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Effect of cincturing on growth and flowering of lychee: preliminary observations in subtropical Queensland

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Summary. The effect of cincturing on growth and flowering of three lychee (*Litchi chinensis*) cultivars (Bengal, Brewster and Tai So) was investigated at four sites in subtropical southern Queensland. Cultivars at these sites displayed a range in the level of natural vegetative dormancy in winter (38–95% of terminal branches) and flowering in spring (25–100% of terminal branches). There was an inverse relation ($r = 0{\cdot}093$; $P < 0{\cdot}005$) between the flowering response to cincturing and potential flowering as indicated by the flowering of the control trees; cincturing reduced flowering in those trees that would otherwise have flowered profusely in spring (70–100%). This occurred when the cincture healed prematurely to allow vegetative flushing in winter. Since these preliminary results suggest that some loss of yield may occur in years and cultivars with good flowering, further work is required before cincturing can be recommended as a standard horticultural practice in lychee cultivation.

Introduction

Interest has developed in Australia in producing lychees (*Litchi chinensis*) for local consumption and export to Asia (Australian Bureau of Agricultural Economics 1984). Small commercial plantings have been made in coastal northern Queensland, central and southern Queensland and northern New South Wales. Yields from these plantings have been low and irregular, probably because of poor flowering in spring, which could be due to winters not being cool or dry enough to satisfy the dormancy requirement of the trees.

Cincturing has been shown to reduce vegetative flushing and induce flowering of lychee in Hawaii and Florida, although the results have not always been consistent (see Menzel 1983). It is not known if cincturing reduces flowering and yield when it is performed on lychee trees that were about to flower profusely. In the case of avocado (Malo 1971), citrus (Cohen 1981) and olive (Lavee *et al.* 1983), cincturing trees that were about to crop heavily actually reduced yield. This suggests that yields may decrease in years when vegetative dormancy is maintained naturally during autumn through to winter.

Only limited information has previously been published on the response of lychees to cincturing in Australia (Paxton and Menzel 1983). This paper describes the effects of cincturing on growth and flowering of lychee cultivars in subtropical Queensland (27°S).

Materials and methods

The sites, cultivars and dates of cincturing are listed in Table 1. Although no specific climatic data were available during the experiment, Beerwah is relatively drier and cooler during winter than the other sites. Soil types are sandy-loam on a clay subsoil at Woombye, Beerwah and Brookfield and deep clay at Palmwoods. Elevation above sea level is less than 50 m at all sites.

Trees were cinctured after maturation of the post-harvest vegetative flush. A cut with a hacksaw 3 mm wide and of similar depth was made to remove a layer of bark and cambium down to the central hardwood 10 cm above the base of the trunk. The cut was covered with a saturated paste of copper oxychloride to limit disease infection. Adjacent control, uncinctured trees were left for comparison in randomized complete blocks.

A monthly (May–October) record was kept of vegetative dormancy and flowering (panicle formation) in the terminal branches until the end of fruit set. Trees were also assessed for healing of the cincture and given a rating from 0 (no healing) to 10 (complete healing of cincture circumference with the callus above the level of the bark).

Dormancy and flowering data are expressed as a percentage of the terminal branches on a tree, recorded as visual estimates by two observers working independently.

Table 1. The effect of cincturing on flowering of lychee cultivars
Data are the means of six trees expressed as a percentage of terminal branches. Trees were cinctured after maturation of the post-harvest flush.

Site and cultivar	Tree age (years)	Tree vigour	Date of cincturing	Flowering (%) Control	Flowering (%) Cinctured	Month of fruit set Control	Month of fruit set Cinctured
Palmwoods							
Bengal	8	Medium	24 March 1983	72·5	86·7	October	October
Tai So	8	Medium	24 March 1983	100·0	12·5*	September	September
Woombye							
Tai So	6	High	10 March 1983	47·5	95·8*	October	September
Beerwah							
Tai So	4	Medium	24 March 1983	93·3	40·0*	August	September
Brookfield							
Bengal	6	Medium	10 May 1983	63·3	31·6*	September	October
Brewster	6	Medium	10 May 1983	25·0	70·0*	October	October
Tai So	6	High	10 May 1983	63·3	78·3	August	August

*Differences between control and cinctured trees significant ($P<0.01$).

