

Solving Biennial Bearing

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Over the past seven years, AgFirst have become aware of the very real problem with biennial bearing on Australian orchards. Whilst this problem is not unique to Australia, the microclimates here tend to make biennial bearing more extreme than in other more moderate climates.

All pome fruit have strong biennial bearing tendencies. Intensity of the problem varies with variety. Among varieties Fuji, Red Delicious, Golden Delicious and sometimes Granny Smith tend to be more prone to biennial bearing than Cripps Pink and Royal Gala. Even so, if fruit set fails due to a climate disaster, lack of pollination, or conversely trees are severely over cropped even varieties that are not particularly prone to biennial bearing can go into a biennial bearing pattern.

Once a biennial bearing pattern becomes established it is difficult to overcome and usually needs a multi facet approach that involves most of the crop husbandry practices known to influence biennial bearing.

Factors that influence Biennial Bearing

Excess crop load – over cropping in “on” crop year is by far the most common factor associated with persistent biennial bearing. Initial establishment of a biennial bearing pattern is usually triggered by fruit set failure which has numerous causes:

- Frost or hail event over the critical fruit set period.
- Nutrient deficiency usually nitrogen, inhibiting fruit set.
- Poor pollination.
- De-fruiting young trees or grafts during their tree development phase then suddenly going from the non-bearing to the full crop mode.
- Excess vigour can suppress fruit set incurring heavy natural fruit drops, or abort spurs and terminal fruiting sites into vegetative growth.
- High summer temperatures – pome fruit growing in hot climates show a greater tendency towards biennial bearing problems than when grown in more temperate climates.

Among these factors, control those you can and proactively manage those you can't.

Avoid Biennial Bearing if you can

The best way out of a biennial bearing problem is to avoid its development. Critical steps here are:

- Weather proof the orchard – good frost protection, hail netting.
- Progressively build cropping levels as the canopy develops. Avoid aggressive primary blossom thinning programmes until good vigour cropping balance is established.
- Commence using benzyladenine (BA) dominant thinners post bloom starting in the first year significant blossom occurs.
- Provide adequate provision for cross pollination. In netted orchards this means pollinators in every tree row.
- Ensure that nutrient deficiency, particularly nitrogen does not limit fruit set. Robust post harvest foliar nitrogen programmes supplemented by pre-bloom nitrogen foliar sprays ensures adequate nitrogen levels for fruit set with lowered risk of lifting overall nitrogen status to levels likely to suppress fruit colour.

Managing your way out of Biennial Bearing

The fundamental tools for overcoming biennial bearing are vigour control, canopy management to maintain sufficient fruiting sites and aggressive early season fruit thinning in “on” crop years to establish crop loads to establish crop loads the tree can support within 6-8 weeks of full bloom.

1 *Create the right canopy.*

Calm canopies carry high yields and generally have regular crops. Weak growing slightly pendant branches dominate these canopies. There are key relationships between branch diameter at source and its length. While there may be subtle differences among varieties and between different growing environments as a general rule branch size should not exceed 2-2.5cm diameter for each metre of its length. These branches also need to be well furnished with good fruiting sites, including weak, slightly pendant fruiting laterals growing off the branch. Excessively vigorous annual shoot growth, particularly those exceeding 25-30cm in length or growing from the top of the branch need to be eliminated or stubbed back in late spring.

The objective is to carry sufficient crop load to soak up the photosynthates produced in the branch once sufficient shoot leaves have developed to support the crop and prevent any surplus being used to fuel further shoot growth. Cultivars with strong biennial bearing tendencies need to carry high bud to fruit ratios, probably 3 to 1 or more. The objective is to try and maintain two resting fruiting sites for each fruit bearing site.

As most shading problems responsible for poor fruit colour development are caused by rampant annual shoot growth and high tree vigour caused by excessive pruning it is possible for calm fruiting canopies to carry generous levels of fruiting wood without compromising fruit colour. Where excess tree vigour is a



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problem the fruiting canopy is too small for the root system. Such trees usually have numerous high vigour branches responsible for their shading problem. Selective complete removal of these over vigorous branches together with minimal pruning of those remaining branches and ***definitely*** no branch heading, shortening or “lifting” cuts will calm the trees down within a couple of seasons. Consider alternate year pruning strategies. Prune in the winter prior to the “on” crop.

