

## RESEARCH NOTE: NECTAR CONTENT OF NEW ZEALAND 'HASS' AVOCADO FLOWERS AT DIFFERENT FLORAL STAGES

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### ABSTRACT

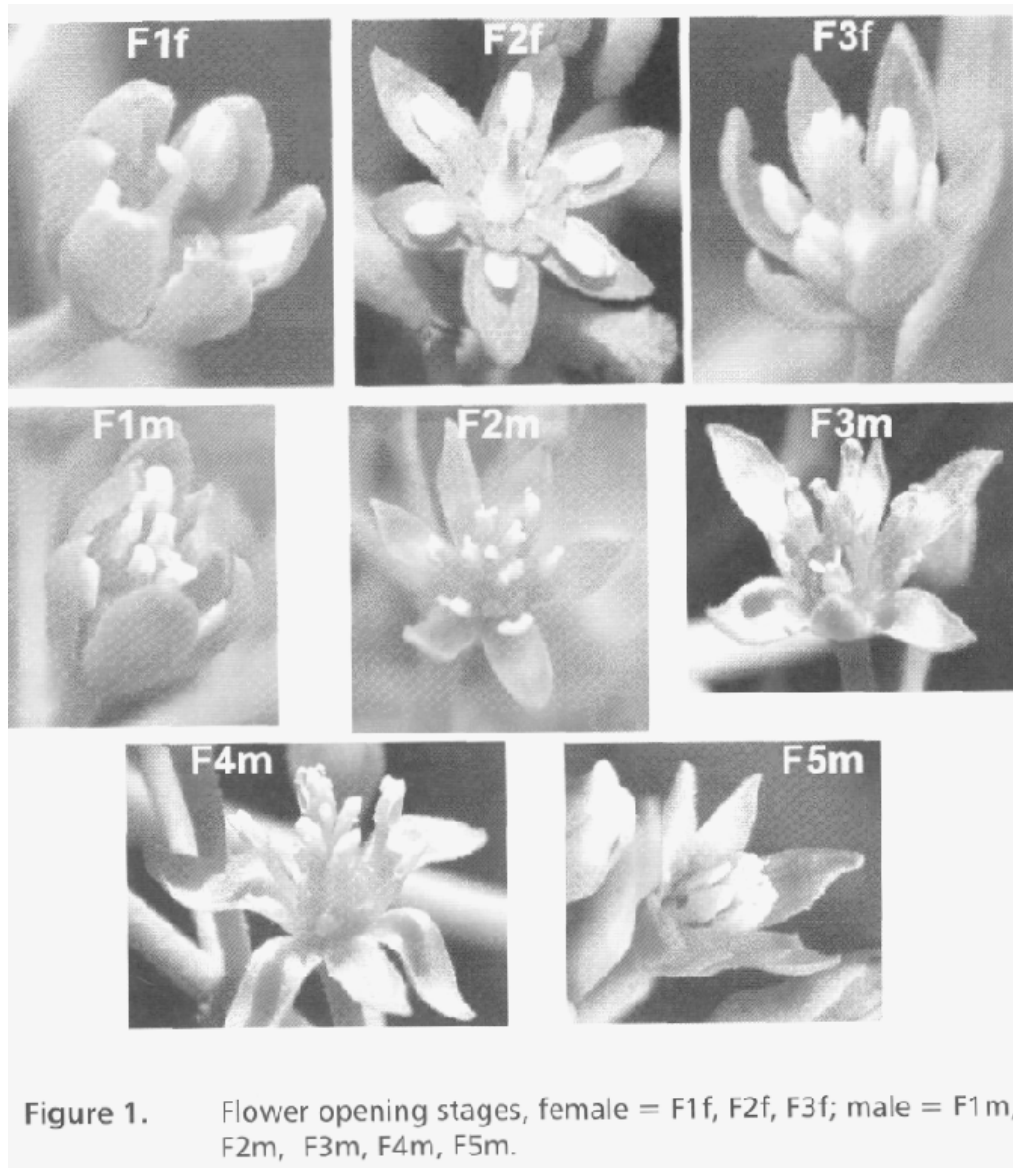
The factors affecting avocado flowering and fruit set in New Zealand are poorly understood. Effective pollination relies on good honeybee activity, which may be related to the nectar "reward" in the flowers being foraged. 'Hass' avocado flowers were assessed over two days to determine if the flower nectar content was influenced by the stage of flower opening. When bagged flowers were fully opened as either male or female at least 5 individual flowers per inflorescence on ten branches were sampled for nectar. 'Hass' avocado flowers in New Zealand produced very small amounts of free nectar (<1 µL). Flowers in the male or female phase had similar nectar volume and sugar content in contrast to that reported for 'Hass' flowers in Israel. The time of day at which the flowers were sampled had little effect on the sugar content of the flowers. The length of time the flowers were bagged had an impact on sugar content of the flowers. Flowers bagged for longer than six hours tended to have greater sugar content than flowers bagged for lesser times. The very small volume of nectar in New Zealand 'Hass' avocado flowers would explain why bees in New Zealand produce very little avocado honey.

