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PLANT SPECIES VISITED BY HONEY BEE FORAGERS DURING INDUCED CANTALOUPE POLLINATION

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ABSTRACT. The purpose of the research was to determine, by identifying pollen in corbicular pellets, the different plant species visited by honeybees (*Apis mellifera* L.) during cantaloupe (*Cucumis melo* L.) induced pollination. This work was carried out in La Laguna region, located in the states of Coahuila and Durango, Mexico in the spring of 2003. During the first 31 days of cantaloupe bloom, 18 honey bee colonies were placed in a six ha field, nine of which had a bottom pollen trap. Trapped pollen was collected twice per a week weighed and frozen. Through the year, anthers of wild and cultivated flowering plant species around the cantaloupe field and in La Laguna were collected, acetolyzed and preserved for pollen identified. Corbicular pollen from the 5th, 9th, 12th, 20th, 24th and 31st sample dates after start of staminate bloom was processed, identified and counted by microscopy. Pollen size was calculated with the formula: volume $V=\pi a^2 b$ where "a" is the major axe and "b" the minor axis and multiplied by the number of pollen grains to get the total volume. Cantaloupe pollen made up 8.7 %, 9.8%, 17.6 %, 9.3 %, 28.1% and 83.5% of that collected (number of pollen grains) on respectively for the sample dates. The percentage of volume basis pollen for cantaloupe was: 51.6%, 85.0%, 66.6 %, 84.4 %, 68.9% and 95.0% respectively. It is concluded that the cantaloupe was the main species visited as a plant pollen source for pollinating honeybees and that the plants present in the sample like mesquite (*Prosopis juliflora* (Swartz) DC.), alfalfa (*Medicago sativa* L.), creosote bush (*Larrea tridentata* (DC) Cov.), cucumber (*Cucumis sativus* L.), London rocket (*Sysimbrium irio* L.) and sorghum (*Sorghum vulgare* L.) were species visited as supplementary pollen sources.

Keywords: *Apis mellifera, Cucumis melo,* foraging bees, pollen, acetolyzation

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RESUMEN. El objetivo de la investigación fue determinar, a través de la identificación del polen corbicular, las diferentes especies de plantas que son visitadas por las abejas (*Apis mellifera* L.) durante la polinización inducida del melón (*Cucumis melo* L.). El trabajo se llevó a cabo en La Laguna

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localizada en los estados de Coahuila y Durango, México en la primavera del 2003. Durante los primeros 31 días de la floración del melón, un campo de seis hectáreas fue polinizada por 18 colmenas, nueve de las cuales tenía una trampa para captura de polen. El polen fue colectado dos veces por semana, pesado y congelado. Durante el año se colectaron anteras de plantas silvestres y cultivadas en floración alrededor del cultivo y en la región para preservarlas e identificar su polen usando la técnica de acetolisis. El polen corbicular, muestreado los días 5°, 9°, 12°, 20°, 24° y 31° contados a partir del inicio de la aparición de las flores estaminadas, fue procesado y contado en el microscopio óptico. El tamaño del polen fue calculado mediante la fórmula: volumen $V=\pi a^2 b$ donde "a" es el eje mayor y "b" el eje menor y multiplicado por el número de granos de polen se obtuvo el volumen total. El polen de melón fue el 8.7 %, 9.8%, 17.6 %, 9.3 %, 28.1% y 83.5% del colectado (en base al número de granos) respectivamente en las fechas de muestreo. El porcentaje del polen de melón en base al volumen fue: 51.6%, 85.0%, 66.6 %, 84.4 %, 68.9% y 95.0% respectivamente. Se concluye que el melón fue la principal planta visitada por las abejas como fuente de polen y que las especies de plantas con mayor número de granos de polen presentes en las muestras como mezquite (*Prosopis juliflora* (Swartz) DC.), alfalfa (*Medicago sativa* L.), gobernadora (*Larrea tridentata* (DC) Cov.), pepino (*Cucumis sativus* L.), mostacilla (*Sysimbrium irio* L.) y sorgo (*Sorghum vulgare* L.) fueron especies visitadas como fuentes suplementarias de polen.

