Journal of Fruit and Ornamental Plant Research vol. 12, 2004 Special ed.

THINNING OF FLOWERS/FRUITLETS IN ORGANIC APPLE PRODUCTION

Matej Stopar

Agricultural Institute of Slovenia
Hacquetova 17, 1000 Ljubljana, SLOVENIA
e-mail: matej.stopar@kis.si

(Received May 7, 2004/Accepted August 16, 2004)

A B S T R A C T

Some blossom thinners were investigated for possible use in organic apple production on ten-year-old 'Golden Delicious'/M.9 trees. A strong thinning (overthinning) and consequently an accelerated fruit growth happened after a full bloom application of 3% lime sulphur (CaS_x). Significant thinning was observed after the application of rape, sunflower or soybean oil emulsion (3%) while a little weaker (not significant) thinning effect occurred after the full bloom treatment with sodium chloride (1 and 1.5%) or acetic acid (1 and 3%). Two weeks after spraying, numerous smaller and scorched leaves were still present on CaS_x treated trees, while a less pronounced phytotoxicity was observed when the application of 3% oils caused blistering and stunting of leaves or when a higher concentration of sodium chloride or acetic acid scorched leaf edges and suppressed the growth of some leaves. Trees yielded bigger size fruit (> 68 mm) comparable to hand thinning treatment when sodium chloride (1.5%), acetic acid (3%), or different oils (3%) were sprayed. Russeting of fruit in autumn was not significantly stronger in any of the treatments comparing to non-thinned trees. Return bloom was evidently enhanced in effect of sodium chloride (1 and 1.5%) and CaS_x (3%) treatments.

Key words: apple thinning, organic, lime sulphur, sodium chloride, oils, acetic acid

INTRODUCTION

Thinning of apple fruitlets is one of the most important techniques for the improvement of fruit quality and for the impulsion of sufficient flower

bud formation to prevent biennial bearing. A prerequisite for an annual, high quality crop is an adequate number of flowers/fruitlets per tree, so their chemical thinning is a common measure in commercial apple orchards (Wertheim, 2000). In organic apple production only hand thinning could be used because no synthetic compounds or growth regulators are allowed. Due to high labour cost, hand thinning is neither economical nor practical. Fruitlets should be thinned up to a few weeks after flowering to prevent biennial bearing but this could not be achieved by hand thinning (Tromp, 2000; Greene, 2002). Recently, some thinning trials were conducted with potential organically acceptable compounds. Lime sulphur (calcium polysulphide), a chemical product permitted in organic apple production under EU legislation, was found to be effective as a thinning agent on apples (Meland, 1998; Bertschinger et al., 2000). Vegetable oil emulsions could also be used for this purpose (ZhiGuo and YouSheng, 2001). Pendergrass et al. (2000) reported that soybean oil could delay bloom and thin peach fruits, while corn oil emulsion was successfully used as a flower thinner on 'Delicious' apple, 'Feng Huang' peach and 'Bing' cherry (ZhiGuo et al., 2001). In Weinsberg Pfeiffer and Ruess (2002) tested different potential apple thinning compounds (plant oils, lime sulphur, starch, sodium bicarbonate and sodium salt) and found that sodium hydrogen bicarbonate and sodium salt resulted in a high fruit shedding, while russeting was obtained after sodium salt and oil application. The flower thinning agents such as rape oil or soap caused a partial leaf necrosis, fruit russeting and deformation on 'Delicious', 'Golden Delicious' and 'Elstar' apples (Strimmer et al., 1997). Warlop (2002) reported that rape oil or lime sulphur are considered the most promising organic apple thinning agents.

The aim of this experiment was to evaluate potential organic flower thinning compounds such as sodium chloride, acetic acid, lime sulphur, rape oil, sunflower or soybean oil emulsions and dextrin (starch) on 'Golden Delicious'/M.9 apple trees.