**Keywords:** *pollination, bee activity, flowering stages, nectar content*

### INTRODUCTION

Many avocado orchards in New Zealand have had poor crops over the past two seasons. It is well recognized that yield is a key driver for orchard profitability and that maintaining avocado productivity at high levels is only achieved by a few New Zealand avocado growers. Little is known about avocado flowering in New Zealand and the factors that may be important in affecting pollination and fruit set. Research in Israel has indicated that effective pollination relies on good honeybee activity (Ish-Am and Eisikowitch, 1993; 1998). An important aspect of honeybee activity is the food reward of the nectar in the flowers being foraged. Avocado flowers open and close over a two day period going through readily identifiable stages (Dixon and Sher, 2002) that have been described in detail by Soriano *et al.* (2003).

The extent to which nectar content of avocado contributes to fruit set needs to be determined in a series of comprehensive studies. Prior to this it is necessary to gain an understanding of any potentially confounding factors influencing flower nectar content. One important issue to consider is whether the stage at which the flower is open has a major influence on the nectar content of avocado flowers. To determine if the stage of flower opening in either the male or female phase influenced flower nectar content 'Hass' avocado flowers from a single healthy tree at 50-60% open flower were assessed over two days in a Bay of Plenty orchard.



## MATERIALS AND METHODS

Ten flowering branches exposed to full sun from a seven year old 'Hass' grafted onto

'Zutano' seedling rootstock avocado tree were selected for nectar sampling of flowers. Each inflorescence, comprising of 6 to 7 panicles, were covered with a brown paper bag (250mm wide, 580mm long and 140mm deep) at 12:30 on the 10/11/2004 and at 8:30 on the 11/11/2004. The temperature inside the paper bags was 0.3°C higher than outside the bags. Bags were used to exclude bees from the flowers to prevent loss of nectar due to bee foraging and should not affect the nectar content of the flowers (Wyatt *et al.*, 1992). During the course of the afternoon when flowers were fully open at least 5 individual flowers per inflorescence were sampled for nectar. The flowers were tagged and not sampled again. The time and floral stage (Soriano *et al.*, 2003; Figure 1) were recorded at sampling. Bee density was estimated by counting honeybees on the whole tree in 90 seconds while walking around the tree (Ish-Am and Eisikowitch, 1998).

As the flowers produced very small volumes of free nectar (< 1 µL) 5 µL of distilled water was added to each flower between 1.5 to 3 minutes before sampling. The diluted nectar was collected using graduated 5 µL micro capillary pipettes (Ish-Am and Eisikowitch, 1998; Corbett, 2003) and the volume read in microliters. After nectar sampling the bags were placed back over the inflorescence. The sugar concentration of the nectar sample was measured using a low volume field refractometer calibrated against standard sucrose solutions. The amount of sugar in a flower was calculated as the product of the volume recovered and the Brix reading on the refractometer and converted from percent w/w to percent w/v and expressed in milligrams per flower. To calculate nectar volume the Brix values of 1µL raw nectar samples from each of 5 flowers diluted with 3 to 4µL of distilled water were corrected to their average raw nectar equivalent that was 43° Brix. For the purposes of calculating nectar volumes raw nectar was assumed to be 43° Brix. Nectar volume was calculated as the product of sample Brix value divided by raw nectar Brix times the diluted nectar volume.

