Pollination Tests With Africanized Honey Bees in Southern Mexico, 1986-88

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ABSTRACT

From 1986 through 1988, as the African honey bee (AHB) extended its range into southern Mexico, a series of experiments and observations were conducted near Tapachula, Chiapas. These studies compared the pollination behavior/flower visitation times of both European honey bees (EHB) and AHB on small plots of cotton. While there were no measureable differences between the two types of bees as far as pollination effectiveness, the AHB used in the experiments became increasingly defensive (1988 vs 1987) and did not adapt to use inside screen cages. It is expected that, for use in many pollination applications, AHB colonies will have to be selected for gentleness before they can be moved and used to pollinate crops.

INTRODUCTION

MEXICO HAS a large number of beekeepers with colonies kept mainly for honey production (Wilson *et al.*, 1984). Thousands of colonies are also rented for pollination of melons, sunflowers and mangoes in northwestern Mexico. In the fall of 1986, Africanized honey bees (AHB) reached southern Mexico (Moffett *et al.*, 1987). It is anticipated that AHB will have a detrimental effect on the use of honey bees in commercial fields requiring bee pollination (McDowell, 1984). We investigated the potential impact of AHB on pollination by examining foraging activity and yield in cotton. Colonies of both European bees (EHB) and AHB were used in pollination studies during the fall of 1987-88 after a preliminary study using only EHB in 1986. This report describes our research methods, results, and some of the changes in beekeeping required in Mexico now that AHB are becoming widely established.

MATERIALS AND METHODS

Studies were conducted near Tapachula, Chiapas, in the extreme southwest corner of Mexico. The climate near Tapachula is characterized as tropical, but one which has a distinct wet season (June through October) and dry season (little rain, but still high humidity) from November through May. Cotton is typically planted in early July when there is usually a short (one- or two-week) break in the rain. The cotton crop is harvested in late November or early December.

Field Studies

The experimental planting pattern was the arrangement used to produce hybrid cotton seed. Insects must move pollen from rows of male-fertile plants to adjacent rows of male-sterile (genetic cytoplasmic male sterile, 'cms') plants. In the center of the plot, two rows of the cms line were flanked on each side by two rows of the male-fertile line (Fig. 1). On each side of these male-fertile rows, 10 more rows of the cms line were planted. In each year of the tests, the yield from the two center cms rows was the highest and yields of the other cms rows were compared to them. Bloom phenology was documented by counting the number of open flowers in the center rows of the normal and cms rows. While counting the flowers (between 10-12 AM), the number of flowers with bees was also counted.

Colonies of bees were placed on the edge of the experimental plots. In 1986 the colonies were EHB headed by Starline queens. In 1987 and 1988 only AHB colonies were used in the field (other managed and feral colonies in the area may have supplied a mixture of EHB and AHB foragers). In both 1987 and 1988, insect screen cages (3m x 3m x 2m) were also used to confine either EHB (ultrayellow queens) or AHB colonies provided by the local office of the Secretaria de Agricultura Y Recursos Hidraulicos (SARH), which is the Mexican equivalent of USDA. The screen cages covered 1 male-fertile row with 3 male-sterile rows. Observations on colony development, individual bee visitation behavior on flowers and boll set were made in the cages.

The AHB colonies were obtained from swarm traps maintained by SARH. Samples of workers from all the colonies were analyzed by morphometrics (Daly method) and by analysis of their cuticular hydrocarbon (olefins) profiles (R. K. Smith, 1988).

RESULTS

Africanization of the Area

During the first year of our experiment, only EHB swarms were being caught in SARH bait hives. The AHB was first found in Mexico in September 1986 only 20 km from our experimental cotton plots. By the fall of 1987, colonies in the area of our experiment were definitely Africanized according to morphometric, cuticular hydrocarbon and behavioral analyses. This change in bee populations continued; as a simple example, on a subjective scale of 0-10, where 0 equals EHB defensive behavior and 10 equals AHB defensive behavior as experienced in Venezuela, one of us (GML) graded our 1987 AHB colonies as "3" and our 1988 AHB colonies as "9." Analysis by hydrocarbon profile clearly verified the EHB and AHB colonies whereas, 1 AHB colony was variously identified as either AHB or EHB (2 different samples) using the morphometrics test.

Cotton Pollination Studies

1986. Initially, we lost 4 of our original 12 EHB colonies to ants! Overnight, 3 colonies were totally destroyed and a fourth made useless. These bees were replaced and the experiment went on with no further problems. Stephen Buchmann collected non-honey-bee floral visitors in our cotton plots (Table 1); it was judged that only the *Melissodes* bees might have contributed any significant cross pollination since they are large (similar to the size of honey bees), but because of intensive pesticide use in the experimental area, the numbers of all bees were low relative to honey bee populations.

Table 1. Insect visitors to cotton flowers at Campo Rosario Izapa (La Norteña), Oct. 6, 1986; Tapachula, Chiapas, Mexico.