Palabras clave: *Apis mellifera, Cucumis melo,* pecoreadoras, polen, acetolisis

INTRODUCTION

Cantaloupe (*Cucumis melo* L.) flowers require visiting bees to transfer pollen for seed set (Gorelick 2001; Cane 2002). Flowers that produced fruits had yield and quality associated with higher numbers of visits and higher cumulative durations of these visits by honey bees (Reyes *et. al.* 1982; Gingras *et al.* 1999). Many kinds of insects can be found on flowers (Kevan and Baker 1983) and previous studies have compared the pollination values of different bee species solely by the speed with which they handle flowers and the proportion of visited flowers tripped (Cane 2002).The native bee community is important in providing crop pollination services but the temporal fluctuations in bee populations are known to be highly variable across space and time (Kremen *et al.* 2002). Insecticides, herbicides and cultural practices had been reduced or eliminated the wild population of insects (Kearns *et al.* 1998) until the point that are not enough to pollinate the commercial crops (DeLaplane and Mayer 1996). This is of economic importance, and farmers should therefore consider enhancement of bee populations as part of their field management (Ricketts *et al.* 2004), this could be done by a reduced use of pesticides and by improving pollen and nectar availability for bees (Klein *et al*. 2003).

Scented wild flowers (Dieringer and Cabrera 2002; Bernhardt *et al.* 2003), ornamentals (Corbet *et al*. 2001) and blooming crops (Cane and Schiffhauer 2003) with a pollen and nectar reward act as a lure for several pollinator insects. On the other hand, in a study on foraging behavior of commercial honey bee in cucumber and zucchini, it was found that foragers collected 40% higher pollen from those target crops (Pankiw 2004).Thus, many commercial crops depend of the induced pollination by honeybees that at the same time are attracted by other flowers that can be potentially visited by forager-bees.

The purpose of the research was to determine the different plant species visited by honey bees (*Apis mellifera* L.) during induced cantaloupe (*Cucumis melo* L.) pollination.

MATERIALS AND METHODS

This work was carried out in La Laguna region, which is located in the Mexico states of Coahuila and Durango (101º40’ and 104º45’ W L and 25º05’ y 26º54’ N L), during the 2003 spring. In the first blooming month which is considered optimal for pollination and fruit-set (Eischen *et al*. 1994), 18 bee colonies were placed in a six ha commercial cantaloupe field, each located 25 m from the crop and equidistantly distributed adjacent to one side of the field. Every other colony had a modified-Ontario pollen trap (Waller 1980). The corbicular pollen were collected twice a week, weighed and frozen to preserve until processed. Through the year, anthers of wild and cultivated flowering plant species around the cantaloupe crop and in La Laguna region were collected in order to isolate and identify the pollen, using the acetolyzation technique (Kearns and Inouye 1993; Kapp 2000). Plants were photographed, collected, dried in a plant press and stored in our herbarium (Roubik and Moreno 1991; Kearns and Inouye 1993). The pollen was examined with a microscope (Olympus model BH-2), connected to a TV screen, measured with ocular micrometer at 1000X (using immersion oil). Pollen were photographed at 400X and 1000X with a reflex Minolta SRT 101 camera, Rokkor lens PF 58 mm mounted in a tripod with color slide film (ASA 100). At least two images at different angles were taken and scanned (3500C HP). An aliquot of the corbicular pollen from the 5^{th}, 9^{th}, 12^{th}, 20^{th}, 24^{th} and 31^{st} sample dates after start of staminate bloom was processed by acetolyzation, mounted to identify the pollen and counted in the light microscope by fields at 400X (Jones and Bryant 1998). Pollen volume was calculated with the formula: $V=\pi^2 b$ where “V” is volume, “a” is the major axe and “b” the minor axe and multiplied by the number of pollen grains to get the total volume (Kearns and Inouye 1993). In order to stabilize the variances of the original data, they were transformed by arcsine of the sample proportion (Ott 1988), prior to the statistical analysis. Data were examined with analysis of variance and differences among means were evaluated with the $LSD_{.05}$ test. Pollen amount were correlated with the blooming cantaloupe sample day (Steel and Torrie 1960).

