The pattern of growth, flowering and fruiting of guava varieties in subtropical Queensland

C. M. Menzel and B. F. Paxton

Maroochy Horticultural Research Station, Queensland Department of Primary Industries,
P.O. Box 5083, Sunshine Coast Mail Centre, Nambour, Qld 4560 Australia.

Summary. The seasonal pattern of development in seven guava (*Psidium guajava*) varieties grown in subtropical coastal southern Queensland was investigated to test the hypothesis that the growth pattern of some varieties is more suited to this environment. Leaf initiation commenced 4 weeks after defoliation by spraying with urea dissolved in water (250 g/litre) in September and continued for 22 weeks. Floral bud emergence and fruit set began 4–8 weeks later and continued for most of the period of shoot growth. Fruit took 14 weeks to reach maturity and the last fruit was harvested in mid-June when the trees passed into winter dormancy. Varieties varied in time to maturity, although the patterns and levels of leaf initiation, flowering and fruit set were similar. Yields ranged from 68·8 to 138·7 kg/tree.

Differences between the varieties in yield could not be attributed to any characteristic such as the rate, timing or duration of flowering, fruit set or fruit growth. There was no variety with a different growth pattern closely related to high yields under conditions at Nambour. However, some varieties appear more suited to this environment, since they set a heavier crop which ripened before fruit quality declines in winter.

Introduction

The guava (*Psidium guajava*) is a hardy tree from tropical America which produces a fruit suitable for fresh fruit and processing. It has an extremely high level of ascorbic acid (up to 10 mg/g) and has been taken to practically all tropical and subtropical countries, with substantial industries in India, Hawaii and South Africa (Knight 1980).

Guava has the potential to make a useful contribution to commercial horticulture in subtropical Australia, especially by utilizing cheaper marginal land unsuited to other horticultural crops (Batten 1984; Menzel 1985). Results indicate that some seedling guava varieties in southern Queensland (Chapman *et al.* 1979, 1981) and northern New South Wales (Batten 1981, 1983) can produce sufficiently high yields to support commercial ventures.

In establishing a local guava industry, it is important to understand the effect of genotype and management on the pattern of plant and crop development in this environment. This paper describes the seasonal patterns of growth, flowering and fruiting of seven guava varieties in subtropical coastal, southern Queensland. We examine the hypothesis that the pattern of growth of some varieties is more suited to this environment. It is anticipated that this information will aid the selection of adapted varieties.

Materials and methods

Seven processing guava varieties (Ka Hua Kula, GA11-56CSIRO, GA11-56T3, GA11-56T7, GA11-56R1T1, GA11-56R5T1 and GA11-56R5T2) grown from stem cuttings were planted in November 1980 at Nambour (Lat. 27°S) in a heavy clay soil. Trees were planted at intervals of 4·0 m in rows 6·0 m apart, equivalent to density of 416 trees/ha in a randomized block with five single tree replicates and external guard trees.

Trees were defoliated by spraying to run-off with urea dissolved in water (250 g/litre) plus wetting agent (Shirwet, 0·6 ml/litre) on 27 September 1982. Irrigation by mini-spray (after defoliation) was applied twice each week based on foliage ground cover and replacement of 80% of Class A pan evaporation, with rainfall less than 5 mm per week considered ineffective. Trees received nitrogen (122 g), phosphorus (112 g) and potassium (122 g). After defoliation, the trees were trimmed back from the interrow area and low branches were removed.

In 1982–83 (the second year of cropping), a record was kept of the number of mature leaves, unopened floral buds, open flowers and young fruitlets (< 1 cm long) on six uniform tagged branches (3 cm diameter) per tree (three facing north, three facing south) at 2-week intervals from 4 weeks after defoliation. The number of abscissed fruit under the trees was recorded every 2 weeks and fruit yield was measured weekly. Daily maximum and minimum air

Table 1. Climatic data during the experiment at Nambour

	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June
Mean daily min. temperature (°C)	10·6	11·4	15·0	17·8	18·5	18·3	18·4	15·2	14·4	10·3
Mean daily max. temperature (°C)	24·1	25·9	27·3	30·0	28·8	29·8	28·5	25·7	23·6	20·7
Total monthly precipitation (mm)	40	51	22	84	246	57	129	212	369	534
Total monthly pan evaporation (mm)	108	150	166	175	165	155	133	96	69	59

Table 2. Leaf, flower and fruitlet production of guava grown at Nambour
Values presented are means and ranges of five trees of each of seven varieties

No. of mature leaves per branch	80·5 (59·2–99·2)
Peak no. of floral buds per branch	28·7 (16·0–36·8)
Peak no. of open flowers per branch	8·4 (5·9–13·2)
Estimated flower abscission (%)	67·0 (34·0–82·4)
Total no. of fruitlets per branch	44·0 (27·0–54·4)
Total no. of abscissed fruit per tree	1639 (564–2557)
Total no. of harvested fruit per tree	639 (422–851)
Estimated fruit abscission (%)	69·2 (44·2–81·9)

temperatures, precipitation and evaporation were monitored at the site.

