EAST MALLING TRUST FOR HORTICULTURAL RESEARCH REPORT

Project SP113: Effects of foliar application of trace elements on Bramley apple quality

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Final report

Background

The aim of this project was to determine whether foliar applications of boron and zinc were beneficial to blossom, harvest yield and fruit quality in Bramley apple trees.

Skin colour and freedom from blemishes are critical components of fruit quality. Bramley apples are susceptible to storage disorders that blemish the skin and flesh, particularly when storage temperatures drop below recommended levels. Some of these disorders are related to levels of minerals in the fruit at harvest. Better guidelines are needed on the use of boron and foliar applications of zinc to maximise blossom and fruit quality of apples grown under UK conditions. As crop load influences fruit quality, it must be taken into account when considering the effects of nutritional treatments.

Boron plays a major role in the fruit set of apple trees, and flowers contain high concentrations of boron. Deficiency in boron is known to reduce fruit set. One of the primary functions of boron is in cell wall development in growing plant parts and this has implications for fruit quality and texture. Increasing boron concentration in apples also has been associated with reduced incidence of skin cracking.

Apple is more susceptible than many other deciduous species to zinc deficiency. Deficiency causes reduced shoot extension and, in extreme cases, tip death. Zinc is associated closely with the production of primary growth hormones, and enzymes that control protein synthesis, fruit set and ripening. Zinc has also been implicated in increasing dry matter concentration, sugar content and acid content and cracking of fruit.

Five experiments investigated the effects on blossom and fruit quality of boron and zinc applications at the post-harvest, bloom and cell division stages of tree and fruit development from 1997 until 1999. Severe frost damage in 1997 made the results from the first experiment unreliable, so only the results from the 1998 and 1999 experiments are summarised here. The application rates for boron and zinc are given in Table 1. Boron and zinc were applied at doses greater than those normally recommended in order to maximise any physiological effects.

Boron application

Boron in the flower is transported there from reserves in the wood during the development of the flower. Post-harvest application of boron significantly increased the concentration of boron in the flower receptacles at full bloom in 1998 by 37% compared to untreated trees, whereas application at full bloom had no effect. However, no effects of the post-harvest application of boron were found in the flower receptacles in 1999, whereas application at bloom increased the concentration of flowers by 128%. Therefore, applications of boron post-harvest and at bloom are recommended where the intention is to increase concentration of boron in tissue near to the developing embryo that produces the fruit.

Increasing the concentration of boron in the flower or fruitlet by application of boron at bloom or during fruit cell division also did not influence fruit set. This suggests that, even in the absence of supplementary boron application, the supply to flowers was sufficient to enable good fruit set.

The application of boron at cell division doubled the concentration of boron found in fruitlets sampled in June and July and application at bloom had a similar but smaller effect. The autumn application had no effects on fruitlets compared to the untreated controls. In both years, the concentration of boron in untreated fruit at harvest was significantly increased by application at cell division, and in 1999, the bloom application had a similar but smaller effect. Application of boron at all three stages of growth more than doubled the concentration of boron found in the fruit.

The mean yields and number of fruit per tree and grade-out of Class I fruit at each harvest were unaffected by boron application. Supplementary boron had no influence on storage disorders following long-term storage of the 1998 fruit. Therefore, it may be concluded that boron application at any stage of tree growth was not beneficial to blossom quality, harvest yield and fruit quality.

Zinc application

Post-harvest application of zinc was ineffective in raising the concentration of zinc in the flowers in the following spring, but application during bloom significantly increased concentrations by 7% compared to untreated trees in 1998 and by 66% in 1999. This confirms recent work from elsewhere that has shown that zinc is relatively immobile (c.f. boron) and, after uptake, it remains in the leaves and is not transported readily to other plant organs. Preliminary investigations using leaf washing and marker techniques have indicated that the zinc was absorbed more slowly than boron. Therefore, loss due to wash off by rain is more likely.

In 1998, the application of zinc at cell division massively increased the concentration of zinc in spur leaves (202 μg zinc/g dry weight) sampled in June compared to the untreated control trees (33 μg zinc/g dry weight) but, by July, these differences between treatments has disappeared. The concentration of zinc found in fruitlets sampled in July was also greatly increased by the cell division application, and this effect persisted until harvest. The untreated control trees contained 25 and 30 μg zinc/100 g fresh weight in 1998 and 1999 respectively, whereas those treated at cell division had 45and 38 μg zinc/100 g fresh weight respectively over the same period. This latter effect was due to absorption of the zinc into the fruit flesh. The post-harvest and bloom applications of zinc had no effect on the concentration of zinc found in the fruit.

Zinc application post-harvest or at bloom had no effect on the number of floral buds that developed but initial numbers of fruit per tree were significantly reduced by 17% by application after petal-fall in 1998. This effect was particularly marked where zinc also had been applied previously at other stages of growth and fruit numbers per tree were reduced by 32%. However, in 1999 a different effect occurred. Application of zinc at bloom caused a small reduction in fruit set, whereas application during fruit cell division caused the opposite effect compared to the untreated trees.

The increased abscission of fruit caused by the cell division or bloom applications of zinc in 1998 and 1999 respectively resulted in fewer fruit at harvest and lower harvest yields than on non-sprayed trees or on trees sprayed with zinc post-harvest. However, in 1998 the reduction in the number of fruit per tree resulted in a higher dry matter concentration per fruit, but did not result in an increase in fruit size. Zinc application slightly reduced the severity of core flush that developed during CA storage.

Conclusions

- Autumn application of boron increased the concentration of boron found in flowers

- The application of boron and zinc during fruit cell division has the largest single effect on increasing boron and zinc concentrations respectively in fruit.

- Boron application at any stage of growth was not beneficial to fruit set, harvest yield and apple quality following long-term storage.

- Application of zinc during bloom or after petal fall (i.e. during the period of fruit cell division), significantly reduced fruit numbers by causing increased abscission of fruitlets. This resulted in fewer larger fruit at harvest and lower harvest yields than on non-sprayed trees.

Table 1 Application of boron (2 ml bortrac/l) and zinc (4.4g $ZnSO_4.7H_2O$/l) at 1.4 – 1.8 l/tree during 1998 and 1999.

	1998		1999	
Growth stage	No. of applications		No. of applications	
No application	0		0	
Post harvest	3 (Zinc 2)	14/10 – 3/11/97	2	8/10 - 5/10/98
Bloom	3	8/4 - 8/5	3	26/4 – 6/5
Cell Division	3	21/5 – 12/6	3	27/5 – 10/6
All	9	14/10/97– 12/6/98	9	8/1098 – 10/6/99