The results for flowers were grouped into their flowering stage and analyzed using MINITAB version 13.31.

## RESULTS AND DISCUSSION

'Hass' avocado flowers opened female on the first day before closing and reopening as male on the second day. The time of day and the duration of when the flowers were open at each sex phase were about the same each day (Table 1). Bee density was very high with over 50 bees actively working the tree each day. There was a short period of overlap between the sex phases each day on the tree that was similar for other 'Hass' avocado trees adjacent to the experimental tree (data not shown).

Date	Sex	Opening	Closing	Overlap	Bee density <sup>1</sup>
10/11/2004	Female	11:00	14:00	1-2 hours	51
	Male	13:00	17:30		
11/11/2004	Female	11:00	14:00	2-3 hours	60
	Male	12:00	17:00		

<sup>1</sup>Number of bees observed on the tree in 90 seconds

The average shade temperature within the canopy over the flowering period was 20°C ± 0.2°C on the 10/11/2004 and 20°C ± 0.4°C on the 11/11/2004. Air temperature in full sun was 6°C to 7°C higher than the shade temperature. The relative humidity ranged from 57% RH to 72% RH on the 10/11/2004 and 54% RH to 80% RH on the 11/11/2004.

In the male phase as flowering progressed there was a significant increase in the nectar volume and sugar content (Table 2), even though relatively small numbers of flowers were sampled at each stage of flowering. By contrast the middle female flower stage had the most nectar and greatest sugar content within the female phase. The reason for this is not known but it could be a chance occurrence due to the small numbers of flowers sampled. Alternatively the flowers may have reabsorbed the nectar as can occur in *Brassica napus* L. (Burquez and Corbet, 1991) to use again the next day in the male phase.

**Table 2.** Estimated flower nectar volume and sugar content of 'Hass' avocado flowers at different phases of flowering.

Flower stage	Nectar volume (μL)	Sugar content (mg)	(n= )
Female			
F2f	0.83bc <sup>1</sup>	0.36ac	33
F3f	0.49ab	0.21ab	8
Male			
F2m	0.48a	0.21b	19
F3m	0.78b	0.33ab	47
F4m	1.18c	0.51c	9

<sup>1</sup>Values within the same column with the same letter are not different according to a One-way analysis of variance using Tukey's family error rate of 5%.

The calculated sugar content per flower was similar to values reported for male 'Hass' flowers in Israel (Ish-Am, 1994) but was higher than reported for 'Hass' female flowers. The values reported here would suggest that avocado flowers in the female or male phase would be equally attractive to bees. Casual observations at the time of nectar sampling would suggest that the bees were equally active on the inflorescences when the flowers were in male or female phase.

The time of day the nectar was sampled had no effect on the sugar content of the flower (Figure 2) while flowers that were bagged for longer than six hours tended to have greater sugar content (Figure 3). The longer times in bags also corresponded to a more advanced male flower stage and the increase in sugar content of the flowers is likely to reflect the accumulation of nectar over the period when the flowers were open. The amount of sugar per flower was greater on the 11/11/2004 than the 10/11/2004 (Figure 2) suggesting that small differences in the weather from day to day may have a large influence on the nectar production of the flowers.