Family	Genus	Species	Relative Abundance
Apidae	*Apis*	*mellifera*	+ + +
	Trigona	*nigerima*	+ +
Anthophoridae	*Xylocopa*	spp. (*fimbriata*?)	+
	Melissodes	*thelypodii*	+ + + +
Megachilidae	*Megachile*	sp.	+ +
Halictidae	*Halictus*		+
	Lasioglossum		+
	Agapostemon	spp.	+ +
	Neocorynura	sp.	+
Scoliidae	*Scolia*	spp.	+
Eumenidae	??		+

In December, the cotton was hand-harvested from both the male-fertile rows and the male-sterile rows. Since the two center male-sterile rows were flanked by male fertile rows (see Fig. 1), their yield was considered to be the agronomic maximum and all other male-sterile row yields were compared to that. Percent flower visitation (# flowers with bees out of 100 flowers) by honey bees averaged an adequate 1.1%. Moffett *et al.* (1976) considered 0.5% visitation to be adequate in similar fields. Seed cotton yields on the male-sterile rows, however, dropped off rapidly with increasing distance from the pollen rows (Table 2).

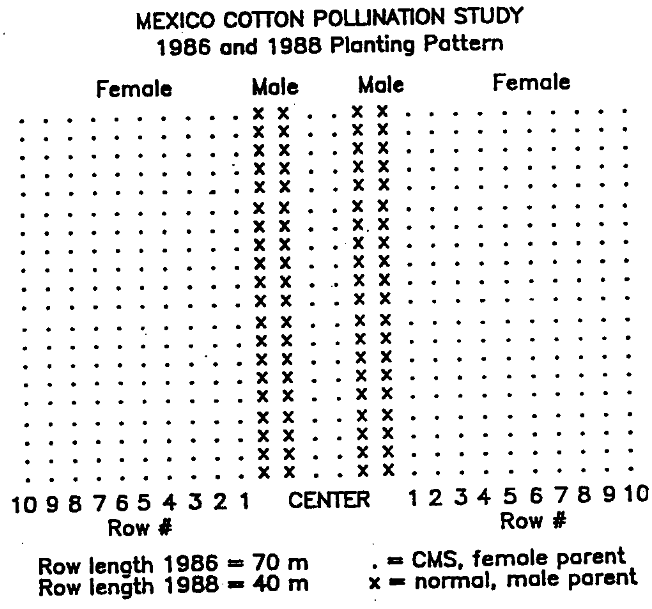

Fig. 1

Table 2. Cotton pollination yields as a function of distance from male-fertile rows. Only European honey bees were available in 1986; by 1988 Africanized honey bees predominated in the area. Chiapas, Mexico.

Row #*	Yield (% of center male-sterile rows)** 1986 (EHB)	1988 (AHB)
1	73.2	86.3 (± 10.4)
2	73.0	84.2 (± 17.2)
3	39.0	66.0 (± 11.8)
4	46.4	58.9 (± 13.8)
5	44.0	42.6 (± 15.0)
6	38.8	41.3 (± 5.2)
7	29.5	32.9 (± 12.6)
8	43.0	27.7 (± 7.6)
9	21.2	26.8 (± 11.3)
10	10.4	30.2 (± 8.5)

*Row 1 was adjacent (1 m) away from the male-fertile rows while row 10 was 10 m away.

**In 1986, the results are the average of 2 samples per row (n = 2) whereas in 1988 n = 6 (± standard deviation).

1987. The male-fertile/male-sterile experiment was not repeated in 1987 because an overnight rain of 12" washed out the planting and only male-fertile seed was immediately available for replanting. In the screen cages, EHB and AHB visits to male-fertile or emasculated (simulated male-sterile) flowers were observed. No statistically significant difference in the average duration of flower visits was found between AHB (49 seconds ± 42 (standard deviation), n = 91) and EHB (35 seconds ± 34, n = 95). There was a very large range in duration of flower visits by both AHB and EHB (from 1 to 511 seconds). Moffett *et al.* (1975) found floral visitation times by EHB in Arizona cotton fields averaged 12.5 sec, with a range of 1-60 sec.

Bolls developing from hand pollinations averaged 33.1 (± 4.4, n = 20) seeds per boll, while those resulting from 1 bee visit averaged 6.4 (± 6.2, n = 48) seeds per boll. Flowers covered with nylon mesh bags to prohibit insect pollination set no bolls (n = 240). Thus some bees did forage normally inside the cages, transferring viable pollen. Other studies have shown that cotton flowers need to be visited more than once (by honey bees) in order to set a full boll. We limited the flowers to just one bee visit so that all comparisons of visitation times would be based on flowers with a full complement of nectar.

