Crop Regulation and Skin Finish with Fuji Apples

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Introduction

Early experiences with Fuji apple trees in Tasmania showed that this cultivar was difficult to thin. Three-year-old trees could be thinned with the blossom thinners naphthalene acetic acid (NAA) or ethephon, however, high concentrations were required. Trees on vigorous seedling rootstocks were also easier to thin than those on MM.106. Higher concentrations of ethephon were needed to thin 5-year-old trees than younger trees. Thinning early at full bloom (FB) produced better results than later applications at 14 days after full bloom (DAFB). In addition, high concentrations of chemicals could cause unacceptable levels of russet in Fuji. Selections of Fuji vary in susceptibility to russet, with Naga-fu 2 Fuji being particularly sensitive. A hand thinning experiment showed that blossom thinning was vital to fruit size with Fuji. It was also clear that Fuji trees could be cropped at higher levels than cultivars such as Golden Delicious or red Delicious due to inherently large fruit size potential and later picking dates. Strategies for thinning red Fuji in Tasmania are based on low chemical use, early thinning and programmed use of thinners.

Use of Blossom Thinners

Our first thinning trials with Fuji in Tasmania were conducted in 1986-87 with 3-year-old Aki-fu 1 Fuji on MM.106 and seedling rootstocks. Surprisingly, it took 100 to 200 ppm ethephon to thin these young trees. This compared with later findings that 100 ppm ethephon or less could thin large, mature red Delicious at blossom time. High levels of NAA were also required to achieve acceptable thinning levels. However, fruit size was depressed as a result of these high concentrations.

Work on 5-year-old trees on MM.106 rootstock showed that the timing of the ethephon sprays was critical. Sprays at FB thinned to a greater extent than those applied 14 days later. This increased thinning was reflected in increased fruit size. We identified optimum timing of NAA and ethephon sprays more accurately. Ethephon was most effective when sprayed from balloon blossom (BB) to FB while FB applications were more effective for NAA. This work defined the

best timing for primary thinners and raised the proposition of reducing chemical rates at this time.

Attempts were made to combine NAA and ethephon in a program to thin Naga-fu 2 Fuji, which was the selection of choice in Tasmania. While thinning effectively, the combination also revealed some drawbacks. Firstly, the high concentrations of ethephon used at FB could have contributed to significant russeting in Naga-fu 2 Fuji. Previously we had shown that this strain was much more sensitive to russet induced by chemical sprays than Aki-fu 1 Fuji. In this same work it was shown that trees on vigorous seedling rootstocks were less sensitive to russet than those on MM.106 rootstocks. Other work showed that severity of pruning could affect russet with heavy pruning stimulating vigorous growth which resulted in reduced russet. Secondly, applications of post bloom sprays of NAA caused unacceptable production of pygmy fruit. These disadvantages effectively ruled out combinations of NAA and ethephon. Jones (1994) discusses these considerations in detail.

Use of Post Blossom Thinners

The use of carbaryl and thiram, which are used as post bloom thinners in Australia, was put in doubt for Fuji for two reasons: russet promotion and the move to reduce the use of persistent chemicals on food. 6-benzyladenine (BA) was investigated as a replacement for these post-bloom sprays. Early work showed that BA could effectively thin Fuji when applied at 20 DAFB at concentrations of 100 to 400 ppm. Higher concentrations of BA had two major disadvantages, fruit russeting and lateral shoot proliferation.

Later work in Tasmania developed a detailed model of BA timing and established rates of application on Fuji after ethephon was used as a primary thinner. Target thinning was achieved at 19 to 23 DAFB and at BA concentrations of 140 to 160 mg/liter. The ethephon used in this trial appeared to prevent lateral shoot proliferation when used with BA. This combination is now the recommended standard practice in Australia (Bound, 1996).

Modeling Fuji Thinning

Work in Tasmania showed that larger fruit could be achieved by early thinning and this increase in fruit size was not at the expense of crop load. This showed that Fuji is able to carry larger crop loads than previously studied cultivars such as Golden Delicious and red Delicious.

We also conclusively demonstrated that later thinning reduced fruit size. Trees thinned at FB had a mean fruit weight of 265 g while those thinned at 56 DAFB had a mean fruit weight of 175 g.

Optimum results on mature trees will depend on a number of factors. We have developed a practical computerized thinning model (Jones, 1996) where many of the identified factors affecting thinning are considered before a recommendation is given. In order to deliver best practice all the cultivar data included has been properly verified by scientific experimentation.

Advice on how to thin Fuji trees should consider tree cropping and the degree of crop regulation necessary to achieve this result. To do this, the computer program asks questions about the trees and crop required and then applies modifications to a baseline proposal as additions or subtractions. Consideration is given to the following factors: pollination, preferred thinning bioregulators, cultivar, rootstock, age of tree, tree size, vegetative vigor, fruit size required, last year's crop size, density of flower buds on tree and severity of pruning. Method of spray application for the size of tree is fitted into the program which gives advice on the volume of spray to apply and the concentration of bioregulator needed (ml/100 liters of water) is calculated for the required volume per hectare.

The program is flexible and can incorporate new technology, new cultivars or new bioregulators when substantiated data are available.

Russet Complications

Red Fuji is proving to be highly susceptible to russet. While aware of the enormous amount of work done on russet worldwide, much of it has not been applicable under Tasmanian conditions. A series of trials to investigate the possible use of gibberellic acid to reduce russet on Fuji were unsuccessful. Chemical sprays, rainfall and humidity have been found to increase the incidence of russet on red Fuji in Tasmania. Work is progressing to assess the effect of manipulating various factors within the orchard to reduce russet. These include differing chemical applications and timings, "bagging" of fruit, shading trees and pruning methods.

All sprays, including water, can increase russet. Consequently, both the thinning and pest control programs need to be examined thoroughly with the use of known russet inducing chemicals (such as carbaryl, thiram or copper oxychloride) initially minimized or excluded from programs. Dosages of chemicals should be kept to a minimum as the higher the concentration of chemical the more likely russet will occur. Programs should be devised to use chemicals at the

most effective time and with as few applications as possible. Programs should also be flexible enough to allow for the ideal application conditions to be selected. Substituting up to four applications of carbaryl-thiram with a single BA application is a good example of reducing the russet risk.

Conclusions

Effective thinning of Fuji with bioregulators is feasible. In order to achieve optimum success, all the factors impacting on thinning should be assessed. Timing of sprays is critical and to avoid high dosages a program should be developed for each set of trees. Avoiding spray application either during or just after weather that is cold, wet or a combination of both is a priority in minimizing russet. Both ethephon and BA work best in warm, dry conditions which should optimize thinning and reduce the incidence of russet.

References

Bound, S. A. 1996. Reliable thinning programs being developed. Pome Fruits Australia, September 1996, 22-25.

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Table 1. General thinning recommendations.

Trade name	Generic name	Time of application[z]	Conditions for application
Ethrel	ethephon	FB	dry, 16-24˚C
NAA	naphthalene acetic acid	FB	humid, 14-24˚C
Sevin TMTD	carbaryl thiram	14-40 DAFB	20˚C plus and dry before and after application
CyLex	BA	Fuji 15-22 DAFB Red Delicious 10-20 DAFB Golden Delicious 10-20 DAFB	dry, maximum daily temperature at least 15˚C

[z]FB, full bloom; DAFB, days after full bloom.