Results

Climatic data are presented in Table 1. Total rainfall during the experiment was 1774 mm, with 70% falling between March and June. Total pan evaporation was 1276 mm. Temperatures during the experiment were close to the long-term averages for Nambour, while precipitation was lower than average between October and December, and higher than average in May and June.

Since the timing, duration and pattern of shoot development, flowering and fruit set did not vary significantly between varieties, the data have been pooled for all seven varieties (Fig. 1). Leaf production was very rapid after defoliation, but declined with time, with few leaves emerging after fruit set. Floral bud emergence began 6 weeks after bud appearance and continued for 8 weeks. Fruit set commenced 8 weeks after defoliation and continued for 14 weeks. The 6 weeks immediately following the time of maximum fruit set (14 weeks after defoliation) was the period of highest fruit abscission.

There were very few differences in the total number of leaves, flowers and fruitlets produced by the varieties (Table 2). Consequently, the data are pooled for all seven varieties. There was no significant correlation between peak flower bud production and the number of mature leaves per branch ($r=0{\cdot}52$, $P>0{\cdot}05$). In contrast, abscissions of both premature flowers and fruitlets were proportional to the initial numbers of each organ. Flower abscission (%, y) was correlated with peak number of floral buds per branch (x) ($y=1{\cdot}93+11{\cdot}44x$; $r=0{\cdot}85$, $P<0{\cdot}05$). Fruitlet abscission (%, y) was correlated with number of fruitlets set per tree (x) ($y=37{\cdot}8+0{\cdot}014x$; $r=0{\cdot}77$, $P<0{\cdot}05$).

There was a wide range in average fruit weight and fruit yield amongst the varieties (Table 3) and no simple association between yield and fruit number ($r=0{\cdot}51$, $P>0{\cdot}05$) or average weight ($r=0{\cdot}47$, $P>0{\cdot}05$) alone. The first fruit were harvested in early March and the last in

Table 3. Peak harvest date, fruit yield and fruit weight of guava varieties at Nambour
Data are the means of five trees

Variety	Peak harvest date[A]	Fruit yield (kg/tree)	Average fruit weight (g)
GA11-56T7	6 April	98·3	116
GA11-56R5T1	4 May	108·8	161
GA11-56T3	4 May	68·8	141
GA11-56CSIRO	11 May	122·6	187
Ka Hua Kula	18 May	138·7	207
GA11-56R1T1	1 June	111·0	156
GA11-56R5T2	15 June	85·6	203
l.s.d. ($P=0{\cdot}05$)	–	38·6	35

[A]Day on which the greatest amount of fruit was harvested.

