Flower thinning of apples cv 'Elshof' using environmentally friendly compounds

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Abstract

As part of the ISAFRUIT project we conducted three years of thinning trials using environmental friendly compounds that potentially may be registered and allowed for organic fruit production. In the first year four different compounds were tested; two clay compounds, NaCl (kitchen salt) and lime sulphur. In the second year the number of compounds was reduced to the three compounds that had showed potential as thinners in the first year and finally in the last year focus was solely on NaCl. Based on three years experiments we conclude that NaCl is a potential thinner of Elstar which is normally regarded as hard-to-thin variety. Multiple applications, however, may lead to over-thinning. Thinning with NaCl improved return bloom significantly and to an extent that levels out biennial bearing. NaCl application caused moderate to severe leaf damage, but no russet on the fruits. NaCl is a cheap, efficient and environmentally friendly compound (in the dosages used – which is equivalent to brackish water) that is capable of thinning even difficult and biennial apple varieties.

Keywords: apple, flower thinning, NaCl, kaolin, lime sulphur.

Introduction

Thinning of flowers and fruits is fundamental to the production of high-quality apple fruit, and thinning of apple flowers remain the only tool to overcome problems with biennial bearing of certain varieties (Wertheim 2000). In non-organic production a range of chemicals are available for thinning – but in the smaller fruit producing countries – like Denmark – and in organic production in general, few thinning compounds are available and environmentally friendly alternatives are sought. In recent years a large range of such products have been tested ranging from oils, teas, acids, soaps over salts to fertilizers – the majority of which has shown no or very erratic thinning effects (Pfeiffer and Ruess 2002, Alegre and Alins 2007). However, fertilizers containing N (Weibel et al. 2008), lime Sulphur (Kelderer et al. 2002) and standard kitchen salt (NaCl) (Pfeiffer and Englert 2004, Stopar 2004 and 2008) have in several trials shown potential as quite aggressive thinners. Since relatively little work has been done with NaCl it was an obvious candidate for further testing when we in the years 2006-08 had the opportunity to do so as part of the ISAFruit project. Included in the trials was also Kaolin clay. Kaolin has a growing application in organic production where it can be applied as a broad utility material that provides effective insect control without the adverse effects on ecosystems (Glenn and Puterka 2004) and we thought it of interest to test if Kaolin and similar clay compounds could deter bees and other insects from pollinating the flowers and/or have a desiccating effect on flower stigmas that would prevent pollination.

Material and methods

The thinning experiments were carried out in 2006-2008 at the Department of Horticulture, Faculty of Agricultural Sciences, Denmark. In all years, Elshof (Elstar clone)/M9 trees at a spacing of 1 x 3.5m from the same planting were used for the experiment, but different

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experimental trees were selected each year dependent on a high flower density. Initially the trees were four years old and all were trained as spindles and exhibited a moderate growth. In all years, a standard randomized block design was used with minimum 12 replications and single tree plots. The number of flower clusters on all trees was counted prior to thinning application and return bloom was determined in a similar way the following year after the trees had been pruned. Yield and number of fruits per tree were determined at harvest. The number of harvested fruits per tree was also used to determine final fruit set, and average fruit size on the tree.

Table 1: Thinning compounds and concentrations used in the thinning trials.

Year	Treatments	Dosage (Vol. %)
2006	Control (no thinning)	-
	Control (Hand-thinning)	-
	Lime Sulphur (fungicide, allowed for organic production in some countries)	2%
	NaCl (kitchen salt)	2%
	Kaolin (clay mineral)	4%
	Absomol AB 300G (silica algae 70%, clay minerals 30%)	4%
	Absomol AB 300G + rapeseed oil	4%+2%
2007	Control (no thinning)	-
	Control (Hand-thinning)	-
	Lime Sulphur	2%
	NaCl (kitchen salt)	2%
	Kaolin (clay mineral)	0.5kg/tree
	Absomol AB 300G + rapeseed oil	0.5kg/tree
2008	Control (no thinning)	
	Control (Hand-thinning)	
	NaCl (kitchen salt)	2%

Chemical treatments were applied with a commercial sprayer (Schaumann) using 1000 l/ha. In 2007, Kaolin and a similar clay compound containing 70% silica algae called Absomol were applied in a non-aqueous form by the use of a fan blower. All treatments were intended to be applied twice, the first application was aimed at flower clusters on spurs when these had reached the full bloom (FB) stage, and the second application was carried out when flower clusters on the annuals were at FB. In 2006 the second application had to be cancelled due to unfavourable weather conditions. All data were subjected to analysis of variance using the General Linear Models (GLM) procedure of the Statistical Analysis System (SAS Institute, Cary, NC).

Results

In 2006, the spring was cool with prolonged periods of rain and wind causing the flowering period to be long. Still a fruit set of 55/100 clusters in the control was more than sufficient and in comparison the fruit set had to be reduced by 30% in the hand-thinned control (Table 2). The number of fruits on the tree was reduced significantly by lime sulphur and NaCl, but not to the level of the hand-thinned control. Fruit size was improved by the lime sulphur, NaCl and the two Absomol treatments, but remained significantly lower than the hand-thinned control. Return bloom of the control trees was very low averaging only 33 flower clusters, which was not adequate for a normal harvest. The NaCl treatment along

with the combined Asomol and rape oil treatment improved return bloom significantly and doubled the number of flower clusters on the tree compared to the control. The lime sulphur, which showed good thinning results, did not have a positive effect on the return bloom.

