RESEARCH NOTE: IMPACT OF SPRING AND SUMMER FLUSH TYPE ON FLOWERING INTENSITY IN 'HASS' AVOCADO

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ABSTRACT

Spring and summer flush timing have been shown to have an impact on the type of flowering shoot produced. In this study (under New Zealand conditions) it was found that vegetative flush which grows in the spring and hardens in early summer shows a bias to heavy determinate flowering. Similarly vegetative flush which grows in summer and hardens in late summer or early autumn tends to have less intense weaker flowering with a strong bias toward indeterminate flowering.

INTRODUCTION

The avocado tree grows rhythmically and develops tiers of branches as a result of a series of annual vegetative growth flushes. Floral inflorescences develop from lateral buds close to the terminal vegetative bud (Scora *et al*., 2002). Under New Zealand conditions Hass avocado trees typically flush once or twice in the spring-summer period and again in the summer-autumn period (Cutting and Dixon, 2000). Figure 1 illustrates the start of the summer flush originating on the spring growth. The flushes are demarcated by a scar left from the scales of the terminal vegetative bud.

An interesting observation is that in many years 'Hass" avocado trees show a preference to terminal vegetative bud abortion resulting in a high proportion of functionally determinate flowering shoots. This has an impact on crop load and alternate bearing as the subtending terminal vegetative bud can have significant implications on fruit set due to excessive vegetative dominance in the balance between vegetative and reproductive competition when the newly emerging leaves are still an effective sink. Fruit set and yield are further complicated and determined by the amount of axillary inflorescences present on a flowering shoot with greater fruit set on flowering shoots with 4 or more axillary inflorescences (Thorp, 1992).

Whole trees tend to either flower heavily or lightly often side by side and it has been suggested that the dominance of either spring or summer flush may play a role in flowering intensity and influence the proportion of functionally determinate or indeterminate flower shoots. The question this study set out to answer was what impact, if any, does the spring and summer flush have on flowering intensity and to determine if there is a difference in the determinate versus indeterminate flowering habit under cool warm temperate New Zealand growing conditions.

A)

B)

Figure 1. A) Summer flush originating on spring growth. B) Close-up of summer flush on the same shoot. The red arrows indicate the position of the bud scars demarcating the flushes.

MATERIALS AND METHODS

Five year old 'Hass' avocado trees on seedling 'Zutano' rootstock' grown on a typical volcanic ash Andosol soil in Te Puna, Bay of Plenty, New Zealand were used in this study. The trees were subject to normal cultural practices and were carrying a heavy crop at the time of tagging. On each of three trees, 10 spring flush units and 10 summer flush units were tagged in the autumn of 2003. The spring flush units were fully developed and hardened by the end of January 2003, whereas the summer flush units were fully developed and hardened by the end of March 2003. Units were identified and tagged in the autumn of 2003.

The flush units were scored for flowering intensity in early November of 2003 (late spring) using a scoring system from one (no flowering) to 10 (very heavy fully determinate flowering) according to Table 1.

Table 1. Flower intensity scoring system

Score	Description
1	No flowering at all
2	Very light flowering (less than 10 flowers) associated with vigorous vegetative flushing
3	Very light flowering (10 to 25 flowers) associated with vigorous vegetative flushing
4	Light flowering off weak to normal panicles and associated with vigorous vegetative flushing
5	Normal indeterminate flowering sometimes down the stem and associated with vigorous vegetative growth
6	Heavy indeterminate flowering sometimes down the stem and associated with vigorous vegetative growth
7	Very heavy largely determinate flowering right down the stem and associated with moderate vigour vegetative growth
8	Very heavy determinate flowering right down the stem and associated with weak vegetative growth from below the flower panicle
9	Very heavy determinate flowering right down the stem and without any vegetative growth
10	Very heavy determinate flowering right down the stem without any vegetative growth and associated with leaf drop

The data was analysed by standard ANOVA using Minitab.

RESULTS

There were no significant differences between trees in the intensity of flowering on either type of flush unit (Table 2). Spring flush had a significantly higher ($p<0.001$) flowering intensity than summer flush. Examples of shoots showing different flowering intensities are shown in Figure 2 and 3. These results indicate that there are differences in the flowering characteristics of spring and summer flush. Under New Zealand conditions the spring flush produces functionally determinate flowering shoots which show greater flowering intensity and the summer flush produces

functionally indeterminate flowering shoots that flowers with less intensity but produces the spring flush for the following year.

Figure 2. Shoot showing a flowering intensity with a rating of 5 .

Figure 3. Shoot showing a flowering intensity with a rating of 2.

Table 2. Comparison of mean rating (± standard error) of flowering intensity for individual trees determined on 10 shoots per tree for spring and summer flush units.

Flush type	Tree	flowering intensity	s.e.
Spring	1	6.40	0.43
	2	6.20	0.29
	3	6.35	0.26
	overall mean	6.31	0.19
Summer	1	2.70	0.26
	2	2.60	0.27
	3	2.56	0.24
	overall mean	2.62	0.14

DISCUSSION

This study has shown that growers have to make management choices if they are to produce the types of functionally active flowering shoots that provide both crop and return bloom. A too strong bias toward either of the two flush types carries risk in that it can induce alternate bearing patterns. This is obtained by either 1) flowering too heavily on flowering shoots which are spring produced (and not achieving suitable flush for the following return bloom flowering) or 2) flowering too lightly with too strong a vegetative bias on flowering stems which were summer produced (and setting up a heavy flowering for the following year). This study combined flowering unit type (determinate versus indeterminate) with the number of flowers produced on each flowering stem as a "flowering intensity" measure. Future studies should separate these two variables out to provide better information as to the impact of flush development on other yield factors such as fruit set and fruit retention. The study should also be repeated to determine if the relationships identified here hold true for both "good" and "difficult" fruit set years considering the annual variability in the New Zealand spring.

These results provide growers with some guidance as to what they should be striving for in terms of flush production and flowering shoots to maximize their regularity of cropping. This study has determined that spring flush more frequently results in axillary flowering down the flowering shoot. It has been suggested by some industry advisors that the ratio should be 60% spring flush and 40% summer flush to achieve the necessary balance of flowering shoots for regular fruiting. However, this has not been established empirically. It has been determined that functionally determinate flowering and axillary flowering both result in increased yield (Thorp, 1992) thought to be due to decreased competition between vegetative and reproductive growth (Whiley, 1994; Scora *et al*., 2002) .

CONCLUSIONS

This study has shown that under New Zealand conditions vegetative Hass shoots (spring/ early summer initiated flush) that harden before the end of January are significantly more determinate. We can therefore conclude the majority of fruit harvested are from flowering shoots that had ceased growing and hardened prior to January the previous year.

REFERENCES

Cutting, J.G.M. and Dixon, J. (eds.) (2000). *New Zealand Avocado Growers Manual*. New Zealand Avocado Growers Association, Tauranga, New Zealand.

Scora, R.W., Wolstenholme, B.N. and Lavi, U. (2002). Taxonomy and Botany. In Whiley, A.W. Schaffer, B and Wolstenholme, B.N. (ed.) The Avocado: Botany, Production and Uses. CABI Publishing, Oxon, United Kingdom.

Thorp, G.T. (1992). A study of modular growth in avocado (*Persea Americana* Mill.) PhD thesis, Faculty of Agricultural and Natural Resource Sciences, University of Adelaide, Australia

Whiley, A. (1994). Ecophysiological studies and tree manipulation for maximization of yield potential in avocado. PhD thesis, Department of Horticultural Science, University of Natal, Pietermaritzburg, South Africa.