MATERIAL AND METHODS

Ten-year-old 'Golden Delicious'/M.9 apple trees were selected according to high bloom density and homogeneous growth vigour. Trees 3 m high and 1.5 m wide were trained as a slender spindle. In the field trial, a standard randomized block design with six replications and a single tree per plot was used. All spraying applications were performed at full bloom (morning, April 29, 2002), sunny day with temperatures about 18°C and RH 65%.

Treatments were as follows:

1) Control – no thinning.
2) Hand thinning (just after June drop).

3) Sodium chloride (NaCl) 1.0%.
4) Sodium chloride (NaCl) 1.5%.
5) Acetic acid (CH_3COOH) 1.0%.
6) Acetic acid (CH_3COOH) 3.0%.
7) Lime sulphur (CaS_x) 3%, using 1300 ml 22.5% CaS_x/10 l water.
8) Rape oil 1%, using Ogriol (Pinus, Rače, Slovenia – 92% rape oil with 8% emulsifier), 107 g Ogriol/10 l water.
9) Rape oil 3%, 326 g Ogriol (Pinus, Rače, Slovenia)/10 l water.
10) Sunflower oil 3% (96% oil with 4% emulsifier), 312 g (oil and emulsifier)/10 l water.
11) Soybean oil 3% (96% oil with 4% emulsifier), 312 g (oil and emulsifier)/10 l water.
12) Dextrin 5% (as 100% starch – partly hydrolysed).

The spraying was performed with a hand (knapsack) sprayer to the point of drip. At maturity time the fruit was harvested, counted, weighed and graded into two size classes, < 68 mm and > 68 mm diameter. Phytotoxic effect on trees was estimated two weeks after spraying. Fruit russeting was assessed by visual scale 1-10:1 – no russeting; 10 – more than 90% of fruit covered by russet. Return bloom was estimated visually next spring using the scale 1-10 (1 – no flower clusters on trees; 10 – abundant flowering). During the experiment the trees received treatments upon the standard pest and disease control programme. Data were subjected to a statistical analysis using ANOVA with Duncan's multiple range test ($P = 0.05$) in the programme Statgraphics 5.0 (STSC, Rockwille, USA).

RESULTS

At the start of the experiment within the treatments there was no significant difference in the number of flower clusters per tree comparing to the control (Tab. 1). Full bloom application of 1 and 1.5% sodium chloride (NaCl), or 1 and 3% acetic acid (CH_3COOH) caused a moderate thinning not significantly different from the control (fruit number/tree; fruit number/100 clusters) (Tab. 1). Very strong and severe thinning occurred when 3% lime sulphur (CaS_x) was applied at full bloom. The application of 1% rape oil emulsion had no influence on fruitlet drop while the higher (3%) concentration of the some agent caused a significant fruitlet thinning. Thinning effect similar to that of 3% rape oil emulsion was seen in response to 3% emulsion of both soybean and sunflower oil. Starch (dextrin 5%) had no effect on fruitlet abscission.

When the return bloom data were compared with the thinning intensity there was no full, inversely proportional relation between both data (Tab. 1). The control, high bearing trees, had a very poor flowering next spring. The same poor return bloom happened on hand thinned trees, because the fruitlets were removed too late to accelerate flower bud induction (Tromp, 2000). A very nice return bloom occurred on CaS_x treated trees, probably because of a strong thinning effect caused by this treatment. However, no promotion on the return bloom was observed when 3% emulsions of rape, sunflower or soybean oil were applied, although thinning evidently occurred. On the contrary, the application of 1 or 1.5% NaCl did not thin significantly while the return bloom was considerably accelerated. The data indicate a positive effect of NaCl on flower bud formation independently of the thinning effect of this chemical.