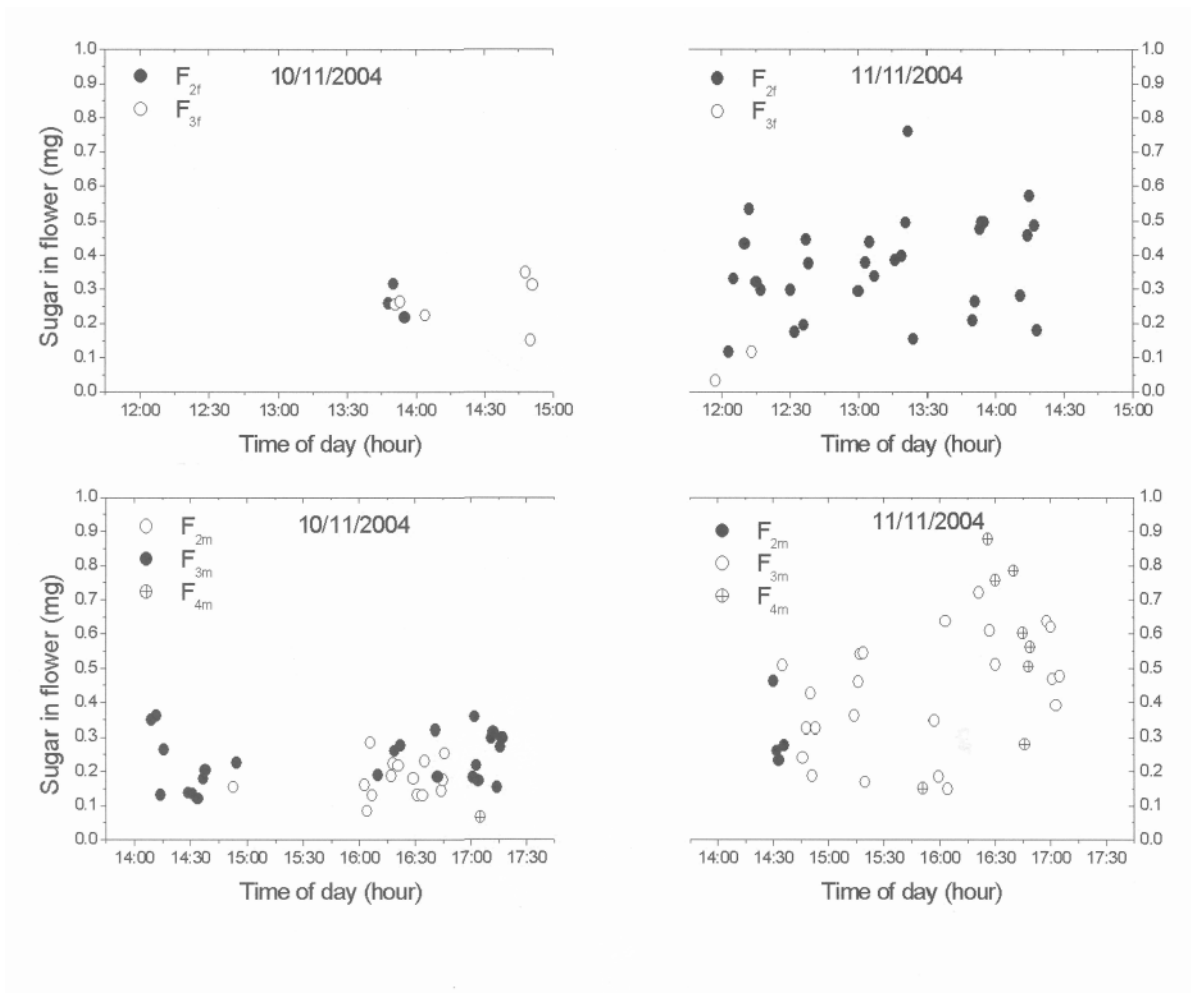


Figure 2. Flower sugar content of 'Hass' avocado flowers when open in the female ( $F_{2f}$ ,  $F_{3f}$ ) and male ( $F_{2m}$ ,  $F_{3m}$ ,  $F_{4m}$ ) phases over two days.

