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EFFECTS OF IRRIGATION AND FOLIAR CULTAR® ON FRUIT YIELD AND QUALITY OF 'HASS' AVOCADO FRUIT

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Abstract

The effects of irrigation and foliar Cultar® on fruit yield and quality of 'Hass' avocados growing in a warm, humid subtropical climate were studied during the growing season of 1993/94. Seven-year-old trees were re-watered to field capacity when tensiometer readings reached 20, 40 or 70 kPa, and fruit growth, yield and quality were assessed. Well-watered trees (20 kPa) had twice the yield of the least watered trees (70 kPa) due mainly to higher fruit numbers and more consistent yield between trees. Fruit quality (size, shelf life, disease and disorders, and fruit minerals concentration) was not affected by irrigation regimes.

Seven-year-old 'Hass' trees were either fertilised with 1 kg tree^{-1} of urea at panicle emergence, foliar sprayed with 2.5 g a.i.L^{-1} Cultar® at mid-bloom, both urea and Cultar® treatments applied, or untreated. The urea + Cultar® combination increased fruit size, with a greater percentage of fruit in the larger size categories. Cultar® alone increased the days from harvest to maximum ethylene production at 22ºC, and fruit calcium concentrations.

1. Introduction

Predictability of fruit quality is important for most markets. Recent studies have identified considerable variability in avocado fruit quality and postharvest performance (Hofman et al., 1995). Production factors (e.g. locality, soil type, climate, cultivar, nutrition and irrigation) have a significant impact on quality and postharvest performance of fruit (Hofman and Smith, 1994).

Irrigation practices and Cultar® (paclobutrazol) have been developed to enhance fruit yield and maturity (based on % dry matter; DM) through water stress and a reduction in vegetative growth at critical stages of fruit ontogeny. However there has been relatively little assessment of these practices on postharvest quality. This paper reports the effects of irrigation and Cultar® (ICI Australian Operations Pty Ltd) on 'Hass' avocado fruit yield and quality.

2. Materials and methods

2.1 Irrigation

Seven-year-old 'Hass' avocado trees growing on clay loam soil (krasnozern) were selected in a commercial orchard in SE Queensland, latitude 20'S. The climate is described as warm, humid subtropical with a mean annual rainfall of 1000 mm in a summer/wet, winter/dry pattern. Trees were irrigated over a cropping cycle to field capacity using under-tree micro-sprinklers when tensiometer readings at 30, cm soil depth reached 20, 40 or 70 kPa. Ten uniform trees per row were used, with each row receiving one of the irrigation treatments.

Fruit dimensions, dry matter (DM) and flesh mineral concentrations were determined at regular intervals from six weeks after anthesis, and tree yield, fruit number and size recorded at maturity. Twenty fruit of average size were harvested from each tree and immediately dipped in 0.55 $mL.L^{-1}$ prochloraz for 30 sec. Ten fruit per tree were ripened at 22T under humidified, ethylene-free air in ventilated containers, and the other 10 fruit stored at 7ºC for 3 weeks, then ripened at 22ºC as above. Ethylene production was measured by gas chromatography, and days to eating soft and disease incidence recorded.

2.2. Cultar®

The experimental trees and orchard site were similar to those described above. The following treatments were applied to each of five single tree replications, in a randomised block design:

1. untreated control (standard commercial practice),
2. urea, soil applied at the rate of 30% of annual N (1 kg $tree^{-1}$) at panicle emergence,
3. Cultar® , sprayed at the rate of 2.5 g a. i. L^{-1} at full bloom, and
4. treatments 2 and 3 combined.

Fruit measurements, sampling and harvest procedures were as above.

3. Results

3.1. Irrigation

Fruit yield was greatest when trees were more frequently irrigated (20 kPa), due mainly to increased fruit number (table 1). There was no significant effect of irrigation on average fruit mass (data not presented). Reduced irrigation increased the variation in yield between individual trees, with a greater number of trees having either low or high fruit numbers, but less trees with intermediate fruit numbers per tree (table 2). Fruit from the most frequently irrigated treatment (20 kPa) tended to ripen more slowly, but not significantly different to other treatments (table 1). All other quality parameters measured [days to maximum ethylene production (DMEP) and eating soft after storage, disease severity, internal disorders and fruit minerals concentrations] were not affected by irrigation.

3.2 Cultar®

Fruit from Cultar®-treated trees had a lower length: diameter ratio (figure 1) due to larger fruit diameter (data not presented). Total fruit yield per tree was not affected by treatment, but the use of Cultar® produced greater numbers and yield of fruit which exceeded 3001 (table 3). Average fruit mass was higher in urea + Cultar® -treated trees only. Cultar® alone reduced fruit % DM, increased flesh Ca concentrations, and increased DMEP at 220C (table 3), but not following storage at 7ºC for 3 weeks (data not presented). There was a significant correlation ($r2 = 0.54^{**}$) between DMEP and flesh Ca concentrations (data not presented). No internal disorders were observed.