1988. Both the male-fertile/male-sterile pollination experiment and the screen cage treatment were repeated in 1988. By October, AHB colonies from SARH (established from new swarms caught in May 1988) were "9" on the subjective AHB behavior scale. Percentage visitation in the row experiment was higher in 1988 than in 1986, averaging 5.1% (vs. 2.2% in 1986). The yield comparison between the two center male-sterile rows (flanked by male-fertile rows) and the other male-sterile rows further away from the fertile rows showed similar decreases in yield with distance in both years. The yield at row 4 was 59% of the yields of the center rows (compared to 46% in 1986 Table 2). Seed cotton yields on rows 1-4 were all higher in 1988 than in 1986.

In the screen-cage tests, floral visitation times were not significantly longer in 1988 than in 1987: 51 seconds (± 65, n = 281) for AHB and 70 seconds (± 79, n = 272) for EHB. Again, there was much variability in duration of visits. Both in the field and under screen cages, foragers of both bee types collected cotton pollen under the high humidity conditions typical in the Tapachula area; cotton pollen collection by foragers is rare in arid Arizona cotton fields (Loper and Davis, 1985).

The AHB colonies of 1987 were relatively calm, but in 1988 they were very defensive. At times in 1988, we would enter a cage and begin observations for a few minutes, when suddenly a group of about 50-100 bees would come out, attack our ankles and legs, and work their way up to our faces. When we left the cage, some bees managed to stay with us and continued their defensive behavior for as far as 400 m away. In addition, the AHB colonies kept trying to abscond the first few days after being caged. After 3-4 days, those foragers that remained (after many had died in the corners of the cage) seemed to stay in the colonies in a seemingly demoralized state. However, when a colony was removed from the cage and allowed free flight for a few hours, and after a few scout bees returned with nectar and pollen, a very large number of foragers began flying in front of the colony (like late afternoon cleansing or "play" flights). This activity settled down quickly to very active foraging flights. EHB colonies in the cages never tried to abscond and, unlike the AHB, many foragers visited the cotton flowers.

CONCLUSIONS

No differences in duration of floral visits between EHB and AHB foragers were found. There may have been a slightly improved short-distance movement of pollen by AHB bees in the field experiment possibly because of higher bee populations in 1988 versus 1986. Colonies of AHB are already known to be difficult to handle in commercial pollination systems since moving them greatly increases the loss of bees through absconding and defensiveness compared to EHB colonies (Danka and Rinderer, 1986; Danka *et al.*, 1987). Our work in southern Mexico show that AHB colonies are unmanageable as pollinating units in cages. However, foraging behavior (visitation times) of individual AHB and EHB on cotton flowers and dispersal of pollen is essentially the same. Similar results have been found on sesame (Danka *et al.*, 1990). It is likely that AHB colonies that are managed carefully (for example, provided with room for rapid brood production, but also prevented from swarming) could be effective pollination units. Problems will come when trying to relocate them, especially because of possible stinging episodes. For these reasons, beekeepers will need to select only gentle, non-defensive colonies as moveable pollinating units in the near future. We predict that selection among AHB X EHB hybrids will eventually result in strains of bees that are effective and manageable for commercial crop pollination ●

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REFERENCES

Danka, R. G. and T. E. Rinderer. 1986. Africanized bees and pollination. *Am. Bee J.* 126:680-692.

Danka, R. G., T. E. Rinderer, A. M. Collins and R. L. Hellmich II. 1987. Responses of Africanized honey bees (Hymenoptera: Apidae) to pollination-management stress. *J. Econ. Entomol.* 80:621-624.

Danka, R. G., R. L. Hellmich, A. M. Collins, T. E. Rinderer anc V. L. Wright. 1990. Flight characteristics of foraging Africanized and European honey bees (Hymenoptera: Apidae). *Ann. Entomol. Soc. Am.* 83:855-859.

Loper, G. M. and D. D. Davis. 1985. Disparity of cotton pollen dispersal by honey bees visiting upland and Pima pollen parents. *Crop Sci.* 25:585-589.

McDowell, R. 1984. The Africanized honey bee in the United States. USDA-ERS Ag. Econ. Rpt. No. 519.

Moffett, J. O., L. S. Stith, C. C. Burkhart and C. W. Shipman. 1975. Honey bee visits to cotton flowers. *Environ. Entomol.* 4:203-206.

Moffett, J. O., L. S. Stith, and C. W. Shipman. 1976. Influence of distance from pollen plant on seed produced by male-sterile cotton. *Crop Sci.* 16:765-766.

Moffett, J. O., D. L. Maki, T. Andre and M. M. Fierro. 1987. The Africanized bee in Chiapas, Mexico. *Am. Bee J.* 127:517-519.

Smith, R. K. 1988. Identification of Africanization in honey bees based on extracted hydrocarbon assay. In Africanized bees and bee mites. Needham, Page, Delfinado-Baker and Bowman (eds.) Chap. 34, pp. 275-280. Halsted Press, Div. of John Wiley & Sons.

Wilson, W. T., R. A. Nunamaker and D. L. Maki. 1984. Beekeeping in Mexico. *Am. Bee. J.* 124:446-461.