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NEW STRATEGIES AND TOOLS FOR AVOCADO CANOPY MANAGEMENT

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SUMMARY

Trials were established to investigate the effect of pruning and Sunny® on shoot growth, flowering, yield and fruit quality of 'Hass'. Results of these trials indicate that pruning after harvest reduces yield when pruned for the first time, however this negative effect decreases in subsequent years. Pruning can stimulate vegetative growth and the timing of the post-harvest prune will influence the amount of regrowth during flowering and fruit set. This regrowth may compete with developing fruits and reduce fruit quality. The timing of the summer prune can affect the amount of regrowth and flowering the following spring. Foliar application of Sunny® at flowering increased fruit size and can reduce shoot length and increase flowering when applied to regrowth resulting from summer pruning. Pruning altered the distribution of fruit within the tree with more fruit in the lower section (ground level to 2 m high) of the tree. Pruning can reduce the Ca concentration in the fruit and may be responsible for the increase in fruit rots and disorders.

This research was conducted in warm subtropical southeast Queensland where the crop can be harvested up to several months prior to flowering. There is the need to identify and develop successful canopy management strategies in other growing areas (eg. in cooler, temperate climates where fruit is present on the tree during flowering) before wider industry recommendations can be made. The current research aims to identify canopy management strategies that can be successfully implemented in all major avocado growing areas across Australia. In addition the effect of other growth regulators, such as naphthalene acetic acid (NAA) on regrowth control and prohexadione-calcium (a GA biosynthesis inhibitor) on shoot growth, yield and fruit quality will also be investigated.

Key words: Hass avocado, canopy management, pruning, uniconazole, Sunny®

INTRODUCTION

Canopy management is a significant challenge for the Australian avocado industry. Effective strategies to optimise light penetration, maximise and maintain fruit quality and

yield, reduce production costs, and improve efficiency of harvesting and spraying operations are essential.

The basic problem with overcrowded orchards is insufficient light (Stadler and Stassen, 1985). There are several systems to manage tree size and improve light interception and penetration, including selective limb removal (individual limbs are removed to maintain tree size and inter-row access); mechanical pruning (trees are pruned to form a hedgerow); stag-horning (trees are pruned back to a stump and allowed to re-grow); tree thinning (alternate rows or trees within a row are removed as orchards begin to crowd) and tree removal (whole blocks removed after 10-15 years and replaced with new trees).

In South Africa, results indicate that mechanical pruning can be implemented without adversely affecting yields during the early stages of crowding (Stassen *et al*., 1999a). However in heavily crowded orchards, drastic pruning immediately after harvest resulted in no yield the following year. Several researchers have shown that a hedgerow system, with trees closer together in the row and with more space between rows, is the best way of improving light interception (Cain, 1972; Stadler and Stassen, 1985; Stassen and Davie, 1996). To ensure optimal light penetration a pyramidal shape is preferred with a tree height no greater than 80% of the row width (Stassen and Davie, 1996; Stassen *et al*. 1999a).

Triazoles, a group of plant growth retardants that inhibit gibberellin biosynthesis (Davis *et al*., 1988) have been reported to reduce vegetative growth and increase fruit size in avocado (Köhne and Kremer-Köhne, 1987; Köhne, 1988; Adato, 1990; Wolstenholme *et al*., 1990; Whiley *et al*., 1991; Erasmus and Brooks, 1998; Penter *et al*., 2000; Whiley, 2001). Foliar application of uniconazole (Sunny®) at flowering to increase fruit size has been recently registered for the Australian avocado industry.

Mineral nutrition of avocado has a significant effect on postharvest quality (Whiley and Hofman, 2000). Calcium is the most frequently implicated mineral and there are numerous reports on its effect on fruit quality (Hofman and Smith, 1994). Low fruit Ca concentrations have been associated with several undesirable fruit characteristics, including rapid softening after harvest (Wills and Tirmazi, 1982), susceptibility to chilling injury (Chaplin and Scott, 1980) and flesh disorders (Bower and Cutting, 1988; Cutting *et al*., 1992; Thorp *et al*., 1997). The incidence of anthracnose following postharvest handling has also been reported to increase with low concentrations of fruit Ca (Vuthapanich, 2001).

This paper reports on the results of pruning and uniconazole (Sunny®, Sumitomo Chemical Australia Pty Ltd) on shoot growth, flowering, yield and fruit quality in ‘Hass’ avocado. The effect of pruning on fruit mineral concentration was also examined. The objectives of the current canopy management research titled “The development of canopy management strategies across Australia for increased profitability” are also outlined.