2 *Good cross pollination*

As mentioned earlier, good cross pollination is essential to ensure good fruit set every year not just the years that have favourable spring weather conditions. If cross pollination is poor, there is a high probability that in some years, crop loads will fall below optimal which can set up a biennial bearing pattern.

It is important that there is sufficient volume of well placed pollinator flower and then sufficient bee activity to spread it around.

3 *Strategic use of chemical thinners*

Excess crop loads, particularly when carried well into the growing season cement biennial bearing behaviour in place and will over ride most of the husbandry practices known to reduce the intensity of the biennial bearing problem. Where there is established biennial bearing behaviour the objective should be to bring crop loads down to within 15-20% of final crop load within 6-8 weeks, preferably six weeks or less of full bloom in the “on” crop year. Usually this thinning will comprise of:

- Aggressive blossom thinning programme based on ATS, ethephon or NAA often used as cocktails.
- BA based post bloom thinner, which depending on cultivar usually has to “hotted” up with NAA, carbaryl or a combination of all three.
- Once chemical thinning response becomes obvious hand thinning to clear a minimum of two out of three fruiting sites and set crop loads within 15-20% above final crop load objective.

Experience shows some chemical thinning programmes to be more effective than others for overcoming biennial bearing. Fundamentally it is a matter of clearing fruiting sites rapidly.

ATS in our experience has been superior in stimulating return bloom compared with NAA. It works largely by preventing pollination which gives very rapid reduction in seed load where as with other chemical thinners pollination proceeds as normal so there is initial seed development, with it more endogenous gibberellins loading in the tree. Gibberellins are the growth regulator responsible for suppressing flower initiation.

Ethephon is relatively rapid acting, rapidly breaks down to ethylene which in itself is an important growth regulator that can directly stimulate flower initiation, reduce shoot growth vigour as well as thin fruitlets.



NAA is relatively slow acting, usually does an effective job in reducing fruit numbers in clusters down to one or two fruitlets, but unless rates are at the upper end of the thinning concentration range usually fails to clear fruit sites in sufficient numbers to give adequate flower for the next “off” crop.

BA in our opinion can directly stimulate flower initiation as well as thin fruit.

Unless conditions are very favourable for BA thinning response, e.g. three days with maximum temperatures about 18-20°C, preferably with warm nights BA thinning response is weak. BA thinning response can be enhanced by addition of NAA, carbaryl or both. NAA should not be added to BA for varieties prone to pygmy fruit retention, e.g. Fuji and Red Delicious.

In the “off” crop phase fruit set is often poor because the flowers are weak and poorly developed. Take a cautious approach to chemical thinning. Best options are:

- ATS late in the blossom period
- BA as a post blossom thinner
- Follow up hand thinning will be necessary to break up bunches and should be completed before bunches close or sunburn risk escalates.

While these chemical thinners assist in promoting return bloom excess crop loads will suppress their return bloom response. Consequently it is essential to back up chemical thinning with diligent early hand thinning. Where entrenched biennial bearing patterns have become established good thinning practices are insufficient to overcome the problem so additional crop husbandry practices proven to improve flower initiation are necessary.

4 *Vigour Control*

There is a strong link between high vigour and biennial bearing. Practices which restrict tree vigour generally reduce biennial bearing tendencies except in the situation where low vigour trees have become biennial.

Vigour Control Tools:

- Trunk Girdling / Trunk Incision – reduce annual shoot growth to 30-50% depending on timing. Have a powerful, direct effect on stimulating return bloom by reducing endogenous gibberellins supply from the roots and raising photosynthates concentrations in the upper tree.
- Root Pruning – have a direct effect on annual shoot growth extension which terminates vegetative growth for terminating buds and spurs to form flower buds. Root pruning is a good option for managing excess shoot growth during the “off” crop year.
- Late spring, early summer shoot tipping or stubbing – weakens extension growth, increases fruit bearing terminal bud numbers and may also stimulate fruiting spur development on current season’s extension growth.
- Regalis® - very effective vigour control tool when correctly managed, but can be neutral or even negative in its effects on return bloom if excessive rates applied.
- Ethephon – sequential sprays at low rates commencing around petal fall gives mild vigour control effect and direct stimulation effect on flower bud initiation. Where more vigour control



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is required, ethephon is a good companion product to the second and subsequent Regalis® sprays to ensure that return bloom is not suppressed.