RESULTS

Pollen composition assessed by number of pollen grains. The corbicular pollen collected by bees during the studied period (number basis, Table 1.) showed alfalfa (*Medicago sativa* L.) and mesquite (*Prosopis juliflora* (Swartz) DC.) as the main plant species in the preference by bees through the first three sample dates. In the 20th blooming day, creosote bush (*Larrea tridentata* (DC) Cov.) reached its highest percentage and declined in the 24th sample blooming date, where the main pollen numerically came from sorghum (*Sorghum vulgare* L.). Cantaloupe pollen numerically had its highest percentage only on the 31st day of bloom.

Table 1. Percentage of honey bee corbicular pollen by number of grains during the first 31 days of cantaloupe bloom (numerical basis)

Plant Species	**Sample dates after start of staminate bloom**						
	5th	**9t**	**12th**	**20th**	**24th**	**31th**	**mean ± SD**
Mesquite *P. juliflora*	64.5	29.3	30.5	0	0	0	20.7±25.9 ab*
Alfalfa *M. sativa*	25.4	26.5	45.2	3.2	0.04	0.3	16.7±18.5 abc
Cantaloupe *C. melo*	8.7	9.8	17.6	9.3	28.1	83.5	26.1±29.0 a
Creosote bush *L. tridentata*	0.8	8.3	1.6	82.8	23.23	0.6	19.5±32.1 abc
Cucumber *C. sativus*	0.1	20.2	0.1	0.4	0.3	0.2	3.5±8.1 c
London rocket *S. irio*	0.1	2.4	2.9	0.3	0	0.1	0.9±1.3 c
Sorghum *S. vulgare*	0	0	0	0	42.0	12.7	9.1±16.8 abc
Other species	0.2	3.4	2.3	4.1	6.3	2.7	3.1±2.0 bc
No. species per sample	7	11	13	17	21	15	

*species with same letter are not significantly different

Other plant species, grouped as “other species”, showed a low percentage of the total. Pollinators respond not only to the flower attributes but also to higher number of flowers and often to bigger inflorescences (Pankiw 2004). Flowers with a higher nectar content and pollen reward can also receive more visits. This sensitiveness to the flower condition, external factors that alter the flower fitness can alter its competitiveness (Krupnick *et al*. 1999).

Pollen composition assessed by volume. The diameter of creosote bush (*L. tridentata*) and London rocket (*Sysimbrium irio* L) pollen (Sawyer 1981): is very small size (≤ 20 μm), cucumber (*Cucumis sativus* L.) is small (≤ 30 μm), mesquite (*P. juliflora*) and alfalfa (*M. sativa*) are medium (≤ 50 μm), and cantaloupe is large size (≤ 100 μm). More than the half of the total pollen collected during the first 31 days of bloom came from cantaloupe. Cantaloupe had the higher pollen percentage varying from 51.55% in the first sample day to higher in subsequent samplings (Table 2).

Table 2. Percentage of honey bee corbicular pollen during the first 31 days of cantaloupe bloom (volumetric basis)

Plant Species	Sample dates after start of staminate bloom						
	5th	9t	12th	20th	24th	31th	mean ± SD
Mesquite *P. juliflora*	34.8	2.5	10.5	0	0	0	7.9±13.8b
Alfalfa *M. sativa*	11.7	1.9	13.3	2.2	0.02	0.02	4.9±6.0bcd
Cantaloupe *C. melo*	51.5	85.0	66.6	84.4	68.9	95.0	75.2±15.8a
Creosote bush *L. tridentata*	0.03	9.2	0.1	8.8	0.5	0.01	3.1±4.6bcd
Cucumber *C. sativus*	0.01	0.4	0.01	0.1	0.01	0	0.1±0.2d
London rocket *S. irio*	0.1	0.01	0.1	0.02	0	0	0.1±0.1cd
Sorghum *S. vulgare*	0.1	0	0	0	26.8	3.7	5.1±10.7bc
Other species	1.9	0.9	9.4	4.5	5.6	1.3	3.9±3.3bcd
No. species per sample	7	11	13	17	21	15	

*species with same letter are not significantly different.

