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Thinning response of 'Abbé Fetel' pear to lime sulphur

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Abstract

Thinning is a central management activity in the production of high quality fruit required for the domestic and export market. Early thinning of fruit trees is important since it influences fruit size and the time of application affects flower bud formation for the following season. Furthermore, finding organic blossom thinners is a major challenge as hand thinning is a costly practice. At the High Valley region of Argentina (lat. 38°56' 67°59'W), lime sulphur was evaluated as flower thinner on 'Abbé Fetel' (*Pyrus communis* L.) pear trees trained to palmette leader. Treatments were 1) control, and 2) 7 % lime sulphur applied at 30 % bloom, using an orchard sprayer. Fruit diameter (FD) was recorded two weekly (*n*=20 per date and treatment). At 144 days after full bloom (DAFB), or initial commercial harvest, fruit weight and the maturity indices were determined. Fruits were then graded into size categories. Growth equations were developed using non linear regression and mean separations were computed with Student's *t*-test. The lime sulphur sprays significantly increased mean FD, starting from 115 DAFB. Logistic model best fitted the fruit growth *vs.* time curves. Percentage of fruits with <65mm diameter was 25 % for the control and 5.26 % for lime sulphur treatment. Treatment 2 increased final fruit weight by 16.5 %, as compared to the untreated pears. At 144 DAFB, thinned trees showed firmer fruits than the controls (64.4 *vs.* 61.7 N) and there were no statistical differences among treatments in soluble solids concentration and starch index. Consequently, data indicated that lime sulphur at 7 % was an effective flower thinning agent to enhance 'Abbé Fetel' pear seasonal fruit growth and quality.

Key words: Flower thinning, fruit size, growth curves, lime sulphur, maturity, *Pyrus communis.*

Introduction

Thinning is a central management activity in the production of high quality fruit required for the domestic and export market. Flower and fruit thinning prevent the development of some fruits, allowing the remainder to become larger and more marketable (Dennis, 2002). The challenges posed by chemical thinning are among the greatest obstacles which fruit growers face in achieving profitable production. Thinning must be predictable else recommendations loose credibility and are not used. Loss of credibility is due to underthinning as much as the fear of overthinning (Jones *et al.*, 1998). It is, however, generally considered that cultural factors other than thinning are also important to achieve adequate fruit size. These include balanced fertiliser programs, dwarfing rootstocks and appropriate pruning practice (Meland, 1998b).

The chemical and its concentration, the time of application and environmental factors encountered before, during and after application, all influence the ultimate thinning response. Variation in chemical thinning efficacy between years and within years has made it difficult to accurately predict the best dose and timing for chemical application (Robinson and Lakso, 2004). The inconsistency in the results of chemical thinning practices is at least partly caused by weather factors, such as temperature and air humidity, but tree factors are also involved (Wertheim, 2000).

Early thinning of fruit trees is important since it influences fruit size in the year of application and affects flower bud formation for the following season. According to Greene (2002), efficacy of blossom thinners is less influenced by the weather than hormone type thinners, and to be effective it may not be necessary to have specific physiological conditions within the fruit. Blossom thinners are caustic; they prevent fertilization and reduce fruit-set by damaging different flower parts, including anthers, stigma, style and pollen tubes (Fallahi and Fallahi, 2004). A number of chemicals have been tried as flower thinning agents, including the foliar feeds ammonium thiosulphate (ATS) and potasium thiosulphate, lime sulphur (calcium polysulphide, CaSx), endothalic acid, pelargonic acid and sulfcarbamide, all of which are flower desiccants (Balkhoven-Baart and Wertheim, 1998; Fallahi *et al.*, 2004; Greene, 2004). Ethephon may also thin when applied at bloom (Alina, 2006); it can stimulate flower thinning by inducing flower drop and the response appears to be cultivar and temperature sensitive. Looney (1998) reported that application of MCPB ethyl (a synthetic auxin) at full-bloom significantly reduced fruit-set in 'Fuji' apple in Canada.

Under current organic production methods growers are dependent on hand thinning to reduce crop load and enhance fruit size at harvest. However, because hand thinning is not normally carried out until six to eight weeks after bloom the resulting increase in fruit size is typically less than from chemical thinning applied at or soon after bloom, and there is minimal or no enhancement of return flowering (McArtney *et al.*, 2000). The higher costs of hand thinning combined with the increased potential for biennial bearing are significant obstacles that need to be overcome in order to achieve regular annual yields under organic production systems. With the move towards the use of simple salts that act as blossom desiccants, rather than hormonal type thinning agents, there is more scope for finding suitable chemicals for organic production (Bound and Wilson, 2004).

