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Honeybees in an Avocado Orchard: Forager Distribution, Influence on Fruit Set and Colony Development

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ABSTRACT

The trial orchard consisted of four-year-old Hass trees, every 20 rows of which a single row of Ettinger pollinizer was interplanted. Powder-marked bees foraged up to 300m from the hives along the rows, but only up to 200m across the rows of fruit trees and windbreaks. In open-pollinated and bee-caged Hass x Hass crosses, the initial fruit set was significantly lower and the subsequent fruit drop significantly higher than in similar Hass x Ettinger crosses. In all treatments without bees, fruit set was greatly reduced compared to the treatments with bees. Because of the low natural honeybee population, the size and brood production of the hived colonies were maintained, with two out of four colonies having swarmed.

UITTREKSEL

In die proefboord van vier-jaaroue Hass borne, was elke 20 rye afgewissel met een ry van die bestuiwer Ettinger. Bye wat met poeier gemerk is, het tot 300m van die korwe af gewei maar slegs tot 200m in 'n rigting skuins oor rye van vrugtebome en windbreke. Die aanvanklike vrugset was betekenisvol kleiner in Hass x Hass kruisings, synde oop-bestuif of met bye in hokke, en die daaropvolgende vrugval betekenisvol hoér as in soortgelyke Hass x Ettinger kruisings. In alle behandelings sonder bye was die vrugset opvallend kleiner in vergelyking met die vrugset van behandelings met bye. Weens die lae heuningby bevolking in die boord, het die kolonies in die korwe hulle sterkte en broedproduksie gehandhaaf, en twee van die vier kolonies het selfs geswerm.

INTRODUCTION

Avocado A type cultivars have pistillate (female stage) flowers in the morning and staminate (male stage) flowers in the afternoon. B type cultivars on the other hand have staminate and pistillate flowers during the same respective periods. Starting with the research by Stout (1923), the general opinion seems to be that avocado requires a pollen donor cultivar of the opposite flowering type to increase fruit yield (e.g. Gustafson & Bergh, 1966; McGregor, 1976).

Some avocado cultivars however have been reported to yield commercial crops in single cultivar plantings (Davenport, 1986). This has been explained by the daily

bisexual phase of flowers which enables intra-cultivar pollination particularly in A types (Ish-Am & Eisikowitch, 1991). In Israel the yield of Hass was correlated with the distance of the pollen donor Ettinger and with the number of pollinating bees (Ish-Am, 1994).

Since Hass is a commercial cultivar with which growers experience fruit set and fruit size problems in South Africa, the general aim of this collaborative study (Merensky Technological Services, Pretoria University, and Plant Protection Research Institute), is to determine the influence of Ettinger as pollinator on the yield of Hass under local conditions. Our particular investigation addresses the role of honeybees, namely distances that bees forage from hives, fruit set of open-pollinated as well as caged trees with and without bees, and honeybee colony development during flowering.

MATERIAL AND METHODS

The trial was carried out during August-September 1996 in a commercial avocado orchard planted in March 1992 on the farm Goedgelegen near Mooketsi. The orchard consisted of sixteen 1 ha blocks, each with 20 rows of Hass spaced 5m apart and a single row of Ettinger trees on the north-western side of each block, and spaced 2,5m apart.

Distribution of marked bees

Feral honeybees were already present in high numbers in 1995 on the earlier-flowering Ettinger trees (average of nine bees/tree) throughout the orchard before the trial started. In 1996 therefore, in anticipation of a similar bee population, only four hived honeybee colonies were placed in the middle of the second row of blocks parallel to the southern boundary of the orchard, i.e. opposite to where the feral honeybees were presumed to come from.

Two hives were fitted with pollen dispensers. These were filled on the same day at 11:00, 13:00 and 15:00 with fluorescent 'astral pink' powder to mark outgoing foragers. During the evening of the same day a portable UV light was used to scan inflorescences for deposited powder, i.e. visits by honeybee foragers. Ten inflorescences per tree were randomly chosen and scanned. Hass trees at distances of *5,* 10, 20, 40, 70, 100, 150, 200, 250, 300, 350 and 400m from the hives were surveyed. The counts were made in three different directions from the hives into the orchard, namely N, N-E and E.

Fruit set in caged and open trees

The following treatments were used to test the effect on fruit set of two different pollen sources, and of the presence or absence of honeybees: Two Hass trees covered together in a 40% shade cloth cage of 8m long x 3m wide x 2,5m high, with and without a honeybee colony; adjacent Ettinger and Hass trees caged together with and without bees; uncaged, open-pollinated Hass trees, i.e. with access to the natural bee population, at 5m and 50m from the nearest row of Ettinger trees. Two different orchard blocks, equidistant from the hives, were used. The treatments were replicated three

times.

Honeybee colony development

The condition of the four bee colonies with regard to the number of bees, and amounts of brood, honey and pollen was assessed at the start of the flowering period and subsequently twice at fortnightly intervals.