MATERIAL AND METHODS

In all experiments trees were mechanically pruned at an angle of 15-20°from the vertical

to form a pyramid following harvest in June-September and during summer following maturation of the spring growth flush in December-February. Foliar applications of 1% Sunny® were applied at mid-bloom and when regrowth following summer pruning reached a maximum of 100 mm. Trees were sprayed to the point of run-off using a motorised backpack spray unit. Agral® a non-ionic wetter at 0.05% was included in all Sunny® applications.

Experiment 1

Trees and treatments

In 2000/01, six-year-old 'Hass' trees were harvested in August 2000 and pruned at an angle of 15°after harvest on the 11 September. Trees were unsprayed or sprayed with 1% Sunny® at flowering at 2.25 L per tree for pruned trees or 3 L per tree for unpruned trees on the 25 September. Trees were left unpruned or pruned again in December, January or February. Sunny® was applied at 1% to the summer growth in trees not pruned during the summer at 2.25 L per tree on the 15 January 2001. Regrowth in trees pruned on the 18 December, 19 January or 19 February was treated with Sunny® at 2.25 L per tree on the 15 January, 19 February and 27 March, respectively. There were 12 treatments with six trees per treatment (Table 1).

In 2001/02 trees were re-pruned at an angle of 15°after harvest on the 25 August 2001. Trees were unsprayed or sprayed with 1% Sunny® at flowering at 2.25 L per tree for pruned trees or 3 L per tree for unpruned trees on the 17 September. Trees were left unpruned or pruned again in December, January or February. Sunny® was applied to the summer growth in trees not pruned during the summer at 2.25 L per tree on the 18 January 2002. Regrowth in trees pruned on the 18 December, 18 January or 22 February was treated with Sunny® at 2.25 L per tree on the 18 January, 22 February and 25 March, respectively.

Table 1. Pruning and Sunny® treatments on 'Hass' avocado (Experiment 1).

Treatments
1. Unpruned
2. Unpruned + 1% Sunny® at flowering
3. Unpruned + 1% Sunny® on summer growth
4. Pruned after harvest
5. Pruned after harvest + 1% Sunny® at flowering
6. Pruned after harvest + 1% Sunny® on summer growth
7. Pruned after harvest and in December
8. Pruned after harvest and in December + 1% Sunny® on regrowth
9. Pruned after harvest and in January
10. Pruned after harvest and in January + 1% Sunny® on regrowth
11. Pruned after harvest and in February
12. Pruned after harvest and in February + 1% Sunny® on regrowth

Yield and fruit size

In 2001 and 2002 trees were harvested on the 3 July and 1 August, respectively. The number and weight of fruit was recorded.

Shoot growth and flowering

The effect of summer pruning and Sunny® application on shoot growth and flowering in 2000/01 and 2001/02 was assessed in 10 shoots in six trees for treatments 1, 3, 7-12 (Table 1). Shoots in unpruned trees were selected in December (after maturation of the spring growth flush), while in trees pruned in summer, shoots were tagged 4-6 weeks after pruning. The length of shoots and the number of shoots with floral buds were recorded prior to pruning in August.

Fruit quality

Twenty mature fruit were sampled from each tree from treatments 1, 4, 7 and 8 in 2001 and treatments 1, 2, 4-8 in 2002 (Table 1). Fruit were dipped in Sportak® (prochloraz at 0.05% v/v) at the laboratory for 1 min within 4 h of harvest. Fruit were stored under simulated commercial conditions: 10°C for 3 days, 5°C for 5 days, 18°C + 10ppm ethylene for 3-4 days (until fruit had sprung) and 1°C for 4 days, ripened at 20°C and assessed for quality.

Fruit quality was assessed using the Avocare Quality Assessment Manual (White *et al*., 2001). Fruit firmness was assessed using gentle hand pressure, and the days to ripe (DTR) determined as the number of days fruit were stored at 20°C until ripe. Ripe fruit were then longitudinally cut into quarters, the seed removed, and the skin peeled from the flesh. The quarters were visually rated for the severity of rots and internal disorders as the percentage of flesh volume affected. The incidence or percentage of fruit affected with these rots and disorders were determined.

