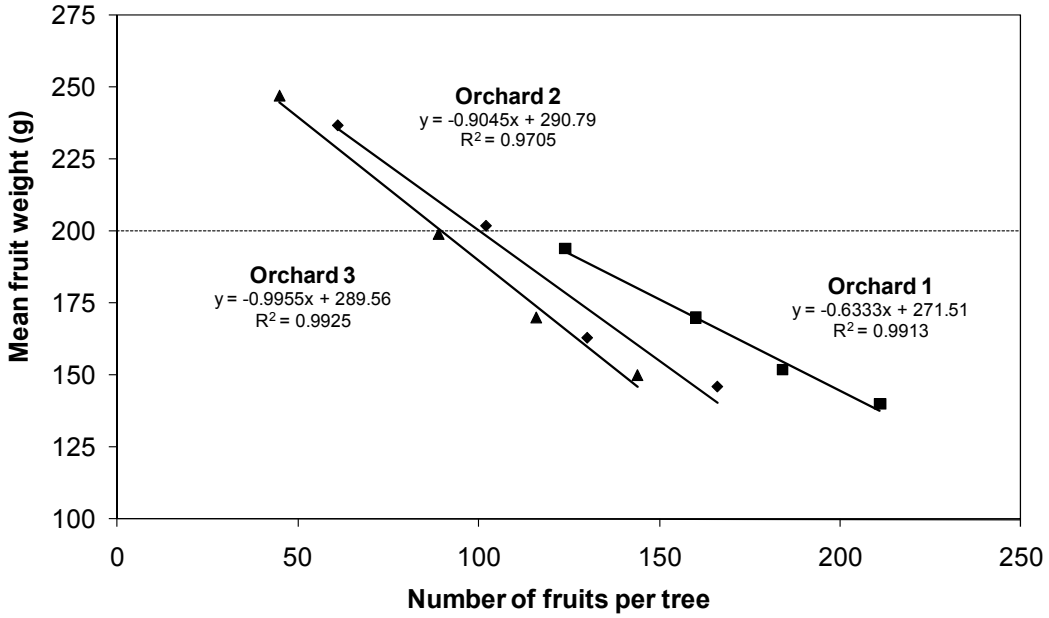

Fig. 2. Relationship between final number of fruit per tree at harvest and mean fruit weight in trees treated with different concentrations of metametron in trial 1. Orchards 1, 2 and 3 refer to locations Randwijk, Ravenswaaij and Waardenburg, respectively.