Table 2: Number of flower clusters prior to thinning and final fruit set, fruit number, average fruit weight and return bloom following various thinning treatments in 2006

	Flower clusters (number/tree)	Final fruit set (fruits/100 clusters	Fruits (number /tree)	Fruit weight (gram)	Return bloom (clusters/tree)
Control (no thinning)	231	54	126	122	33
Control (Hand-thinning)	234	38	88	144	39
Lime Sulphur	224	46	104	134	44
NaCl (kitchen salt)	201	51	104	134	67
Stalosan	243	48	117	124	52
Kaolin	239	49	117	128	40
Absomol AB 300G	237	47	117	133	38
Absomol + rapeseed oil	243	41	115	132	60
$LSD_{0.05}$	41	14	17	9	25

The weather during bloom was much better in 2007 and the general fruit set was high – though this also coincided with the number of flower clusters on the experimental trees being much lower than the year before (Table 3). The number of fruits on the control trees was similar to the year before, but the hand-thinning may have been too aggressive in 2007 since the number of fruits was slightly lower than the year before and trees were just reaching full maturity. The only efficient treatment that year was the 2% NaCl which reduced the number of fruits on the trees to a very appropriate number of 86 fruits. Fruit size, however, was not improved by the treatment and that was possibly a side effect of the quite extensive leaf burnings on the spur leaves. Also lime sulphur caused some leaf burnings while the Kaolin and Absomol showed no phytotoxicity. Return bloom was affected positively by the NaCl treatment and the number of flower clusters was more than doubled compared to the control. Of the other thinning treatments only hand-thinning had a positive effect on return bloom, which is quite unusual and may in this case be an effect of a relatively low number of flower clusters combined with a very aggressive hand-thinning.

Table 3: Number of flower clusters prior to thinning and final fruit set, fruit number, average fruit weight and return bloom following various thinning treatments in 2007

	Flower clusters (number/tree)	Final fruit set (fruits/100 clusters	Fruits (number /tree)	Fruit weight (gram)	Return bloom (clusters/tree)
Control (no thinning)	138	119	130	155	36
Control (Hand-thinning)	103	72	71	184	147
Lime Sulphur	126	110	120	161	59
NaCl (kitchen salt)	126	76	86	160	89
Kaolin	100	127	123	161	43
Absomol + rapeseed oil	138	90	111	165	57
$LSD_{0.05}$	ns	35	23	12	43

In 2008, the weather was perfect for thinning, with relatively warm and sunny weather. Under these circumstances the NaCl worked all too well causing a moderate over-thinning which halved the yield compared to the hand-thinning (Table 4). The NaCl treatment caused moderately severe leaf burns to spur leaves, where necrotic leaf edges remained visible for the remaining season. Fruit size was increased by the NaCl application, but not excessively so. Return bloom was increased significantly and to an amount that should enable normal cropping in the year following NaCl application, whereas both control trees and hand-thinned trees had too few flower buds for a normal crop (Table 4).

Table 4: Number of flower clusters prior to thinning and final fruit set, fruit number, average fruit weight and return bloom following various thinning treatments in 2008

	Flower clusters (number/tree)	Final fruit set (fruits/100 clusters)	Fruits (number /tree)	Fruit weight (gram)	Return bloom (clusters/tree)
Control (no thinning)	267	62	157	149	19
Control (Hand-thinning)	264	45	110	180	52
NaCl (kitchen salt)	265	27	66	176	149
$LSD_{0.05}$	ns	15	21	13	39

Discussion

NaCl was clearly the most promising of the thinning compounds tested in the experiments. It was able to thin Elshof in two of the three years, and it consistently improved return bloom to an extent that may enable consistent cropping in this often very alternating variety. Similar positive thinning results were also reported by Stopar (2004, 2008) using lower concentrations between 1 and 1.5 %. Generally there appears to be consensus that the effect of NaCl is highly concentration dependent, and than the use of 2%, as in our experiment, is pushing the limit, and certainly higher concentrations than that must be avoided or over-thinning / crop loss is possible. In that regard weather conditions may be of importance, in our case the over-thinning occurred in the year where temperatures at time of thinning and in the days afterwards exceeded 20°C. Moderate to severe leaf damage to spur leaves unfolded at time of application is another negative effect of the NaCl application and one that was documented in all previous trials with the compound (Pfeiffer 2004, Stopar 2004, 2008).

The two clay mineral compounds (Kaolin and Absomol) were tested in the hope that they would be able to thin based on a combined action of their desiccation properties and ability to deter insects. The clay compounds proved very difficult to work with in the windy and rainy springtime of 2006 and insufficient coverage may account for some of the lacking thinning effects. However, in 2007 the trees remained well covered in clay dust during the bloom period, but this did not in any way deter bees and other pollinating insects and again no thinning effect was achieved. It can therefore be concluded that clay dusting is not a feasible thinning method. The addition of 2% rape seed oil did contribute some thinning effects, but not enough to achieve sufficient thinning. Similar disappointing results were achieved in a recent American trial where a commercial formulation of Kaolin called Surround was found successful in reducing pollen germination both in vivo and in vitro, but it did not show any significant thinning effect in field trials (Myra et al 2006).

Lime sulphur has been used in numerous trials with ambiguous results, generally there appears to be a concentration dependent effect (Guak et al 2004, Stopar 2008), and rate of 4% may for certain varieties/years lead to over-thinning (Stopar 2008). Thinning effect of

lime sulphur is often associated with leaf damage although the leaves appear more stunted than burned (Stopar 2008).

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