Experiment 2

Trees and treatments

The effect of time of pruning after harvest on shoot growth, fruit yield and quality was investigated in seven-year-old ‘Hass’ trees. Trees were left unpruned or pruned at an angle of 20°immediately after harvest (17 June 2002), or one (11 July) or two months (13 August) later. There were six trees per treatment. Dormant shoots were present in June, floral buds in July and floral buds at the shoot tip and in leaf axes in August.

Shoot growth and yield

Growth was measured on 20 shoots in each tree at early fruit set (7 October 2002) and at harvest (5 August 2003). The number and weight of fruit harvested at maturity was recorded and the average fruit weight calculated.

Fruit quality

Twenty mature fruit were harvested from each tree, stored under simulated commercial conditions, ripened at 20ºC and assessed for quality as described earlier.

Experiment 3

Trees and treatments

The effect of pruning on the distribution of fruit within the tree was investigated over two seasons. In 2000/01, five-year-old trees were pruned after harvest at an angle of 20° on the 10 August. Trees were left unpruned or pruned again on the 18 December, 19 January or 14 February. In 2001/02, trees were re-pruned at an angle of 20º on the 2 August 2001. Trees were left unpruned or pruned again on the 21 December, 22 January or 19 February. In 2002/03, trees were re-pruned at an angle of 20º on the 12 August 2002. Trees were either left unpruned or pruned again on the 10 December, 17 January or 17 February. There were six trees per treatment.

Fruit yield and distribution

In 2002 and 2003, trees were harvested on the 17 June and 5 August, respectively and the number and weight of fruit was recorded. Fruit was harvested separately from ground level to 2 m high (bottom) and from 2 m to the tops of trees (top).

Experiment 4

Trees and treatments

The effect of pruning on fruit mineral concentration and postharvest quality was investigated at two sites.

Site 1: Six-year-old trees were left unpruned or pruned at an angle of 20º on the 2 August 2001. Trees were harvested on 17 June 2002 and the number and weight of fruit recorded in six trees per treatment.

Site 2: Eight-year-old trees were left unpruned or pruned at an angle of 18° on 21 August 2001. Trees were harvested on 26 June 2002 and the number and weight of fruit recorded in seven trees per treatment.

Fruit quality and minerals

Twenty fruit were sampled at maturity from each tree at the two sites. Fruit were stored under simulated commercial conditions, ripened at 20°C and assessed for quality as previously described. Sections of the flesh were sampled from 10 ripe fruit from each tree, oven-dried at 60°C and ground to a fine powder. Two sub-samples (0.5 g) were taken, one for nitrogen and the other for complete nutrient analysis. Nitrogen was determined after Kjeldahl digestion using sulphuric acid. The other elements including calcium were determined using an ICPOES spectrometer after digestion with nitric acid and hydrogen peroxide.

RESULTS AND DISCUSSION

Experiment 1

Yield and fruit size

In 2000/01 pruning after harvest reduced yield compared with unpruned trees (Table 2). There was no effect of additional pruning in summer or Sunny® application on yield.

Average fruit weight was increased with pruning after harvest and Sunny® at flowering. In 2001/02, trees pruned after harvest had similar yield to the unpruned trees (Table 2). However, yield was reduced when the trees were pruned again in February. Average fruit weight was greatest with Sunny® applied at flowering and especially in trees pruned after harvest.

Table 2. Effects of pruning and Sunny® on 'Hass' avocado yield and average fruit weight in 2000/01 and 2001/02 (Experiment 1). Data are means of six trees per treatment. Means followed by the same letters are not significantly different ($P > 0.05$).

	2001		2002	
Treatment	Yield (t/ha)	Av. fruit wt. (g)	Yield (t/ha)	Av. fruit wt. (g)
Unpruned	23.4a	206de	14.9ab	192cde
Unpruned + 1% Sunny® at flowering	20.7ab	230bc	15.4a	222ab
Unpruned + 1% Sunny® on summer growth	18.7abc	201e	12.9abc	182e
Pruned after harvest	10.2d	247b	14.9ab	201cd
Pruned after harvest + 1% Sunny® at flowering	13.5cd	267a	13.0abc	228a
Pruned after harvest + 1% Sunny® on summer growth	13.8cd	226c	13.6abc	183de
Pruned after harvest and in December	10.4d	232bc	10.5abcd	204bc
Pruned after harvest and in December + 1% Sunny® on regrowth	10.5d	219cde	10.3bcd	199cde
Pruned after harvest and in January	16.0bcd	214cde	10.1bcd	204bc
Pruned after harvest and in January + 1% Sunny® on regrowth	15.1bcd	219cde	9.7cd	202c
Pruned after harvest and in February	11.7d	224cd	7.4d	188cde
Pruned after harvest and in February + 1% Sunny® on regrowth	12.7cd	223cd	9.3cd	197cde