- Regulated Deficit Irrigation (RDI) – this is a good strategy for pears, in particular to reduce vigour and stimulate return bloom. With apples high levels of water stress over the critical flower bud initiation period and early bud development period accompanied by high temperatures can suppress return bloom due to the impact this stress has on reducing photosynthesis.

5 *Hand Thinning and Crop Loading*

Once you've done everything possible with the chemical thinners, the next major set is to ensure the final crop load set at hand thinning, not only delivers a good outcome this year, but also delivers a good return bloom outcome next year.

Timing of hand thinning has a large impact on return bloom. The longer that high fruit numbers are left on the tree, the more likely that return bloom will be influenced negatively. There are two effects at play; the seeds release hormones that can turn a spur bud off the following year and high fruit numbers require lots of photosynthate supply that is portioned to the fruit rather than next years developing fruit bud. The general rule of thumb is that all hand thinning should be completed by Christmas in the southern hemisphere. Thin your biennial varieties first, particularly in their on- crop.

Spatial arrangement of the fruit can also influence return bloom. If a fruit is carried on a spur of a biennial variety, that spur will probably be vegetative the following year. That is why it is important to have resting spur on biennial varieties. If the proportion of resting spur is low, the hand thinning regime that will achieve the best return bloom is one where some spurs are completely thinned and others retain a double (rather than thinning all spurs to a single).

Overall crop load can also be very influential. Make sure the total fruit number that is left per tree is at a level that history shows your trees can handle sustainably every year. You are much better off growing 60 tonnes every year than 80 tonnes one year and 30 tonnes the next. Use the crop load calculator

6 *Summer Growth Regulators*

Recent research in North America has found that sequential application of low rates of NAA, ethephon or both commencing around six weeks after full bloom and applied at 10-14 day intervals stimulate flower bud initiation. There is anecdotal evidence in Australia and New Zealand to indicate a similar response. These growth regulators can be applied with cover sprays.

7 *Water and Nutrition*

Place an apple or pear under either water or nutrition stress and biennial bearing is one of the likely outcomes. As with most things, the trick is to find the balance as there are as many negatives with excess as there are with shortages. Regular monitoring of soil moisture and a water budget are good tools to make sure trees do not become water stressed. If dam supplies are inadequate in dry seasons, make sure you adjust your strategies the following autumn and spring to try and offset, the lack of carbohydrate the tree will have laid down in reserves.



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Close nutritional monitoring is also essential. Many poor fruit set problems can be attributed to a lack of one or 2 nutritional elements. Regular, soil and leaf testing should be standard practice if you want to grow large volumes of good quality fruit every year.

Grower Case Study

Focus Orchard ~ Oakleigh Orchard

Variety – Fuji

Location – South Australia

Historical cropping performance “on” crop 50t/ha, “off” crop 15t/ha

Treatments:

Block A

2011-12 Season

Single side root prune late winter

1 Regalis® at 5cm shoot extension at 1kg/ha

Blossom thinners – ethephon ai 72% at 450ml/ha on 4th October and again 9 days later

Post blossom thinner – BA at 9L/ha on 19 October

1x ethephon 72% at 150ml/ha on 05 November

3x NAA (2%) as at 175ml/ha on 06, 13, 20 December

Result

2012 harvest 51.4t/ha

2013 harvest 53.8t/ha

Block B

2011-12 Season

No root prune

Regalis® as per block A

Chemical thinning as per block A

Ethephon as per block A

1x NAA (2%) as at 175ppm

Result

2012 harvest 46.2t/ha

2013 harvest 36.9t/ha

To view photos and diagrams refer to the Biennial Bearing Presentation.



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