Results

Growth and flowering

Cincturing increased the level of flowering in cv. Tai So at Woombye and cv. Brewster at Brookfield, and decreased flowering in cv. Tai So at Palmwoods and Beerwah and cv. Bengal at Brookfield (Table 1). With the exception of the last cultivar, these responses were associated with an increase and decrease in the level of dormancy, respectively (Table 2). Cincturing had only a slight effect on the level of dormancy and flowering in cv. Bengal at Palmwoods and cv. Tai So at Brookfield.

Relationship between flowering in spring and vegetative dormancy in winter

There was a strong relationship between level of flowering on terminal branches and percentage of terminal branches that were dormant in winter, for both cinctured and uncinctured trees, taken together (Fig. 1). Trees that were dormant in winter flowered better than trees that had flushed, with only one exception (cv. Bengal after cincturing at Brookfield), for which there is no obvious explanation.

Table 2. Effect of cincturing on the percentage of terminal branches dormant in lychee cultivars
Data are the means of six trees (±s.e.)

Site and cultivar	May Control	May Cinctured	June Control	June Cinctured
Palmwoods				
Bengal	75·0±6·0[A]	72·5±6·9[A]	70·0±5·3	67·5±11·3
Tai So	95·0±2·5[B]	47·5±13·3[A]	100·0±0·0	87·5±5·1
Woombye				
Tai So	40·0±10·3[A]	90·8±2·3[A]	24·6±5·5	30·0±7·9
Beerwah				
Tai So	85·0±12·2[A]	38·3±6·5[A]	41·7±15·7	38·4±18·0
Brookfield				
Bengal	68·3±8·7[B]	100·0±0·0[B]	44·5±6·2	90·0±4·5
Brewster	38·4±9·9[A]	96·7±10·1[B]	31·5±6·2	69·5±10·1
Tai So	48·0±17·7[A]	90·0±9·1[A]	34·5±6·1	42·0±6·8

[A]Panicle emergence in June.
[B]Panicle emergence in July.

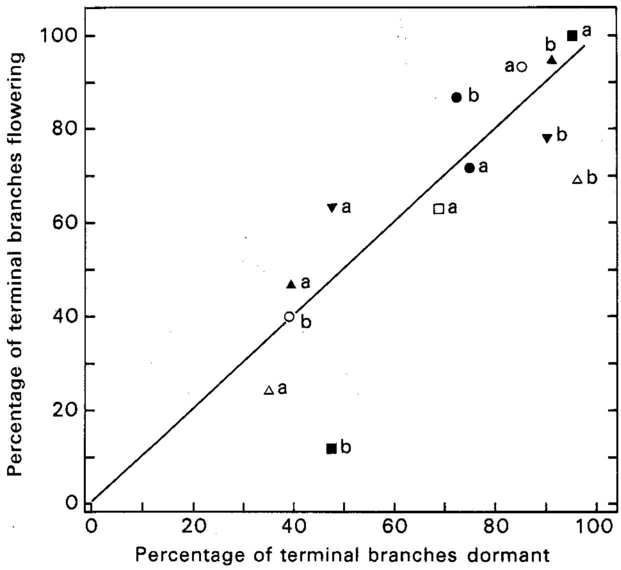

Fig. 1. Relationship between the maximum level of flowering on terminal branches of lychee in spring and vegetative dormancy in winter. Data for vegetative dormancy were recorded 1–2 months after cincturing (May–June). Data are the means of six trees. ● Palmwoods, Bengal; ■ Palmwoods, Tai So; ▲ Woombye, Tai So; ○ Beerwah, Tai So; □ Brookfield, Bengal; △ Brookfield, Brewster; ▼ Brookfield, Tai So; **a**, control; **b**, cinctured. Cultivar Bengal cinctured at Brookfield not included in analysis (see text). $y = 1{\cdot}4 + 0{\cdot}9x$ ($r = 0{\cdot}84$, $P < 0{\cdot}025$).

