Practical Section for Growers – SF 45

Commercial benefits of the project

The profitability of UK cherry orchards is undermined by inconsistent cropping from season to season as fluctuations in yield make contracting supply and planned marketing of UK cherries, by retailers, difficult.

This three-year project examined possible causes for cropping inconsistencies and identified ways of overcoming some of the problems. Some of the key points that emerged from the work included:

- risk of early frost damage was reduced by applying autumn sprays of ethephon. This delayed flowering by several days and increased fruit yields in 'Hertford' trees as a result;
- multiple sprays of gibberellic acid (GA_3) and auxin 1-naphthalene acetic acid (NAA) from the cot split stage increased yields of Colney threefold by reducing fruit run-off;
- irrigation throughout the season or at fruit swelling stage increased shoot growth and in some years doubled the final set;
- applications of GA_3 delayed ripening in 'Stella', 'Hertford' and 'Colney' by two weeks and gave improved fruit firmness and an increase in fruit size.

This final point will have an important impact on the handling and marketing strategies of sweet cherry. Fruit known to be of better quality can be left on the tree to develop improved flavour and size, and later marketing of varieties will result in economic benefits.

Background and objectives

A survey of UK cherry growers, marketers and retailers identified poor seasonal consistency of cropping as the highest priority for new R&D to enable UK growers to produce a reliable source of cherries. The crop is of high value (£1790/tonne in 1995) and a reduction in yield fluctuations would have huge beneficial effect on orchard profitability. Increased consistency of supply would help stem the rising quantities of cherry imports, which in 1995 reached 12,400 tonnes at a value of approximately £16 million. It would also benefit the balance of trade by encouraging increased UK planting of sweet cherry.

There were three main objectives to the project:

- to measure and assess the ability of the sweet cherry flower to set fruit, given less than ideal environmental conditions encountered in the UK;
- to determine the environmental and physiological causes of excessive fruitlet abscission (run-off) several weeks before harvest;
- to identify and test ways of overcoming the problems.

Summary of results and conclusions

Effects of site differences

Using common cherry cultivars on four sites in Kent the effects of the importance of genetical, environmental and physiological influences were compared. It was shown that there was considerable variability in the performance of a single variety at one site from year to year, and wide variation in the performance of the same variety at different sites.

Of the three varieties evaluated differences in initial fruit set were large, but these differences were substantially less at the time of final fruit, and spring temperatures did not explain site differences for initial fruit set. However, marginally warmer seasonal temperature accumulations did appear to result in better yield at one site during the three-year trial.

At another location where site management differed, trees made little annual shoot extension growth, and fruit setting potential declined during the three years. During the project annual shoot extension growth and spur leaves were identified as important for the provision of adequate carbohydrates for fruit development.

Over the three years, of the cultivars trialed, ‘Lapins’ produced the highest and most consistent yields.

Covers

The use of rain shelters at flowering time to increase fruit set and subsequent yield did not appear to provide any benefits. There was some visible evidence that covering trees with Hy-Tex reduced visible frost damage to flowers of ‘Sunburst’, but there was no complimentary increase in fruit set. There was also no evidence to suggest that covers increased air canopy temperature particularly during the flowering period, nor did they protect trees from low temperature injury by allowing them to warm more slowly after frosts, than uncovered trees.

Irrigation

Applying trickle irrigation had a positive influence on tree growth and cropping in 1998 although it produced no consistent effects on yields, fruit size or ripening in 1999. Irrigation either at the fruit swelling stage or throughout the whole 1998 season increased shoot growth, while part irrigation during the season had less effect. Irrigation in 1998 did not affect flowering but final set was doubled compensating for any reduction in flower bud number.

Growth restriction - shoot/root pruning

Tree size was restricted to reallocate resources away from vegetative shoot growth into fruit production. This was achieved by manipulating cherry root growth through root-restriction, root pruning and chemical control.

Roots were restricted in commercial root-bags. After a period of growth during which time the roots filled the root-bags, root-restricted trees produced more floral buds than unrestricted trees. Annual shoot growth was not reduced until the roots had occupied the soil within the root-bag which took several years. Despite the production of more floral buds fruit set was not increased on root-restricted trees.

Root pruning in early May reduced vegetative shoot growth most and increased floral bud abundance, however, it also reduced fruit set, yields and fruit size.

Treating trees with Cultar very effectively controlled shoot growth and increased flower bud density but Cultar-treated ‘Sunburst’ trees cropped much less efficiently despite higher bud numbers. Flowering was also induced two weeks earlier, when the climate was more unfavourable for pollination and fruit set.

Restricting shoot growth highlighted the role of extension leaves as a vital source of carbohydrate for developing fruit. Any attempts to control tree size must not restrict shoot growth to such an extent that the trees have insufficient carbohydrate to retain the crop.