T a b l e 1 . Flower clusters at the start of the experiment, final fruit number and return bloom of 'Golden Delicious'/M.9 apples after the application of thinning agents

Treatment	Flower clusters per tree	Fruit number per tree	Fruit number per 100 clusters	Return bloom [1-10] [z]
1) Control – no thinning	239 ab*	183 de	77 e	1.3 a
2) Hand thinning	240 ab	101 ab	43 b	1.2 a
3) NaCl 1%	227 ab	135 bcd	59 bcde	2.5 b
4) NaCl 1.5%	212 ab	138 bcd	65 cde	2.7 b
5) CH_3COOH 1%	207 a	136 bcd	66 de	2.2 ab
6) CH_3COOH 3%	268 b	157 cde	59 bcde	1.7 ab
7) CaS_x 3%	257 ab	60 a	22 a	6.2 c
8) Rape oil 1%	268 b	183 de	68 de	1.2 a
9) Rape oil 3%	256 ab	109 bc	45 bc	1.8 ab
10) Sunflower oil 3%	233 ab	128 bc	54 bcd	1.0 a
11) Soybean oil 3%	253 ab	128 bc	49 bcd	1.0 a
12) Dextrin 5%	255 ab	193 e	77 e	1.3 a

* Mean separation within column by Duncan's multiple range t-test at P = 0.05

[z] 1 – no flowering; 10 – abundant flowering

The quality of yield referring to fruit size was better on light bearing trees (Tab. 2). The control trees were overloaded so the mean fruit weight was too low, while the hand thinned trees bore a proper size fruit, adequate for commercial standards. Because of serious thinning (overthinning) observed after CaS_x application, those trees witnessed the strongest fruit growth. When 3% oil emulsions were applied (rape, sunflower and soybean) a nice fruit growth happened as a consequence of significant thinning (Tab. 2 – mean fruit weight, number of fruit > 68 mm). Also, the proportion of fruit > 68 mm

was greater (not significantly) on trees treated with 3% NaCl, 3% CH_3COOH and 1% rape oil emulsion, although not significant thinning was observed.

Due to a great variability, none of the treatments showed any significant difference in russeting of the fruit, though for 3% rape oil application it was the greatest (Tab. 2).

Table 2. Total yield, mean fruit weight, number of larger size fruit and fruit russeting of 'Golden Delicious'/M.9 apples after the application of thinning agents

Treatment	Yield [kg/tree]	Mean fruit weight [g]	Number of fruit > 68 mm	Fruit russeting [1-10][y]
1) Control – no thinning	19.3 bc*	107 a	65 ab	1.2 a
2) Hand thinning	15.5 ab	152 e	87 abc	2.2 a
3) NaCl 1%	15.7 ab	116 ab	58 ab	2.5 a
4) NaCl 1.5%	18.9 bc	135 bcde	92 bc	1.8 a
5) CH_3COOH 1%	15.2 ab	119 abc	48 a	2.2 a
6) CH_3COOH 3%	19.1 bc	121 abc	83 abc	2.0 a
7) CaS_x 3%	11.0 a	189 f	55 ab	1.2 a
8) Rape oil 1%	23.1 c	128 abcd	109 c	2.0 a
9) Rape oil 3%	16.4 abc	149 de	80 abc	3.2 a
10) Sunflower oil 3%	18.2 bc	142 cde	96 bc	1.8 a
11) Soybean oil 3%	17.1 abc	131 abcde	80 abc	2.0 a
12) Dextrin 5%	21.3 bc	110 a	77 abc	1.7 a

*For explanation, see Table 1

[y]1 – no russeting present; 10 – more than 90% of fruit covered by russet

DISCUSSION

The cultivar 'Golden Delicious' was chosen for testing potential organic thinning compounds because it is known as hard to thin and susceptible to fruit russeting. The application of 3% CaS_x at petal fall thinned the fruitlets too strong (overthinned), the yield was cut by half because better fruit growth cannot compensate for fewer fruit. When phytotoxicity was estimated two weeks after spraying there was a lot of small (stunted) leaves on CAS_x treated trees and this effect did not recover completely by the summer. High phytotoxicity effect of lime sulphur was also found by other researchers (Hobl et al., 2003; Warlop, 2002). Due to a strong thinning effect and no influence on fruit russeting, this agent would require further testing as a promising organic fruit thinning compound.