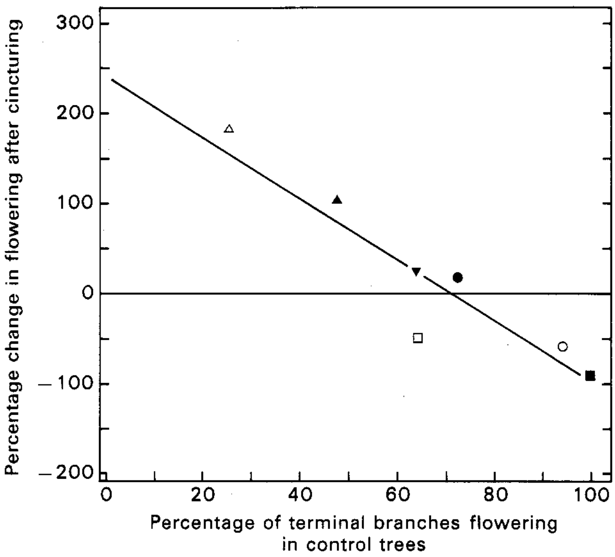

Fig. 2. Relationship between flowering response of lychee to cincturing and level of flowering in control, uncinctured trees. ● Palmwoods, Bengal; ■ Palmwoods, Tai So; ▲ Woombye, Tai So; ○ Beerwah, Tai So; □ Brookfield, Bengal; △ Brookfield, Brewster; ▼ Brookfield, Tai So. $y = 249 - 3{\cdot}5x$ ($r = 0{\cdot}93$, $P < 0{\cdot}005$).

Relationship between flowering response to cincturing and level of flowering in control trees

There was an inverse relationship between the flowering response to cincturing and the level of flowering in control, uncinctured trees (Fig. 2), cincturing increased flowering in those trees that would have had a low bloom in spring and reduced flowering in those trees that would have flowered profusely. Cincturing had only a slight effect on the level of flowering in those cultivars in which about 60–80% of the terminal branches flowered in the controls.

Cincture healing and tree health

Most of the cinctures did not begin to heal until fruit set (Table 3). The exceptions were cultivar Tai So at Palmwoods and Beerwah, where healing began soon after cincturing. This earlier recovery was associated with vegetative flushing during winter (Table 2). A few cinctured trees displayed leaf scorching and chlorosis, but none died during the experiment.

Table 3. Cincture healing in lychee cultivars
Data are the means of six trees (±s.e.)

Site and cultivar	May	June	July	Aug.	Sept.	Oct.
Palmwoods						
Bengal	0·0±0·0[A]	1·0±0·2	1·7±0·2	2·8±0·2	3·5±0·1	3·7±1·0
Tai So	3·7±0·2	6·3±0·2	7·2±0·2	7·3±0·2	7·8±1·0	7·8±1·0
Woombye						
Tai So	0·0±0·0	0·0±0·0	1·0±0·2	1·5±0·1	2·2±0·1	2·9±0·1
Beerwah						
Tai So	3·7±0·2	6·6±0·1	7·0±0·1	7·2±0·2	7·6±0·1	7·9±0·1
Brookfield						
Bengal	—	0·0±0·0	0·7±0·2	1·2±0·1	1·8±0·2	2·3±0·3
Brewster	—	0·0±0·0	0·8±0·4	1·2±0·1	1·5±0·2	1·8±0·3
Tai So	—	0·0±0·0	1·0±0·3	1·5±0·3	1·8±0·2	2·3±0·2

[A]0, no healing; 10, complete healing with callus above level of bark.