*t/ha was calculated from the tree spacing of 5 x 6 m (333 trees/ha)

Shoot growth and flowering

In both years, pruning increased new shoot length compared with no pruning (Table 3). December pruning resulted in the greatest shoot length, while Sunny® reduced shoot length in all the pruning treatments. The timing of the summer pruning also influenced flowering the following spring. Flowering was least in trees pruned in February, however application of Sunny® increased flowering in the January and February pruning treatments.

Fruit quality

In 2000/01, pruning after harvest and pruning after harvest and again in December increased the severity and incidence of diffuse discolouration in fruit stored under simulated commercial conditions compared with unpruned trees (Table 4). Sunny® reduced severity and incidence to levels statistically similar to no pruning.

Table 3. Effects of pruning and Sunny® on shoot growth and flowering in 'Hass' avocado in 2000/01 and 2001/02 (Experiment 1). Data are means of 60 shoots from six trees per treatment. Means followed by the same letters are not significantly different ($P > 0.05$).

Treatment	2000/01		2001/02	
	Shoot length (cm)	Flowering (% of shoots)	Shoot length (cm)	Flowering (% of shoots)
Unpruned	21.8ef	88ab	19.6de	92ab
Unpruned + 1% Sunny® on summer growth flush	17.5f	93a	16.0f	95a
Pruned after harvest and in December	47.9a	78bc	37.1a	85bc
Pruned after harvest and in December + 1% Sunny® on regrowth	30.0cd	92ab	26.4c	92ab
Pruned after harvest and in January	36.1b	55de	29.8b	75d
Pruned after harvest and in January + 1% Sunny® on regrowth	25.6de	75c	22.4d	87abc
Pruned after harvest and in February	35.5bc	43e	27.5bc	65e
Pruned after harvest and in February + 1% Sunny® on regrowth	26.2de	67cd	19.1e	78cd

Table 4. Effects of pruning and Sunny® on the severity and incidence of diffuse discolouration in 'Hass' fruit stored under commercial conditions and ripened at 20ºC. Fruit was harvested on 3 July 2001. Data are means of 120 fruit from six trees per treatment. Means followed by the same letters are not significantly different ($P > 0.05$).

Treatment	Diffuse discolouration	
	Severity (% of flesh)	Incidence (% of fruit)
Unpruned	0.50b	5.8b
Pruned after harvest	2.67a	40.6a
Pruned after harvest and in December	3.67a	35.8a
Pruned after harvest and in December + 1% Sunny® on regrowth	2.42ab	26.7ab

In 2001/02, body rots and diffuse discolouration severity was greatest in the trees pruned after harvest and again in December compared with the unpruned trees (Table 5). Stem-end rots were higher in trees pruned after harvest. Sunny® reduced these defects to levels similar to the unpruned treatments. There was no effect of pruning and Sunny® on the incidence of fruit disorders.

Table 5. Effects of pruning and Sunny® on the severity of body and stem-end rots and diffuse discolouration of the flesh in 'Hass' fruit stored under commercial conditions and ripened at 20ºC. Fruit was harvested on 1 August 2002. Data are means of 120 fruit from six trees per treatment. Means followed by the same letters are not significantly different ($P > 0.05$).

Treatment	Severity (% of flesh affected)		
	Body rots	Stem-end rots	Diffuse discolouration
Unpruned	0.73bc	0.01b	0.13b
Unpruned + 1% Sunny® at flowering	0.38c	0.04b	0.14b
Pruned after harvest	1.19ab	0.26a	0.21b
Pruned + 1% Sunny® at flowering	1.08b	0.11ab	0.24b
Pruned after harvest and in December	1.68a	0.11ab	0.51a
Pruned after harvest and in December + 1% Sunny® on regrowth	0.81b	0.07b	0.04b

Experiment 2

Shoot growth and yield

Shoot growth was greatest in trees pruned immediately after harvest, while pruning 1-2 months after harvest resulted in similar shoot length to the unpruned trees (Table 6). All pruned trees had lower yields, despite increased fruit weight. There was no effect of pruning time on yield or fruit weight.

