Canopy management strategies for macadamia

(*Macadamia integrifolia*, *M. integrifolia* × *M. tetraphylla*).

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Abstract

Macadamia is a subtropical evergreen tree native to the east coast of Australia and grown around the world for its edible kernel. The trees are tall with dense canopies and at maturity orchards are heavily shaded and crowded unless tree size is controlled. This shading has been associated with yield decline but the evidence for this is limited to one site. The shading also limits ground-cover growth leading to increased soil erosion; slows orchard floor drying after rain resulting in harvest delays and reduced nut quality; and increases pest and disease pressure. Crowded orchards are also more difficult to spray effectively.

The aims of this study were to further investigate the evidence for yield decline, assess canopy management methods adopted by industry, and investigate the effect of pruning on fruit set to improve outcomes from some of these methods.

A yield survey in mature orchards confirmed earlier conclusions that yield decline occurred at high levels of light interception but that it was small compared with inter-seasonal yield variation.

Selective limb removal increased yield in one trial, decreased it in another and did not have a lasting effect of increasing light transmission to the orchard floor for ground growth or orchard floor drying. Side-hedging maintained light to the inter-row, but reduced yield by 12% on average over 7 seasons. Hedging the tops of trees (topping) was a more practical method of tree size control than selective removal of limbs at the top of the canopy but it reduced yield by up to 50%.

The standard hedging time in the Australian industry is early spring (September) around flowering and early fruit development. Subsequent experiments

demonstrated that hedging at this time decreased yield by accentuating early fruit abscission. The primary cause appeared to be competition for carbohydrates between the post-hedging shoot growth and the young fruit, with a secondary effect due to the loss of photosynthetic canopy. The effect was local with shoot growth on pruned branches having no effect on unpruned branches.

A series of experiments tested the hypothesis that fruit are less sensitive to a limitation in carbohydrate supply outside the premature fruit drop period, and that pruning at a time that avoided shoot growth during this period may mitigate the yield penalty. Hedging time was found to affect yields of the four cultivars tested: 'A4', 'A38', '344' and '816'. Yield losses were lower for trees hedged in November-December than for trees hedged in September. Yields for trees hedged in June were higher than September-hedged trees in one experiment but were similar in another experiment. Yield losses for September- and October-hedged trees were similar. Declines in stem water-soluble carbohydrates occurred after hedging in September, October and November, and preceded an increase in fruit abscission. However, the increase was less pronounced for November-pruned trees, consistent with the idea that fruit become less sensitive to carbon limitation as they mature.

Two other strategies to mitigate the effect of hedging on fruit abscission and yield were investigated. The first of these, the ethylene inhibitor aminoethoxyvinylglycine was applied at a range of combinations up to 600 mg L^{-1} and at two times but it did not increase final fruit set or yield in pruned or unpruned trees. Further work with timing of application may improve outcomes or it may be that ethylene is not the main control of fruit abscission in macadamia. The second strategy, girdling, reduced the negative effect of pruning on fruit abscission, but

girdling was not as effective as varying the time of hedging in mitigating the effect of hedging on yield.

Girdling also reduced shoot growth in pruned and unpruned trees and may have potential as a tree size control strategy for macadamia. Girdling trees in three out of four seasons reduced the tree height increment to half that of ungirdled trees. Average yield for this period was similar for girdled and ungirdled trees, but further monitoring is required to determine long-term yield effects.

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