Discussion

It is generally believed that the lychee needs a period of vegetative dormancy after the post-harvest flush in order to initiate floral buds for the spring (Menzel 1983). In these experiments, trees that had a high proportion of branches dormant flowered better than those in which the growing points were vegetatively active. There was a strong correlation between the incidence of flowering in spring and the degree of vegetative dormancy in May–June; vegetative flushing just before the normal period of floral initiation (July) resulted in little or no flowering. Similar results were recorded by Shigeura (1948) and Nakata (1953) in Hawaii. Shigeura (1948), using auxin applications to restrict vegetative flushing, demonstrated a strong correlation ($r = 0{\cdot}94$) between the incidence of flowering and the degree of vegetative dormancy. He concluded that trees must be in a dormant state during November and December to initiate floral buds in January. Nakata (1953) showed that cincturing did not promote flowering in trees that had flushed late in the season. The best results were obtained by cincturing 2–3 months before floral initiation. In the present experiment, the Woombye site, which was cinctured earliest, gave the largest response (Table 1).

There was an inverse correlation between the flowering response to cincturing and the potential flowering of control trees. Cincturing promoted flowering when it induced dormancy in winter and depressed flowering when it reduced or delayed dormancy. Reductions in flowering after cincturing have not previously been recorded in lychee, although Lavee *et al.* (1983) demonstrated a similar response in three olive cultivars in Israel; cincturing reduced yield when it was practised in orchards with very high production. It is not known what factors might be responsible for the reduction in winter dormancy and spring flowering in those trees that are about to flower profusely. These results suggest that some loss of yield may occur in good flowering years if the cincture is not complete or heals too early to allow growth flushing.

Most of the work on lychee cincturing in Florida and Hawaii has been carried out on small limbs (rather than whole trunks) which are slow to heal (Menzel 1983). Hence, there was a smaller chance of premature callusing and therefore winter flushing. The relationship in Fig. 2 is true only for cinctures that heal quickly (narrow diameter in vigorous cultivars). In years where the cincture is slow to heal, cincturing does not induce vegetative flushing and therefore does not reduce flowering to levels below those of the controls (C. M. Menzel and D. R. Simpson, unpublished data 1985).

A flush of growth during winter following cincturing suggests that either the cincture was not complete or that the cincture healed before it was effective. To be effective the cincture should remain 'open' for 2–3 months. This suggests that for vigorous cultivars (e.g. Tai So) a wider cut could be used. Similarly a wider cut could be used for larger diameter stems. However, there is the chance that a wide cut may not recover by the time of fruit set, with the result that fruit growth is severely restricted.

Our observations suggest that the flowering response to cincturing is not influenced by cultivar, but rather by the degree of potential flushing and flowering (as indicated by the control uncinctured trees), which varied with site. Nakata (1956) stated that he achieved good results from cincturing Brewster, Haak Yip and Tai So, but not from the less-vigorous No Mai Chee. He did not, however, present any data. Increases in yield following cincturing have been obtained with both low- and high-vigour cultivars in southern Queensland (Paxton and Menzel 1983). Fruit yield was increased from 9·3 to 34·1 and 2·6 to 21·6 kg tree in Wai Chee and Tai So, respectively.

Apart from trees in which cincturing reduced the level of flowering, cincturing had only a small effect on yield and tree health. Continuous cincturing in lychee in Hawaii and Florida has been reported to lead to retarded growth, small fruit, tree death and loss of production (see Menzel 1983). Nakata (1956) recommended cincturing half a tree each year or cincturing the whole trunk in alternate years, while covering the cincture with plastic tape, hastened callusing in trees grown in subtropical Queensland (C. M. Menzel and D. R. Simpson, unpublished data 1985). Further experiments, on the tree response and possible interactions with fertilizer and water regimes, over several years are required before cincturing can be recommended as a standard horticultural practice in lychee cultivation.

We conclude that cincturing has possible beneficial effects on trees capable of less than 70% bloom, but has detrimental effects in those capable of 70–100% bloom if the cincture cut does not remain open for 2–3 months.

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