Table 6. Effect of time of after-harvest pruning on shoot growth, yield and average fruit weight in 'Hass' avocado in 2002/03 (Experiment 2). Data are the means of six trees per treatment. Means followed by the same letters are not significantly different ($P > 0.05$).

Treatment	Shoot growth		Yield (t/ha)*	Av. fruit wt.(g)
	7/10/02	5/08/03		
Unpruned	4b	17b	26.0a	180b
Pruned immediately after harvest	15a	31a	18.3b	203a
Pruned one month after harvest	8b	22b	19.5b	205a
Pruned two months after harvest	6b	20b	19.7b	197a

*t/ha was calculated from the tree spacing of 10 x 5 m (200 trees/ha).

Fruit quality

Trees pruned immediately after harvest or one month later had a higher incidence of fruit body rots compared with unpruned trees (Table 7). There was no difference in incidence between the unpruned trees and those pruned two months after harvest.

Table 7. Effect of time of after-harvest pruning on the incidence of body rots in 'Hass' avocado fruit in 2002/03 (Experiment 2) that were stored under simulated commercial conditions and ripened at 20ºC. Data are means of 120 fruit from six trees per treatment. Means followed by the same letters are not significantly different (*P* > 0.05).

Treatment	Body rots (% of fruit affected)
Unpruned	8.27c
Pruned immediately after harvest	40.6a
Pruned one month after harvest	27.5ab
Pruned two months after harvest	18.8bc

Experiment 3

Fruit yield and distribution

In 2001/02, pruning reduced yield compared with unpruned trees (Table 8). Pruning after harvest and again in February resulted in the lowest yields. However in 2002/03, there was no effect of pruning on yield. Pruning also increased the number of fruit harvested in the lower section of the tree (Table 8).

Table 8. Effect of pruning on fruit yield and distribution of 'Hass' avocado in 2002 and 2003 (Experiment 3). The percentage of the total number of fruit harvested from the lower section (ground level to 2 m high) of the tree is presented. Data are means of six trees per treatment. Means followed by the same letters are not significantly different (*P* > 0.05).

Treatment	Yield (t/ha*)	% of fruit harvested at 0-2m height	Yield (t/ha*)	% of fruit harvested at 0-2m height
Unpruned	20.7a	29d	26.0a	12b
Pruned after harvest	11.7b	42c	26.0a	21a
Pruned after harvest and in December	12.6b	50b	25.4a	20a
Pruned after harvest and in January	10.3b	51ab	20.2a	21a
Pruned after harvest and in February	5.5c	55a	23.2a	23a

*t/ha was calculated from the tree spacing of 10 x 5 m (200 trees/ha).

Experiment 4

Site 1

Pruning reduced yield with 9.0 t/ha compared with 19.0 t/ha in unpruned trees. Pruning accelerated ripening with fruit becoming soft in 7.7 days after removal from storage

compared with 8.3 days in unpruned trees. Pruning after harvest also increased the severity of stem-end rots and vascular browning and decreased fruit calcium concentrations in the fruit flesh (Table 9).

Table 9. Effect of pruning on the severity (% of flesh affected) of stem-end rots and vascular browning and fruit Ca concentration in 'Hass' avocado fruit (Experiment 4: Site 1) stored under commercial conditions and ripened at 20ºC. Means followed by the same letters are not significantly different ($P > 0.05$).

Treatment	Severity (% of flesh affected)		Fruit Ca concentration (%)
	Stem-end rots	Vascular browning	
Unpruned	0.11b	0.27b	0.060a
Pruned after harvest	0.59a	0.78a	0.046b

Site 2

Pruning reduced yield to 4.5 t/ha compared with 10.9 t/ha in unpruned trees. Pruning accelerated ripening with fruit becoming soft in 2.8 days after removal from storage compared with 4.7 days in unpruned trees. There was no effect of pruning on the severity or incidence of fruit rots and disorders. However pruning reduced calcium and increased nitrogen concentrations in the fruit flesh (Table 10).

Table 10. Effects of pruning on fruit mineral concentration in 'Hass' avocado (Experiment 4: Site 2). Calcium (Ca), nitrogen (N) as % of dry mass and the N/Ca ratio are presented. Means followed by the same letters are not significantly different ($P > 0.05$).