RESULTS AND DISCUSSION

Distribution of marked bees

The number of inflorescences marked by powder-coated bees declined with increasing distance from the hives up to 300m, at which distance only one marked inflorescence out of ten per tree was recorded (figure 1). A single marked panicle, however, was also found 400m from the hives in the eastern direction. The counts were higher along the two rows towards the north and east. Of these, the northern line had the highest number of marked inflorescences, probably because it was next to an orchard road. The survey in the north-easterly direction, across the rows of avocado trees and casuarina windbreaks, resulted in significantly fewer marked inflorescences, the furthest being only 200 m from the hives.

Table 1
Fruitset of Hass Avocado in relation to bees and proximity of pollenizer

Treatment	*Bees*	*Fruit set rating* Oct. 1996	Jan. 1997
Hass, open, 5m from Ettinger	Natural population	4,0	2,1
Hass, open, 50m from Ettinger	Natural population	2,9	0,5
Hass + Ettinger, caged	No bees	0,8	0,8
Hass + Ettinger, caged	With bees	4,5	3,0
Hass + Hass, caged	No bees	1,0	0,8
Hass + Hass, caged	With bees	3,2	1,5

Fruitset rating: 5 = excellent (A trees)
0 = no fruit

These results confirm observations in deciduous fruit orchards for example that honeybees tend to forage along rows of fruit trees or field crops. Therefore, where pollinizers are involved, honeybee colonies have to be placed in such a way that their field bees must encounter the pollinizers during their normal foraging bouts.

The numbers of bee-marked inflorescences in this trial fall far short of what can be considered adequate visitation for pollination purposes, especially because half of the entire field force of the four hives was powder-dusted. Also, an average of only 1,3

bees/Ettinger tree (n = 36) was recorded throughout the orchard before the hived colonies were introduced, compared to nine bees/tree the previous season. In 1995 there were on average 158 inflorescences per Ettinger tree (n = 10). In 1996 the average number was 222 per Ettinger tree and 206 per Hass tree.

Fruit set in caged and open trees

The fruit set of open-pollinated Hass trees adjacent to their pollinizers or pollen donor Ettinger was significantly higher than that of trees 50m from the pollinizer (table 1). In Israel Ish-Am (1994) similarly found a negative correlation between Hass yield and distance from Ettinger.

The initial fruit set in October 1996 of Hass pollinated with Hass (the caged-with-bees treatment; presumably also the open pollinated trees 50 m away from Ettinger), is significantly lower than that of Hass cross-pollinated with Ettinger. The subsequent fruit drop until January 1997 was also significantly higher in the same Hass x Hass treatments with bees compared to the Hass x Ettinger with bees. A possible explanation for these results is that the intra-cultivar pollinated Hass is less viable genetically, since fruit development is controlled by hormones produced by the developing seed.

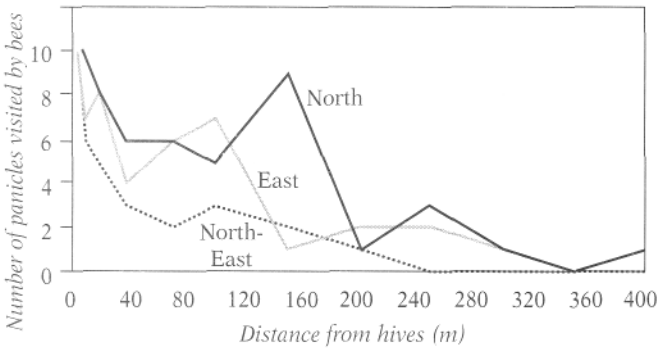

Figure 1
Number of Hass panicles per tree visited by bees at various distances and in different directions from hives

At different dates and different times of day, lower bee activity on Hass flowers compared to Ettinger, was observed. The nectar index (Johannsmeier, unpublished) for the two cultivars was subsequently determined and found to be 135 for Hass and 160 for Ettinger, which may partly explain the differential attractiveness.

Honeybee colony development

Because of the low feral bee population and the small number of hived colonies (four), colony size and brood production was maintained during the month of flowering (figure 2). The reduced brood production of the third evaluation was due to swarming in one

colony and advanced queen cell construction in another. The minor honey production could not readily be explained, considering the size of the colonies. However, during swarming preparations foraging in a honeybee colony effectively stops.

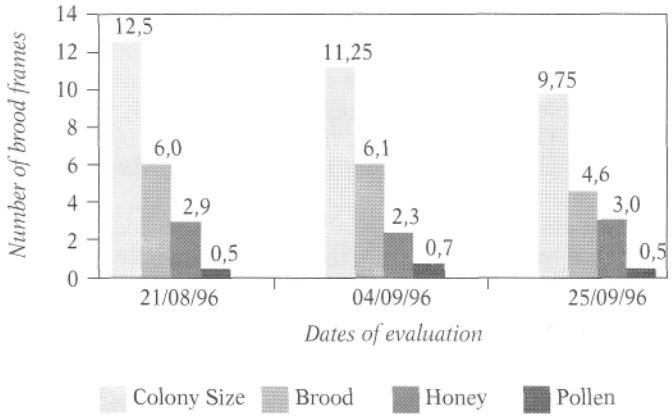

Figure 2
Honeybee colony development during one month in a flowering avocado orchard

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