Full bloom application of 3% oil emulsions (rape, sunflower, and soybean) thinned the fruitlets significantly and enhanced the mean fruit weight. Blisters and stunted leaves were observed two weeks after oil

application but this negative effect would have disappeared by the summer. Further problem indicated in this experiment and reported by other authors (Pfeiffer and Ruess, 2002; Strimmer et al., 1997) was fruit russeting when oil thinners were used at full bloom. ZhiGuo et al. (2001) found an adequate thinning effect and no leaf/fruit injury if 3 or 5% corn oil emulsion was applied on apple trees at the start of blooming. This problem may thus be solved by earlier application of oil emulsion thinners.

Lesser thinning (not significant) occurred at the full bloom application of 1 and 1.5% NaCl or 1 and 3% acetic acid. In both cases fruit growth was accelerated and in comparison to CaS_x or oil thinners, a less pronounced phytotoxicity was observed (it was more pronounced at a higher concentration of NaCl or acetic acid). Pfeiffer et al. (2002) reported russeting on 'Pinova' fruit after bloom application of sodium salt (15 kg/ha) but the fruit was still considered saleable. In this experiment there was a slightly enhanced 'Golden Delicious' fruit russeting after NaCl application, but with no significant difference from the control. Nevertheless, this is a promising organic thinning compound because of its evidently positive effect on the return bloom, although fruit thinning effect was not significant.

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PRZERZEDZANIE KWIATÓW/ZAWIĄZKÓW OWOCOWYCH W EKOLOGICZNEJ PRODUKCJI JABŁEK

Matej Stopar

STRESZCZENIE

Badano wiele substancji pod katem ich przydatności do przerzedzania kwiatów/zawiązków owocowych na 10-letnich drzewach jabłoni 'Golden Delicious'/M.9 w uprawie ekologicznej. Silne (nadmierne) przerzedzanie i w re-zultacie przyspieszony wzrost owocow uzyskano po zastosowaniu w pełni kwitnienia 3% CaS_x (ciecz siarkowo-wapniowa = kalifornijska). Również istotne przerzedzanie wystapiło w wyniku zabiegów 3% emulsjami olejów – rzepakowego, słonecznikowego i sojowego, a nieco słabszy efekt, nieistotny statystycznie, dało zastosowanie chlorku sodu (1 i 1,5%) lub kwasu octowego (1 i 3%).

Działanie fitoksyczne w postaci oparzeń i często zahamowanego wzrostu liści wystąpiło najwyraźniej w przypadku CaS_x i było widoczne jeszcze 2 tygodnie po zabiegu. Przy innych substancjach działanie to było mniej wyraźne, lecz zawsze przejawiało się osłabieniem wzrostu części liści, a ponadto ich pęcherzykowatością w przypadku zabiegów emulsjami olejowymi (3%) i oparzeniem brzegów liści przy wyższych stężeniach chlorku sodu lub kwasu octowego.

Po zastosowaniu chlorku sodu (1%), kwasu octowego (3%) i emulsji olejowych (3%) uzyskano więcej owoców wyższej klasy (>68 mm), co było porównywalne z przerzedzaniem ręcznym. Jesienią nie stwierdzono różnic statystycznych w stopniu ordzawienia owoców z drzew poddanych zabiegom w porównaniu z kontrolą. Zastosowanie chlorku sodu (1 i 3%) oraz CaS_x (3%) spowodowało istotnie intensywniejsze kwitnienie w następnym sezonie.

Słowa kluczowe: przerzedzanie jabłoni, ciecz siarkowo-wapniowa = kalifornijska, chlorek sodu, oleje, kwas octowy