Short Communication:

Preliminary results on chemical thinning of apple blossoms with ammonium thiosulphate, NAA and ethephon

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Abstract

Preliminary tests were carried out using ammonium thiosulphate as a chemical thinning agent for apple ('Cox's Orange Pippin' and 'Braeburn') blossoms. Ethephon and NAA (1-napthylacetic acid) were included for comparison. Whole tree sprays of 37g/l ammonium thiosulphate over-thinned 'Cox's Orange Pippin' blossoms and severely scorched blossoms, foliage, and apical meristems. Ethephon at 0.35 g/l also over-thinned, and NAA thinned to an intermediate extent when compared with the controls. When the lower concentration of 3.7 g/l ammonium thiosulphate was directly applied to stamens and styles of 'Braeburn' blossoms by brush, initial fruit set was only 30% that of untreated blossoms. When 0.35 g/l ethephon was directly applied by brush to spur leaves or petals of 'Braeburn' blossoms at pink bud, initial fruit set was only 23% that of untreated blossoms. It is concluded that ammonium thiosulphate has the potential to thin apple blossoms. Further experiments to define optimum concentrations and spray volumes are needed.

Keywords apple; ammonium thiosulphate; ammonium thiosulfate; blossom sprays; chemical thinning; ethephon fruit set; NAA (1-napthylaceticacid); urea; spray damage

INTRODUCTION

The importance of chemical thinning in New Zealand apple orchards is wall recognized (Davison 1966). Chemical thinners remove large numbers of flowers fruitlets, and this reduces the hand thinning requirement promotes production of large fruit through early thinning, regularizes cropping and reduces branch breakage.

The apple industry is the second largest horticultural industry in New Zealand and relies on NAA (1-napthylacetic acid) and carbaryl (1-napthyl-n-methylcarbamate) for chemical thinning. It is now clear that overseas consumers demand reduced use of chemicals in food production, and NAA and carbaryl are no longer registered in West Germany. Although West Germany is not our sole market for apples, it seems pertinent to assess the value of other chemicals, and to seek, for the longer term, chemical thinning agents which leave no residues and are environmentally safe.

To address these issues, we tested the effectiveness of ammonium thiosulphate as a chemical thinner, and included NAA and ethephon for comparison. Ammonium thiosulphate thins peach blooms (Byers & Lyons 1983; 1984), and is used in both pharmaceutical and food industries. Since there are no published results on the use of ammonium thiosulphate as a thinner for apple blossoms, we report our initial results on thinning action in this communication.

MATERIALS AND METHODS

Experimental sites and tree management

The experiments were conducted on a Ministry of Agriculture and Fisheries experimental sand country orchard in the Manawatu District ('Cox's Orange Pippin') and at the Levin Horticultural Research Centre ('Braeburn'). Trees used were 6-year-old 'Cox's Orange Pippin' (Greenmeadows selection) on MM 106 rootstock at a spacing of 5 x 3 m, and 2-year-old 'Braeburn' on MM 106 at a spacing of 5 x 1.8 m. All trees were trained to a centre leader.

Experiment 1

'Cox's Orange Pippin' trees with uniform butt circumference 30 cm above ground were selected. Sixty flower clusters (thinned to five flowers per cluster) on 5 randomly selected replicate trees were tagged before spraying. On each tree, 20 clusters were marked at each of 3 blossoming stages: (1) pink bud; (2) full bloom (when anthers were pale yellow); (3) full bloom/petal fall (when anthers were brown). Treatments applied are given in Table 1. Chemicals used were: ethephon ((2-chloroethyl) phosphonic acid, Ivon Watkins-Dow Ltd); NAA (New Zealand Fruitgrowers Chemical Company Ltd); purified ammonium thiosulphate (Prolabo, Paris). All sprays (including the controls) included 0.1% (v/v) Regulaid® (Kalo Inc. Overland Park, KS 66211, USA), a non-ionic spreader which was applied with hand-held sprayers. Initial fruit set on labeled clusters was determined 4 weeks after the treatments were applied. Data were analyzed by analysis of variance.