4. Discussion

Differing effects of irrigation have been reported for avocado (Bower, 1985; Arpaia, 1989), but irrigation treatment, soil type, rainfall and other factors can make comparisons difficult. In this experiment, yield was the only parameter improved by increased irrigation, however increased variability in yield between trees with lower irrigation is an important consideration in future investigations. Bower (1985) noted higher Ca concentrations in fruit from trees irrigated at 55 kPa than those from trees at 35 and 80 kPa, indicating that irrigation may have positive effects on fruit quality through fruit Ca. Timing of irrigation can also be important (Bower, 1985), and further investigations into this aspect are warranted.

Cultar® has increased avocado yield in previous studies (Wolstenholme et al., 1990; Kremer-Köhne et al., 1991; Whiley et al., 1991), but this effect has not always been observed (Cutting and Bower 1990; Symons and Wolstenholme 1990). Kremer-Köhne et al. (1991) found that a yield increase in 'Fuerte' only occurred in a low-yield (“off”) year when an ultra-low volume spray application of Cultar® was used, indicating some of the factors affecting treatment response. An increase in the percentage of larger fruit was also found by Symons and Wolstenholme (1990), which is desirable in reducing the small size problem in 'Hass'.

Increases in fruit flesh Ca concentration following foliar Cultar® applications have been reported in previous studies (Cutting and Bower, 1990; A.W. Whiley, pers. comm.). The observed increase in shelf life may have been because of the reduced maturity (based on % DM; Vuthapanich et al., 1995) or the higher flesh Ca.

The positive effects of urea plus Cultar® on tree yield and fruit size may be due to increased photosynthetic efficiency of the over-wintered leaves subtending the early-developing fruits (Whiley, 1994) along with delayed and reduced growth of the renewal spring shoot (Wolstenholme et al., 1990). This treatment shows potential to increase yield and size, with little negative impact of other aspects of fruit quality. This research is being continued for a further season on the same trees to determine consistency of treatment effects.

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Table 1 - Effect of irrigation application at different soil matric potentials (kPa) on yield of 'Hass' avocado trees, and days from harvest to eating soft of fruit at 22°C. "*" indicates significance ($P \leq 0.05$) using weighted variances.

Irrigation Treatment	Fruit Yield kg tree^{-1}	Fruit Yield Fruit no. tree^{-1}	% dry matter	Days to eating soft
70 kPa	40	238	26.08	18.5
40 kPa	44	280	25.87	19.4
20 kPa	81	461	24.91	20.2
lsd	*	*	ns	ns

Table 2 - Effect of irrigation application at different soil matric potentials (kPa) on the number of 'Hass' avocado trees yielding different numbers of fruit tree^{-1}.

Irrigation treatment	Number of trees in each yield category (fruit no. tree^{-1})					
	Nil	1-200	201-400	401-600	601-800	>800
20 kPa	0	0	4	3	2	1
40 kPa	0	5	1	3	1	0
70 kPa	0	7	0	1	2	0

Table 3 - Effect of foliar Cultar® sprays and soil applied urea to 'Hass' avocado trees on average fruit mass and size distribution, % dry matter, flesh calcium (Ca) concentration, and days to maximum ethylene production and to eating soft at 22°C. Values in columns with different letters are significantly different ($P \leq 0.05$).

Treatment	Average fruit mass (g)	Fruit > 300 g		Flesh Ca (mg kg^{-1})	% dry matter	DMEP
		kg $tree^{-1}$	Fruit no. $tree^{-1}$			
Control	196 a	11.6 a	44 a	317 a	25.1 ab	12.0 a
Urea	208 ab	16.0 ab	61 ab	304 a	25.6 a	13.7 ab
Cultar®	213 ab	38.6 bc	139 b	422 b	22.9 b	16.7 b
Urea+Cultar®	233 b	39.4 c	142 b	343 ab	24.7 ab	14.1 ab
lsd	28	22.8	81	102	2.5	3.5

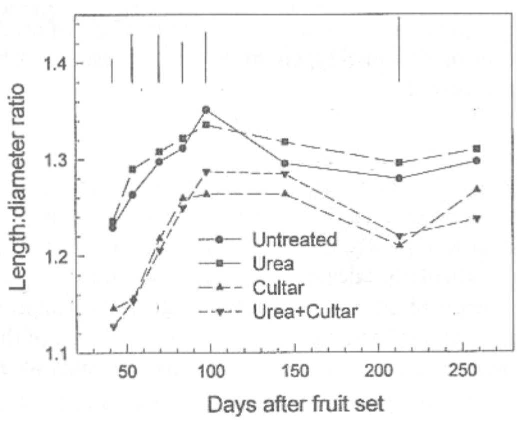

Figure 1 - Effect of Cultar® sprays and soil-applied urea on the length:diameter ratio of 'Hass' avocado fruit during fruit growth. Bars indicate lsd (5%).