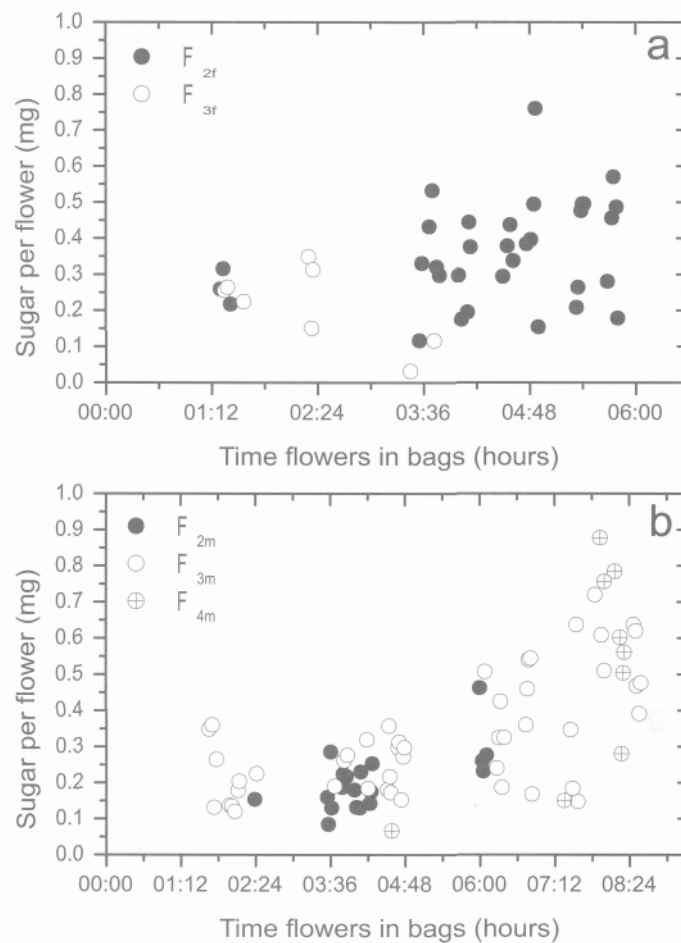
## CONCLUSIONS

The nectar content of 'Hass' avocado flowers in New Zealand depends on the stage of flower development in each sex phase. Male and female flowers have similar nectar volumes in contrast to that found in Israel. The volume of nectar in the flowers is very small and would explain why bees in New Zealand produce very little avocado honey.

## REFERENCES

- Burquez, A. and Corbett, S.A. (1991). Do flowers reabsorb nectar? *Functional Ecology* **5**: 369 - 379.
- Corbett, S.A. (2003). Nectar sugar content: estimating standing crop and secretion rate in the field. *Apidologie* **34**: 1 - 10.
- Dixon, J. and Sher, D. (2002). Review: Pollination of avocados. *New Zealand Avocado Growers' Association Annual Research Report* **2**: 1 - 7.

- Ish-Am, G. (1994). Interrelationship between avocado flowering and honeybees and its implication on the avocado fruitfulness in Israel. PhD Thesis. Tel Aviv University.
- Ish-Am, G. and Eisikowitch, D. (1993). The behaviour of honey bees (*Apis mellifera*) visiting avocado (*Persea Americana*) flowers and their contribution to its pollination. *Journal of Apicultural Research* **32**: 175 - 186.
- Ish-Am, G. and Eisikowitch, D. (1998). Low attractiveness of avocado (*Persea Americana* Mill.) flowers to honeybees (*Apis mellifera* L.) limits fruit set in Israel. *Journal of Horticultural Science & Biotechnology* **73**: 195 - 204.
- Soriano, C.C., Martin, J.J.H. and Gonzalez, J.C. (2003). Estados fenológicos tipo del Aguacate. Cajamar Experimental Station Booklet, ([www.laspalmerillas.cajamar.es](http://www.laspalmerillas.cajamar.es)).
- Wyatt, R., Broyles, S.B. and Derda, G.S. (1992). Environmental influences on nectar production in milkweeds (*Asclepias syriaca* and *A. exaltata*). *American Journal of Botany* **79**: 636 - 642.



**Figure 3.** Flower sugar content of 'Hass' avocado flowers when open in a) the female ( $F_{2f}$ ,  $F_{3f}$ ) and b) male ( $F_{2m}$ ,  $F_{3m}$ ,  $F_{4m}$ ) phases in relation to the length of time in brown paper bags.