Experimental use of Beescent® to influence honey bee visitation to watermelon

Gerald M. Loper

Abstract

A commercial product called Beescent® containing a mixture of chemicals including chemicals used by honey bees as pheromones, was applied to watermelons in early bloom on Aug. 15, 1991. Honey bee visitation to treated, 18-row plots, were significantly higher than to untreated for only 2 days, the day of treatment and the next day. Watermelon yields were not effected. The daily high temperatures reached 86-88°F. so that most of the chemical had volatilized away by the end of the first day.

Introduction

The primary chemical components of the honey bee Nasanov gland have been identified as geraniol and citral with minor quantities of nerolic and geranic acids (Boch and Shearer, 1962, Shearer and Boch, 1966, Butler and Calam, 1968). Two additional minor components, nerol and farnesol, were identified by Pickett, et al. 1980. It was originally assumed that these chemicals were intrinsically attractive to honey bees (but see Wells and Wenner, 1971 for a different interpretation) and some attempts to use them to influence foraging to several crops have been made: to alfalfa, using geraniol and citral (Waller, 1970), to apples, using geraniol (in a mix) (Mayer et al., 1982). These tests generally showed a short-term effect in increased numbers of foragers but no yield effects were measured. However, in another test by Mayer, et al. (1989) a commercial product called BeeScent® was reported to have increased honey bee forager visitation and yields in pears, plums, and apples. This product contains 9% "pheromones" (presumably some Nasanov gland chemicals), has a strong aroma, is viscous (75% TDS) and is recommended for use in attracting bees for increasing cross pollination and yields. The literature supplied by Scentry Corp. indicates that application of BeeScent® to early bloom of honeydew melons may increase yields. This paper presents results of the use of BeeScent® to watermelons (*Citrullus lanates*) under irrigated field conditions in central Arizona, Aug. - Sept. 1991. Data on percent bee visitation and watermelon yields were subjected to statistical analysis (ANOVA) using the "minitabs" program (release 1.1, 1988) from Minitabs, Inc.

Materials and Methods

A commercial planting of watermelons in 2, adjacent 14-acre fields near Coolidge, AZ was studied. Each field was planted (June 28) to two cultivars in a 2 X 4 pattern. Two rows of the cv "Picnic" provided pollen for 4 adjacent rows of a seedless cultivar (Maynard and Elmstrom, 1990). One field was used as a control while the other had alternate, 18-row strips which were either untreated or treated with BeeScent® using an 18-row boom sprayer. Data on percent bee visitation and watermelon yields were subjected to statistical analysis (ANOVA) using the "minitabs" program (release 1.1, 1988) from Minitabs, Inc.

Flower and bee visitation counts were made in both cultivars within 3 treated, 3 untreated, and 3 control plots (20m/plot). On August 15, the plants were in bloom but covered only about 85% of the row. BeeScent® (2qts/acre in 20 gal of water) was applied by a tractor mounted ground sprayer operated at 90 psi and 5 mph.

Application was made between 0725 - 0740h MST at 24.5°C with overcast skies and a slight drift of spray was visible extending out to 2 - 3 rows (2 - 3 m) downwind (windspeed = 2 m/sec.). Honeybees (2 col/acre) had been delivered in the evening of Aug. 8, 1991 and placed in groups of 4 colonies along all sides of the fields. Counts of bees and flowers were made at 0900 and 1000 h on Aug 15, 16, 17, 18 and 19 and counts of watermelons (23 cm or longer) were made on Sept. 16 and 17 (in 20 m of row) in each of 10 randomly selected plots in each study area (treated, untreated, and control).

To evaluate the rate of dissipation of the sprayed volatiles, 10 filter paper disks (VWR Vanlab #74, 9 cm diameter) were placed among the watermelon plots. They were supported on plastic petri dishes, placed on stakes at 15 cm above ground level. After spraying, (at 7:25 AM MST) disks were removed at 7:30, 8:45 and 9:30 AM and also on the following day at 9:30 AM. Individual disks were placed in Ziplok™ bags and placed on dry ice and returned to the laboratory freezer (-60°C). The volatiles were analyzed by capillary gas chromatography (GC) using a purge and trap technique to remove the volatiles from the paper disks. A Hewlett-Packard 5880 GC with FID detector and electronic integrator were used with a J&W DB-1, 15 m (0.53 mm ID) fused silica column (5 ml/min of helium, initial column temperature = 50°C for 1 min, then temperature increased 5°/min to 150°). Only peaks eluting between the retention times of 6.8-12.9 min. (a maximum of 20 peaks typical of those from liquid BeeScent®) were totaled and used to evaluate volatile dissipation.

Results

Dissipation of BeeScent® Volatiles

Based on the GC analyses, one microliter (μl) of BeeScent® gave a total peak area of 3,594 (arbitrary units) and the analysis was reasonably quantitative as shown by the area counts of 50:1 and 100:1 dilutions (Table 1). The paper collected at 7:28, 2 - 3 minutes after spraying, gave an area count of 689; just 1¼ hours later, the area count had decreased to 90 and basically stayed at that level even through to the next morning (Table 1).