Lime sulphur is permitted under current guidelines for organic production and impedes fruit-set by lowering the number of pollen grains that reach the ovary at the base of the flower; this response is cultivar specific. It was found to be effective for pome and stone fruits (Meland, 1998a; Bertschinger *et al.*, 2000; Webster and Spencer, 2000; Lenahan and Whiting, 2006). Fallahi (2006) used lime sulfur and fish oil and combination of these chemicals and found them to be effective organic blossom thinners for apples and peaches.

According to Warlop (2002), CaSx is considered one of the most promising organic apple thinning agents. Chemical thinning of pears is not as generally satisfactory as with apples. Problems with inadequate fruit-set are more common and application of blossom desiccants may show different responses among cultivars, directly associated to special sensitivities presented by them to the materials. Trials conducted on the pear cultivar ‘Conference’ have shown that a proportion of flowers may be prevented from setting fruits using sprays of ATS applied at or around the time of full bloom (Webster, 2002).

‘Abbé Fetel’ is becoming a variety of interest to the pear industry because of the excellent fruit quality and the high degree of consumer demand. Fruit size is critical for marketing this cultivar. Thus, in order to set up a strategy to enhance seasonal fruit growth, a trial was carried out to evaluate lime sulphur as a flower thinning compound on ‘Abbé Fetel’ (*Pyrus communis* L.) pear trees.

Materials and methods

The study was conducted on 10-year-old ‘Abbé Fetel’ pear trees on *P. communis* L. rootstock, growing in sandy loam (Irisarri, 1987) and trained to palmette leaders at the experimental farm, Comahue National University, Argentina (38º 56’S, 67º 59’W). The trees were spaced 4.0 × 2.3 m and row orientation was north south. Surface-flood irrigation was applied in the orchard.

The experimental site was located in an arid region, with average annual rainfall of 250 mm. Relative humidity, relative sunshine duration, maximum, mean and minimum temperature were monitored in orchard with Metos, Gottfried Pessl., Weis, Austria. Meteorological data before, during and after lime sulphur application and during the growing season (2002-03) are presented in Tables 1 and 2, respectively.

Ten trees were selected for uniformity of size and fruit density. Each tree was an experimental unit and there were five replications per treatment, in a completely randomized design. Treatments were 1) control, and 2) 7 % lime sulphur applied at 30 % bloom. The applications were performed with an orchard sprayer until run off, on a cool day. Relative sunshine duration, mean temperature and relative humidity were 50.0 %, 7.9 ºC and 66.0 %, respectively (Table 1).

Fruit diameter (FD) was recorded two weekly (*n*=20 per date and treatment). At 144 days after full bloom (DAFB), or initial commercial harvest, fruit weight (FW) was determined with an electronic scale (model Mettler P1210, Mettler Instruments AG, Zurich, Switzerland). Fruits were then graded into size categories.

Ten-fruit samples were harvested for determination of the maturity indices. Fruit firmness was monitored with a fruit pressure tester (model FT 327, Effegi, Alfonsine, Italy) on three peeled equatorial positions. Soluble solids concentrations (SSC, %) were determined on the expressed juice with a hand-held refractometer (Brix 0-32 %, Erma, Tokio, Japan). Starch pattern index was measured by staining with an iodine-potassium iodide solution, where each fruit cut transversely in half was assessed in a scale of 1 (all tissues stained blue/black) to 6 (no staining), indicating least and maximum maturity, respectively.

Growth equations were developed using SYSTAT procedure. Model suitability was evaluated using goodness-to-fit measures. Mean separations were computed with Student’s *t*-test.