Experiment 2

Ammonium thiosulphate (3.7 g/l) and ethephon (0.35 g/1), both in 0.1% Regulaid®, were applied to 'Braeburn' blossoms as follows: (1) petals, at pink bud; (2) petals, at full bloom; (3) stamens and styles, at full bloom; (4) spur leaves of a blossom cluster, at full bloom. Applications were made using a small brush to completely wet sites of application. Clusters were labeled and thinned to 3 blossoms each before treatment. There were 5 single tree replicates of uniform size according to butt circumference 30 cm above ground for each chemical. There were 5 tissue treatments (including the controls which were sprayed with 0.1% non-ionic spreader), with 4 replicate clusters per treatment per tree. Initial fruit set on labeled clusters was recorded 3 weeks after treatments were applied. Data were analysed by analysis of variance.

RESULTS AND DISCUSSION

In Experiment 1, chemicals which thinned blossoms did so at the pink bud, full bloom, and full bloom/petal fall stages equally (data not shown) and therefore pooled data for each treatment are given in Table 1. Ethephon, NAA, ethephon plus NAA, and ammonium thiosulphate (37 g/1) produced the greatest thinning effect on ‘Cox's Orange Pippin'. However, the chemicals over-thinned as the target was about 4.5 (transformed data), or 20 fruit set per 100 blossoms. Ammonium thiosulphate (37 g/l) caused petals to lose turgor within 2 hours of application. After 2 days, there was marked scorching of petals, apical meristems, and leaves, and these symptoms were still apparent after 16 days.

Ammonium thiosulphate at 3.7 and 0.37 g/l had no thinning effect in this experiment, although 3.7 g/l ammonium thiosulphate caused mild burning of petals and foliage. Ammonium thiosulphate at 0.37 g/l produced no visible effects on trees. When applied directly to stamens and styles of 'Braeburn' blossoms, 3.7 g/l ammonium thiosulphate effectively reduced fruit set (Table 2). Clearly, further research should examine thinning and side effects of concentrations between 3.7g/l and 37 g/l.

Byers & Lyons (1985) suggested that desiccants interfere with fertilisation and/or produce phytotoxic effects in the peduncle leading to fruit abscission in peach. These mechanisms could explain the thinning action of ammonium thiosulphate in apple. 0ur observations draw us to conclude that 37 g/l ammonium thiosulphate thinned ‘Çox’s Orange Pippin' by completely desiccating the blooms, whilst in the `Braeburn' experiment, desiccation of styles may have been the mechanism of thinning.

Ethephon had, as expected, a very good thinning effect (Table 1). Ethephon has been widely tested as a chemical thinning agent, but with different degrees of success (Jones et al. 1983; Knight 1980), possibly because there are two periods of sensitivity: blossoming, and near the main fruit drop period (June or December drop). In our experiment, ethephon was effective from the pink bud stage through to petal fall and was particularly effective when applied to petals at the pink bud stage and to leaves of 'Braeburn' (Table 2). NAA did not enhance the thinning effect of ethephon. Mavrodiev & Manolov (1987) and Schneider (1978) suggest that ethylene is not the primary cause of fruitlet abscission but that reduction in assimilate supply to fruitlets is the main reason for fruit drop. However, when applied to petals, ethephon presumably induces abscission of blossom parts. It is unlikely that the mechanism of ethephon thinning is the same for both foliage and petal application.

Our preliminary data show ammonium thiosulphate has the potential to thin apple blossoms. In view of public attitudes towards insecticides (such as carbaryl) and growth regulators (such as NAA and ethephon), it is of interest to develop alternatives to such chemicals. For ammonium thiosulphate, it is necessary to define optimum application rates and spay volumes to reduce foliage injury and to improve thinning effectiveness. In addition, other desiccating compounds, such as urea, should be tested for thinning action.

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Table 1 Chemicals used, rate of application and initial fruit set per 100 blossoms (√(x+0.5) transformed figures), following application to 'Cox's Orange Pippin apple. ATS= ammonium thiosulphate.

Chemical	Rate (g/l)	Fruit/100 blossoms (√ (x+0.5))
Ethephon	0.35	1.7
NAA	0.02	3.7
Ethephon+NAA	0.35+0.02	2.6
ATS	37	2.8
ATS	3.7	6.6
ATS	0.37	5.5
Control		6.3
SED		0.6

Table 2 Initial fruit set on 'Braeburn' following application of 3.7 g/l ammonium thiosulphate (ATS) or 0.35 g/1 ethephon to blossom parts or leaves. ND = not determined.

	Fruit/100 blossoms	
Tissue treated	ATS	Ethephon
Petals		
pink bud	30.6	6.2
full bloom	ND	16.6
Stamens & styles	11 .9	ND
Leaves	32.3	6.3
Control	37.7	27.0
SED	3.5	0.8