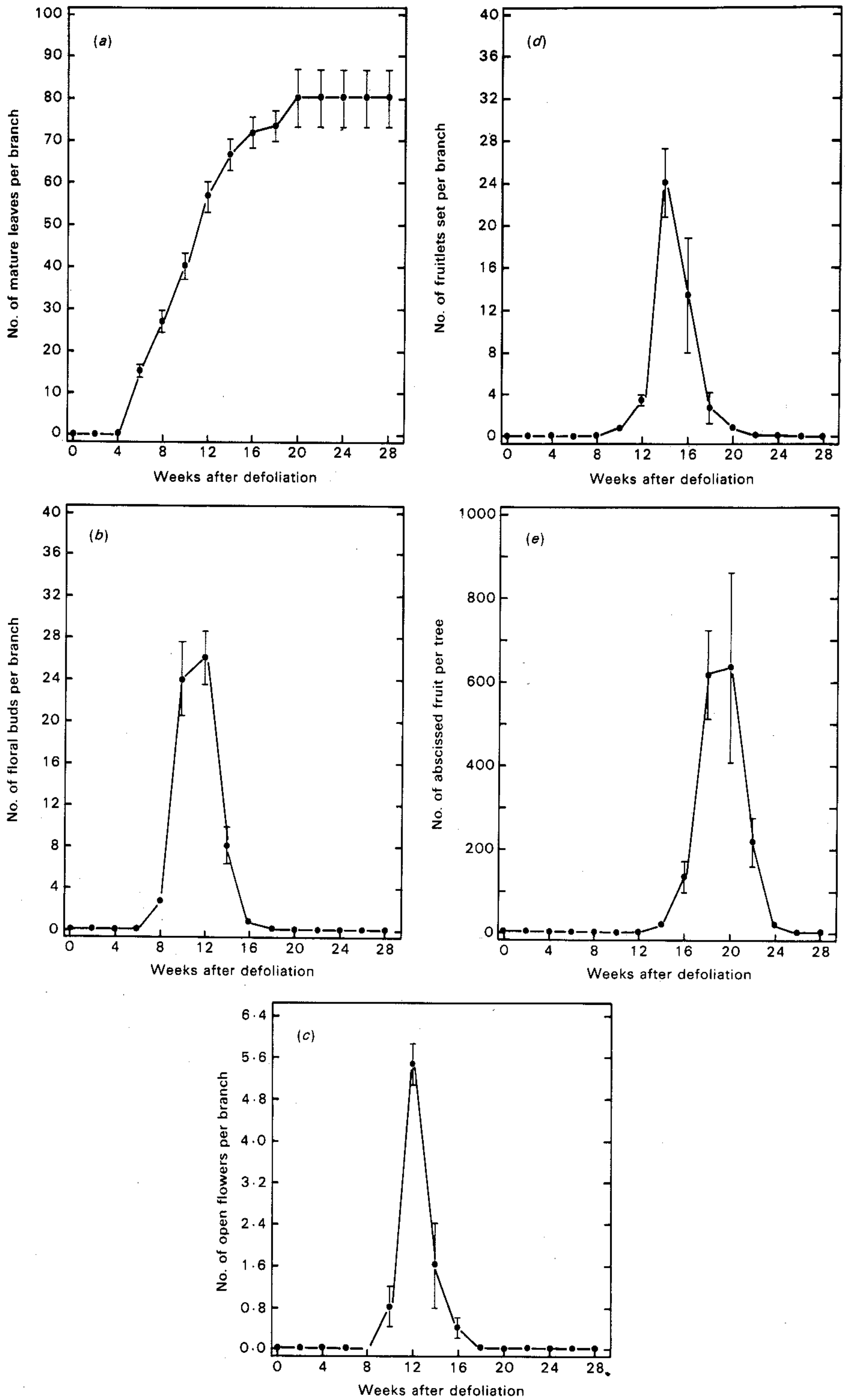

Fig. 1. The pattern of leaf production, flowering and fruiting following defoliation of guava cultivars in spring at Nambour. Means are of data pooled from five trees of each of seven cultivars. Vertical bars indicate standard errors.

mid-June (38 weeks after defoliation). The varieties varied in time of peak harvest (see Table 3).

Discussion

Although some varieties produced a crop earlier than others, they were not always the highest yielders, and there was no obvious growth pattern related to high production at Nambour.

Flowering behaviour of the varieties was similar; flowers were borne singly or in cymes of 2–4 in the leaf axils of current season's axillary growth. Floral buds appeared soon after the first leaves matured, but there was no direct association between leaf appearance and flower production. Chou *et al.* (1973) found that cambial growth and leaf initiation in guava in Taiwan was accelerated by temperatures above 15°C up to a maximum of about 28°C and that there was no association between floral initiation and cambial growth. Similarly, Rathore and Singh (1974) reported that flower production was greater in India during summer. Temperatures at Nambour are above the lower threshold for vegetative growth for guava (15°C) between September and June, but rarely reach the temperature for maximum growth (28°C). Flowers took 28 days from emergence to reach anthesis, although not all flowers, especially those initiated late in the season, set fruit. Guava trees at Nambour are often exposed to hot, dry winds during a normal season. Low soil moisture, high temperatures, low humidity and strong winds can accelerate flower drop in India (Rathore and Singh 1974). In our experiment, there was considerable variation between the varieties in the amount of premature flower and fruit abscission, although this tended to be proportional to the initial number of buds present.

High yields could not be attributed to any factor such as final fruit number, average fruit weight or time of maturity, nor could differences in the number of fruit harvested be related to differences in the rate, timing or duration of flower or fruit set (Fig. 1 and Tables 2 and 3). Differences between the varieties in the time of fruit maturity cannot be readily explained, but may involve differences in the rate of fruit growth, since there was very little variation between varieties in the time of fruit set. Fruit growth rate does not seem to be affected by crop load, since there was no correlation between maturity and yield. Fruit harvested late in the season during cool weather is often of poor colour, flavour and soluble solids content (Rathore and Singh 1974). Fruit quality varies between cultivars (Batten 1984).

The high yields recorded from some of the varieties in this trial suggest that management of these varieties was close to optimal. There was no indication that altering the timing or duration of growth stages (vegetative growth, flowering, fruit set and fruit growth) would increase yield.

The yields per tree were about double those for trees of similar age grown in southern Queensland (Chapman and Paxton 1980*a*, 1980*b*; Chapman *et al.* 1981) and northern New South Wales (Batten 1981). This increase is probably due mainly to the trees in this work being planted at approximately half density (416 *v.* 805 trees/ha) to reduce planting, irrigation and fertilizer costs and to enable easier management and harvesting. Yields per hectare were similar to those obtained at the higher plant densities.

Conclusion

Although fruit quality was not assessed in this experiment, these results suggest that early season guava cultivars may be more suited to conditions found in subtropical Queensland. Fruit quality is known to decline towards the end of the season. Information is required on the seasonal changes in fruit quality of the early and mid-season, high-yielding varieties (GA11-56CSIRO, GA11-56T3 and GA11-56R5T1) before any particular variety is recommended for guava production in subtropical Queensland.

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