Results and discussion

Growth curves: Lime sulphur sprays significantly increased (P<0.01) mean FD, starting from 115 DAFB (Fig. 1). This flower thinner reduced competition between fruits at an earlier stage in the season than was achieved using the fruitlet thinner naphthaleneacetic acid described in a previous trial (Garriz *et al.*, 2004). Under the climatic conditions of this study (Table 1), logistic models best fitted the fruit growth *vs.* time curves on treated (I) and non-thinned trees (II):

$$FD=81.00/(1+e^{2.30-0.03DAFB}),\ R^2=0.98,\ P<0.001 \qquad (I)$$

$$FD=77.87/(1+e^{2.26-0.03DAFB}),\ R^2=0.97,\ P<0.001 \qquad (II)$$

In commercial fruit-growing, knowledge of the seasonal course of fruit growth is essential for correct timing of the different cultural practices like fertilization, pruning, fruit thinning, etc. (Westwood, 1993). Different kinds of seasonal fruit growth patterns were described for the pear cultivars ‘Bartlett’, ‘Packham’s Triumph’ and ‘Abbé Fetel’ (Garriz *et al.*, 1995, 1999, 2005).

Final fruit size: Final size grading showed that percentage of fruits with <65mm diameter was 25.0 % for the control and 5.26 % for treatment 2 (Fig. 2). Lime sulphur sprays significantly altered final fruit size in terms of FW; values were increased by 16.5 % in relation to control fruits (Table 3). Fruit size increases following blossom thinning are attributable to increased cell division as well as to cell expansion in the persisting fruits. Increased cell division in fruits leads to firmer fruits with improved texture. In ‘Golden Delicious’ apples, very severe thinning occurred when 3 % CaSx was applied at full bloom (Stopar, 2004).

Table 1. Relative humidity, relative sunshine duration, maximum, mean and minimum temperature in orchard from 15 September to 19 September.

Parameter	15 September	16 September	17 September	18 September	19 September
Relative humidity (%)	70	66	45	46	51
Relative sunshine duration (%)	74	50	83	54	75
Maximum temperature (ºC)	22.5	16.5	17.5	15.6	15.6
Mean temperature (ºC)	12.4	7.9	10.7	10.3	9.6
Minimum temperature (ºC)	-1.1	4	1.9	6.4	1.7

Table 2. Relative humidity, relative sunshine duration, maximum, mean and minimum temperature in orchard during the growing season

Parameters	Month						
	September	October	November	December	January	February	March
Relative humidity (%)	53	58	53	60	57	57	60
Relative sunshine duration (%)	63	57	72	63	83	81	66
Maximum temperature (ºC)	18.9	21.9	26.0	28.4	30.6	29.4	27.7
Mean temperature (ºC)	11.4	14.2	18.3	20.2	22.3	20.1	18.6

Table 3. Effects of 7 % lime sulphur (LS) on fruit diameter and weight of ‘Abbé Fetel’ pears at commercial harvest. Trees were treated at 30 % bloom. Means followed by different letters within columns are significantly different from one another (Student’s *t*-test, $P < 0.01$)

Treatment	Fruit diameter		Fruit weight	
	(mm)	Increment in relation to control (%)	(g)	Increment in relation to control (%)
Control	68.9 a	0.00	229.8 a	0.00
LS	72.5 b	5.22	267.7 b	16.50

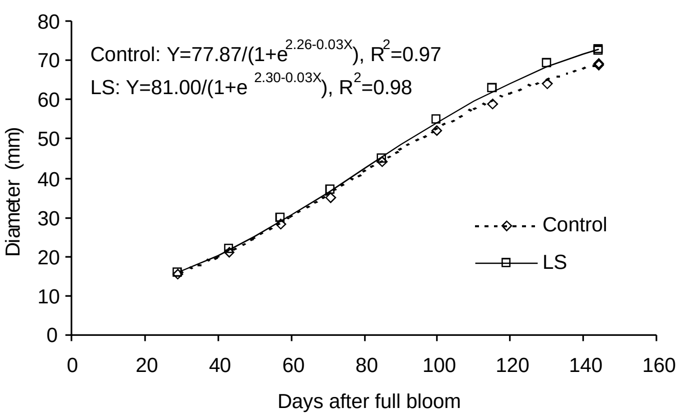

Fig. 1. Changes in ‘Abbé Fetel’ fruit diameter plotted on a time-from-bloom basis, as affected by lime sulphur (LS), applied at 30 % bloom. The lines are the fitted models to the data. Statistical differences ($P < 0.01$) between means at each date are indicated by the asterisk, according to Student’s *t*-test.