The chromatogram of BeeScent® reveals a complex mixture with at least 20 components (retention times, RT from 6.55 to 13.73 min)(Fig 3). The largest peak eluted at 6.87 minutes and comprised approximately 28% of the total (liquid BeeScent® and paper #1). However, this compound evaporated faster than most of the others; from all the other paper samples it comprised only 1-11% (Av = 7.6%) of the total.

The use of filter papers to quantitate the release of BeeScent® volatiles was very semi-quantitative and gave variable results. However, the results showed a rapid loss of the volatiles such that only 80 minutes after spraying, volatiles left on the filter paper had decreased by 87% (Table 1). The results show that the residual concentration stayed fairly constant during the first morning, even possibly increasing a little overnight. There was evidently some drift since a filter paper placed 9 m away from direct spray ("control", Table 1) had a low level of BeeScent®. Additionally, the chromatographic results showed a change in the relative concentrations of the volatiles. The ratio of the first major peak (RT = 6.90 min.) to another large peak (RT = 8.33 min.) was 1.72 from liquid BeeScent®, and 1.77 from paper #1 (immediately after spraying) but 1.01 from paper #3 only 80 minutes after spraying.

Table 1. Summary of BeeScent® Volatiles

Sample	Date	Time(MST)	Area Total X	Range	Ratio 6.90/8.33
1	7:28-7:30	8/15/91	689.4	689.4	1.77
3 & 4	8:43-8:45	8/15/91	87.8	59.4-116.2	1.0
6	9:38-9:40	8/15/91	89.8	89.8	*
7, 8 & 9	9:30-9:32	8/16/91	114.3	12.2-183.5	*
10 Non sprayed	7:35	8/15/91	120.6	120.6	*
1μl BeeScent®			3,594.3	(overloaded FID)	1.72
1μl 50:1			56.3	48.5-64.1	1.45
1μl 100:1			27.2	27.2	1.54

* One or both peaks too small to integrate

Percent bee visitation was high (7.6%) on the day of application, dropped on the next day and then generally remained close to 4% even as flower numbers increased. In the seedless cv, there was a significant ($P < 0.06$) difference in bee visitation between treatments only on Aug. 16. In the "Picnic" cv there was a significant increase in number of bees on Aug. 15 ($P < 0.01$) and Aug. 16 ($P < 0.14$) but again the difference disappeared with time. We have no explanation for the different results on Aug. 15, the day of application, but after that the trends were similar, more bees on the treated plots for the next day but by the 3rd day after treatment there was no difference between treatments. Watermelon yields were considered "above average" by the grower so pollination had been accomplished satisfactorily but there was no significant difference in yields between the treatments. In fact, with both cvs, there were slightly more watermelons in the control field than in the treated field.

The use of BeeScent® did increase honey bee visitation for up to 2 days, but the influence quickly disappeared. The chromatographic results documented that volatilization was rapid, but with a low residual continuing into the morning after spraying. Temperatures by 1000 h were 30 - 32°C (86 - 88°F) and increased to 35 - 38°C (94 - 100°F) daily under sunny skies. It was not possible for us to smell the applied spray even on the afternoon of the day of application. Waller (1970) noticed that marked foragers returned to a scent-treated plot on subsequent days. We suspect that bees that chanced upon the treated plots soon after spraying tended to return to that plot even after the actual scent was gone and that this effect temporarily increased bee visitation to the sprayed plots. Since watermelon yields were not increased it is concluded that application of BeeScent® under these condition was ineffective, but that a longer lasting, slow release formulation may improve bee visitation.

References

Boch, R. and D.A. Shearer. 1962. Identification of geraniol as the active component in the Nassanov pheromone of the honey bee. Nature, Lond. 194:704-706.

Butler, C.G. and D.J. Calam. 1968. pheromones of the honeybee - the secretion of the Nassanoff gland of the worker. J. Insect Physiol. 15:237-244.

Mayer, D.F., R.L. Britt, and J.D. Lunden. 1989. Evaluation of BeeScent® as a honey bee attractant. Am. Bee J. 129:41-42.

Mayer, D.F. and C.A. Johansen. 1982. Field evaluation of chemical pollinator attractants on tree fruits. Am. Bee J. 122:287-289.

Maynard, D.N. and G.W. Elmstrom. 1990. Seedless watermelon production in Florida. Florida Grower & Rancher. July pp. 12-13.

Pickett, J.A., I.H. Williams, A.P. Martin and M.C. Smith. 1980. Nasonov pheromone of the honey bee, *Apis mellifera* L. (Hymenoptera: Apidae) Part I. Chemical characterization. J. Chem. Ecol. 6:425-434.

Shearer, D.A. and R. Boch. 1966. Citral in the Nassanoff pheromone of the honeybee. J. Insect Physiol. 12:1513-1521.

Waller, G.D. 1970. Attracting honey bees to alfalfa with citral, geraniol and anise. J. Apic. Res. 9:9-12.

Wells, P.H. and A.M. Wenner. 1971. The influence of food scent on behavior of foraging honey bees. Physiol. Zoo. 44:191-209.