The number of different plant species including cantaloupe in the samples dates varied from 7 to 21, but the percentage for the “other species” group remained low in every sample. The amount of pollen collected varied significantly (F =3.5, df =8, P =.002) with the blooming periods of the plants and cantaloupe vine growth (Fig. 1).

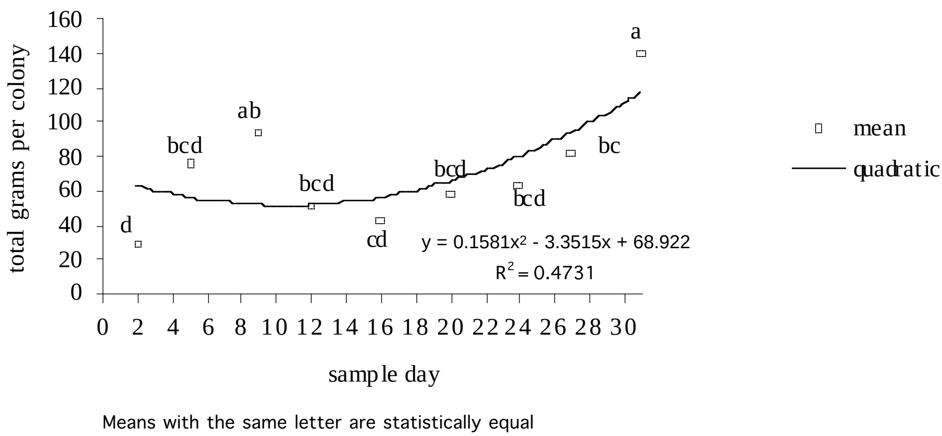

Figure 1. Corbicular pollen through the first blooming month in the cruiser cantaloupe

DISCUSSION

In La Laguna region, mesquite has a short flowering period that ended about the 12th day of cantaloupe flowering. The same occurred with the alfalfa which is not a reliable pollen and nectar source because growers harvest it prior to peak bloom (see Tables 1 and 2). This is probably the cause for the reduction of pollen collection in the middle of the cantaloupe bloom, from the 9th to the 27th. The supplemental pollen came from creosote bush and sorghum from an undetermined distance.

Research related to pollen availability for bees has shown that environmental conditions can affect pollen production on plants by altering flower number and pollen production per flower (Delph *et al*. 1997) and selection on the amount of stored pollen in honey bee colonies (pollen hoarding) changes the probability that worker bees will forage for pollen (Amdam *et al*. 2004) . The honey bee exhibits easily manipulated feeding behavior coupled with extremely high fidelity (Meller and Davis 1996), and olfactory learning (Wright and Smith 2004). The amounts of pollen ingested by worker bees varies with the age, increase within the 1st three days of a honey bee's life, reach it maximum around age eight days and then decrease continuously to the lowest values, measured in forager bees (Hrassnigg and Crailsheim 1998; Pankiw 2004). At the end of the month we observed the maximum income pollen quantities to the beehives and this increment occurred with the maximum percentages of pollen from the target crop. At this moment the cantaloupe vine was long enough to maintain a larger number of flowers. Correlation between pollen amount and blooming period had a low R^2 value doing poor for predictive purpose.

In this trial we did not consider the distances of the flowering plants that might be important in an arid zone like La Laguna region, and this may explain the differences among pollen collected. Future research must include vegetative aspects as well as the relationship among the bee-density, foraging-distance and pollen-nectar amount available from target crop and competitor plants.

We conclude that the cantaloupe is the main pollen source for pollinator honey bees and, the main pollen grain-number basis. Plants present in the sample like: mesquite (*P. juliflora* (Swartz) DC.), alfalfa (*M. sativa* L.), creosote bush (*L. tridentata* (DC) Cov.), cucumber (*C. sativus* L.), London rocket (*S. irio* L.) and sorghum (*S. vulgare* L.) were visited for collecting pollen only as a secondary importance sources.

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