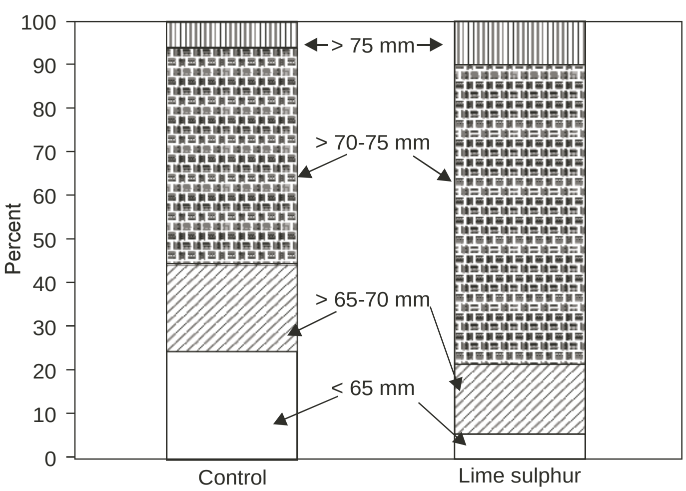

Fig. 2. Effect of thinning with 7 % lime sulphur (LS) on fruit size distribution of ‘Abbé Fetel’ at commercial harvest.

Fruit deformations or marks were not detected on treated pears. Kelderer *et al.* (2002) carried out thinning trials with lime sulphur and the sprays were applied during blossom to various apple varieties. In most cases, it was possible to increase the average fruit size; the influence on fruit-russeting was non-significant and the fruit deformations increased slightly. Their results showed a correlation with the amount of active ingredient, water volume and number of treatments.

Fruit maturity: Ripening changes are associated with the transition from growth to senescence and whilst these phenomena appear common to all pear cultivars, the rate of fruit development is a varietal characteristic, although there is a lesser influence of growing conditions, particularly of climate. Fruit ripening is a coordinated series of biochemical changes that renders the fruit attractive to eat; the process is under genetic regulation, but plant hormones play an essential control (Vendrell and Palomer, 1998). The maturity indices of ‘Abbé Fetel’ pear samples picked at 144 DAFB, or initial commercial harvest in the High Valley region are shown in Fig. 3. Blossom thinning improved fruit quality as well as size, since treated trees showed firmer fruits than the controls (64.4 *vs.* 61.7 N) and there were no statistical differences among treatments in soluble solids concentration (11.5 *vs.* 11.8) and starch index (3.6 *vs.* 3.7). Guak *et al.* (2004) treated Fuji and Gala/M9 apple trees with lime sulphur at 85 % full bloom at rates up to 4 %. Treatments caused Fuji fruits to be slightly longer than the untreated control but other fruit quality characteristics at harvest were largely unaffected. After 3 or 4 months of 1°C storage, firmness of Gala was slightly reduced by lime sulphur treatment but juice soluble solids and acidity were unaffected.

From the present study with ‘Abbé Fetel’ under conditions in the High Valley region of Argentina it can be concluded that Lime

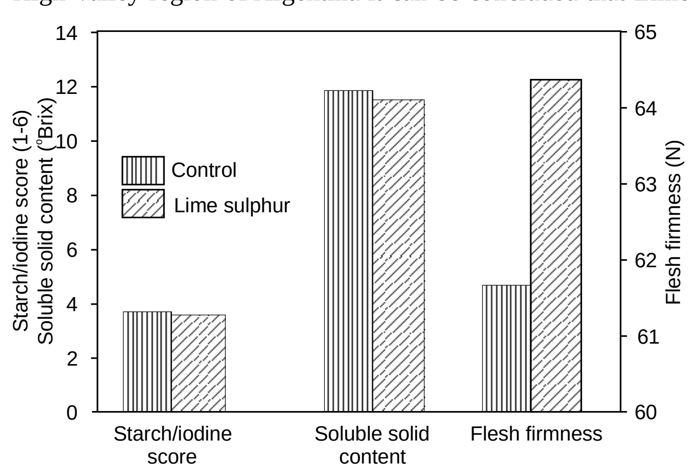

Fig. 3. Effect of 7 % lime sulphur (LS) on starch/iodine score, soluble solids concentration and flesh firmness values of ‘Abbé Fetel’ pears at commercial harvest.

sulphur sprays at 30 % bloom significantly altered seasonal fruit growth in terms of mean fruit diameter. Percentage of fruits with < 65 mm diameter was higher (25.0 %) in control and 5.26 % in lime sulphur spray. Final fruit weight increased by 16.5 % as compared to control fruits. More research is needed to determine how lime sulphur concentration and time of application influence the thinning response on different pear cultivars.

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