Treatment	Flesh concentration (%)		N/Ca
	Ca %	N %	
Unpruned	0.032a	0.88b	27.9a
Pruned after harvest	0.025b	1.11a	46.7b

CONCLUSIONS

The results of these trials indicate that pruning can reduce yield in trees pruned for the first time but after 2-3 years there was no significant difference between pruned and unpruned trees. A considerable amount of growth was removed (2-2.5 m) in the first year compared with 1 m in the following years. Penter and Snijder (2001) found trees pruned for the first time had a negative effect on yield due to removal of large branches. However there was no significant effect of pruning on yield in the second year. Stassen *et al*. (1999a) showed that orchards in the initial stages of crowding can be selectively or mechanically pruned without adversely affecting yields. In heavily crowded orchards, drastic pruning immediately after harvest resulted in no yield the following year.

Pruning can stimulate vegetative growth and the timing of the post-harvest prune will influence the amount of regrowth during flowering and fruit set. In the warmer

production areas where the harvest is completed before flowering, pruning soon after harvest can induce vegetative growth that may compete with the developing fruit and reduce fruit quality. In southeast Queensland pruning 'Hass' immediately after harvest increased regrowth and the incidence of fruit body rots compared with unpruned trees. However, there was no significant effect of pruning two months after harvest on regrowth and body rots compared with unpruned trees. This increased growth competes with the developing fruit, and is the most likely cause for the increased rots in the early pruned trees.

Stassen *et al*. (1999b) suggest that pruning is not a one-off operation and follow-up summer pruning is required. Summer pruning is dependent on establishing and maintaining the tree shape established before fruit set so that mechanical pruning can be implemented in the presence of the crop. The timing of the summer prune influences the length of regrowth and ultimate increase in tree size. Pruning in mid to late summer in southeast Queensland reduced flowering the following spring and subsequent yield. In 2000/01 (Experiment 1) 55 and 43% of the shoots flowered in trees pruned in January and February, respectively compared with 88% in unpruned trees. Therefore summer pruning is a compromise between controlling shoot growth and reducing the risk of removing flowering wood. Trees should be pruned no later than December to avoid reduced flowering in shoots the following spring.

Foliar application of Sunny® at flowering increased fruit size by 12-16%, reduced regrowth length and increased flowering the following spring in trees pruned in January and February, and reduced the severity of diffuse discolouration and body and stem-end rots when applied at flowering in pruned trees and to regrowth in trees pruned in December. Application of Sunny® at mid-bloom has been reported to increase fruit size and yield (Erasmus and Brooks, 1998; Penter *et al*., 2000; Whiley, 2001) and improve fruit quality by reducing flesh discolouration in 'Hass' following storage of fruit at 5ºC for 4 weeks (Whiley, 2001).

Pruning altered the distribution of fruit within the tree. A greater percentage of the fruit was picked from the lower section (0-2 m) of the tree in pruned trees. This may increase the efficiency of harvesting and spraying operations.

Pruning after harvest reduced the Ca concentrations in the fruit. Low fruit Ca has been associated with poor fruit quality and the reduction in Ca levels observed in the fruit sampled from trees pruned after harvest may be responsible for the increase in fruit rots and disorders. Fruit Ca concentrations are influenced by several factors, including soil Ca, tree vigour, rootstocks, N nutrition and crop load. Competition between vegetative and reproductive growth, especially in the 6-10 weeks after fruit set has been reported to effect fruit Ca concentrations (Witney *et al*., 1990).

This research was conducted on 'Hass' avocado in southeast Queensland. In this warm subtropical climate the crop can be harvested up to several months prior to flowering. However, there is the need to identify and develop successful canopy management strategies in other growing areas (eg. in cooler, temperate climates where fruit is present on the tree during flowering) before wider industry recommendations can be made.

Current canopy management project

The objective of the current project is to identify canopy management strategies that can be successfully implemented in all major avocado growing areas across Australia. Several sites have been selected from each region and information on variety, tree age and spacing, nutrition, irrigation and other management practices, and the timing of flowering, vegetative flushing cycles and harvesting at each site is being recorded. The effectiveness of each canopy management system in terms of cost of operation, impact on yield, fruit size and quality, tree size control and the net return per hectare will be evaluated.

In addition strategies to improve the canopy management systems will be evaluated. The use of other growth regulators, such as naphthalene acetic acid (NAA) for regrowth control and prohexadione-calcium (a GA biosynthesis inhibitor) to reduce shoot growth and improve yield and fruit quality will be investigated under Australian conditions.

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