Addition of micronutrients

It was suggested that certain micronutrients, such as boron, might limit pollen tube growth if they were not at optimal levels in the flower. Boron sprays were applied to supplement the levels just prior to bud burst in March or in September. Despite the addition of boron pollen germination from treated trees was similar to that of untreated trees, and cropping was not increased by the use of these sprays.

Pollen germination and fruit set

i) Short pollination period

Early flower/fruitlet loss was associated with the failure of flowers to set fruit, probably due to embryo/fertilisation problems. Pollination is generally only effective for one to two days after the flower opens, although this varies from season to season.

ii) Pollen viability

Poor pollen viability was not held to be responsible for poor fruit set provided transfer of pollen occurred rapidly and pollen did not come into contact with water. The one exception may be 'Hertford' which exhibited the poorest germination during the three-year period.

iii) Higher temperatures

Increasing temperatures from 5 ºC to 15 ºC increased the germination of pollen from 'Sunburst' and 'Lapins' trees. One or two days with temperatures of 15 ºC during flowering could have a significant beneficial influence on pollen germination as bee activity is encouraged in addition to improved pollen germination.

iv) Pollen tube growth

The speed and ability of the pollen tube to grow down the flower style to fertilise the ovule can vary significantly from year to year and may have been a severe constraint on fruit set in 1998.

v) Tree age

The age of the tree in relation to the pollen viability was also considered and it was found that young (one-year-old) 'Colney' trees may have lower pollen viability than that of trees four years older. However no differences in viability were recorded between pollen formed on one-year-old (axillary) or spur blossoms of varieties 'Lapins' and 'Sunburst'.

vi) Further fruitlet loss

The second phase of fruitlet loss occurred as the seed coat hardened, and embryo death was the most likely cause in this instance. There are several hormones that are important in maintaining embryo growth and it is believed that their absence results in fruitlet loss (see 'Hormones').

The later fruit loss (run-off) experienced before harvest in June/July was believed to be the result of climatic events associated with reduced photosynthesis or an inability of the tree to sustain its crop load rather than embryo abortion.

Investigating 'poor climate'

i) Shading

'Poor climate' during the growing season was mimicked by shading trees. At harvest time the yield and mean fruit size of the shaded trees was significantly reduced, however there were none of the typical fruit mis-shapes/abnormalities noted with run-off fruit.

ii) Restricting carbohydrate availability

Poor climatic conditions were also examined by restricting carbohydrate availability to the spur's own leaves by phloem girdling. Performance of individual fruiting spurs was assessed by comparing their fruit to leaf ratios. There was a clear relationship between individual fruit size within a cluster and spur leaf area suggesting that spur leaf area can have a limiting effect on fruit growth. The number of fruit within a cluster also reduced individual mean fruit size. This suggests that fruit, when relying solely on their spur leaves, compete for available carbohydrate and that fruiting spurs do not obtain all their carbohydrates from their own leaves.

iii) Hexaploid rootstock

It was believed that using hexaploid 'Colt' rootstock would restrict shoot growth even further than the standardly used triploid 'Colt' rootstock. The hexaploid rootstock did produce smaller trees than the normal triploid 'Colt', it induced slightly more flower buds, slightly reduced setting efficiency, but yields per tree were similar to normal 'Colt' in 1998. In 1999 trees on the hexaploid clone set similar numbers of fruits per meter shoot length to trees on the conventional clone of 'Colt'. Yields were slightly reduced on the hexaploid rootstocks in 1999.

One hexaploid 'Colt' clone 15-3 produced slightly smaller 'Sunburst' trees than the clone 26-1-3. However, no consistent differences were recorded between these two rootstock clones in their effects on flower induction, fruit set or yields.

iii) Reducing risk of spring frost damage

The risk of frost damage in the spring can be reduced by delaying the short and crucial flowering period by several days using autumn sprays of ethephon (Ethrel C) with or without GA_3. A combination of the two chemicals gave increased fruit yields in 'Hertford'.

Hormones – auxins, abscisic acid and gibberellins

Fruit collected from shaded and unshaded trees had similar concentrations and amounts of auxin and abscisic acid (ABA). More auxin was present in the seed than in the flesh, and the reverse was true for ABA. However concentrations of gibberellic acid (GA) in the fruit of shaded and unshaded trees did differ. There was a lower concentration of seed GA in the fruit from shaded trees than from unshaded trees. This suggests that a reduction in GA_3 seed concentration was a probable factor causing fruit abscission and that an application of GA_3 sprays might sustain fruit set if applied sequentially throughout the season.

Sprays of GA_3 applied on three or five occasions during fruit development in 1998 failed to improve fruit retention on 'Stella'. Similar sprays of GA_3 had a small effect on fruit retention of 'Hertford' in 1998 and 'Colney' in 1999. However sprays of GA_3 on five occasions in 1999 starting at the 'cot split' stage, with the addition of auxin 1-naphthalene acetic acid (NAA), at the first two spray dates, increased the fruit set and yields of 'Colney', threefold. Similar sprays on 'Stella' increased set early in the season but had no significant effect on yields.

However, an advantage of GA_3 sprays was to delay ripening times of all three varieties by up to two weeks allowing fruit to increase in size and become sweeter and firmer. Sprays of Retain also delayed ripening, but less than the GA_3 sprays and did not increase fruit firmness.

Effects of ethylene production

Fruit loss may also be influenced by ethylene production and it was suggested that spray applications of an ethylene-production inhibitor aminoethoxyvinylglycine (AVG) (Retain) might inhibit fruit abscission. Sprays of AVG, applied five times during the season, failed to increase fruit retention on 'Stella' and 'Hertford' in 1998 and reduced yields of 'Stella' in 1999. However the sprays did delay fruit ripening, but not as much as the GA_3 treatment.

Action points for growers

- Cherries should be planted on warmer south facing slopes. Frost pockets and valley bottoms should be avoided.

- The economics of applying covers at flowering time and the ease of removal need to be measured against any clear benefits of increased fruit set. It has been shown that covering trees using umbrella-like rain shelters does not improve fruit set and is unlikely to enhance air temperatures.

- Orchards require good shelter for both trees and bees, and ideally four strong hives of bees should be used per acre to ensure good pollination.

- Cherry cultivars such as 'Summit' which frequently crop inconsistently, require suitable pollinating varieties planted nearby. These should be cross compatible and flower at the same late stage in the blossom season, currently 'Sylvia' or 'Regina' are the best options for 'Summit'.

- Root manipulation, such as root-restriction, root pruning and Cultar treatment, reduce shoot growth but often have an adverse effect on yield.

- Use of the newer cherry dwarfing rootstocks such as Tabel and Gisela 5 may improve fruit set and result in less fruit drop than use of 'Colt' and/or Cultar treatments.

- Trickle irrigation either at the fruit swell stage or throughout the whole season increases shoot growth, both the number of shoots and the shoot lengths. Increased irrigation may reduce floral abundance, however it can result in double the fruit set and an increased fruit size, in some years.

- Applications of Cultar to the soil beneath trees of many varieties (eg 'Sunburst' and 'Stella'), may result in flowering two weeks earlier if too high a dose rates are used, giving half as efficient fruit set and poor crop yields. Any Cultar treatments that result in strong suppression of shoot growth must be avoided (eg rates of 1.6 g product or more per litre).

- Application of sprays of Bortrac 150, as a boron supplement, do not increase cropping in 'Hertford' and 'Sunburst'.

- Five applications of GA_3 starting at the 'cot split' stage, with the addition of NAA at the first two sprays, may increase fruit set and yields in 'Colney' by threefold. Similar sprays to 'Stella' will not increase yields in years when run-off of this variety is particularly severe. These spray treatments are not currently approved for use by UK growers.

- Sprays of AVG (Retain) are unlikely to increase fruit retention on 'Stella' and 'Hertford' trees and may reduce yields in 'Stella'. These spray treatments are not approved for use on cherry trees in the UK.

- Sprays of GA_3 may induce useful delays in ripening in 'Colney', 'Stella' and 'Hertford' of up to two weeks resulting in increased fruit firmness, increased fruit size and improved flavour. Attempts are being made to obtain SOLA approval for use of these spray treatments on UK cherries.

- Autumn sprays of ethephon (Ethrel C) with or without GA_3 can delay flowering by a crucial couple of days, sufficient to reduce the risk of frost damage and increase yields of some varieties in frost years. These sprays are not currently approved for use on UK sweet cherries.

Anticipated practical and financial benefits

The results of this work may not have found all the reasons for poor fruit set and run-off and thereby overcome the problem of inconsistent production, however it provides very useful pointers to assist in improving UK cherry quality which could have significant financial implications for UK growers.

Consistency of yields will be best improved in the short term by choice of favourable site, use of Tabel, Gisela 5 or Gisela 6 rootstocks, provision of adequate shelter and the introduction of bee hives. By reducing use of Cultar for tree growth control yields will also be improved. Future work aimed at gaining approval for use of gibberellins together with either an auxin or ethephon at various times in the season will also significantly aid yield consistency. These and other management techniques aimed at improving the orchard climate (light and temperature) should increase yields significantly.

NB: Only officially approved pesticides may be used in the UK. Approvals are normally granted only in relation to individual products and for specified uses. It is an offence to use non-approved products or to use approved products in a manner that does not comply with the statutory conditions of use except where the crop or situation is the subject of an off-label extension of use. (The UK Pesticide Guide 1999)

Before using all pesticides & herbicides check the approval status and conditions of use.

Read the label before use: use pesticides safely.