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The corn pollen as a food source for honeybees

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ABSTRACT. This experiment was conducted on the campus of the University Center Moura Lacerda, Ribeirão Preto, in 2009 and 2010 with the objective of verifying the attractiveness of corn pollen for the Africanized honeybees *Apis mellifera*. The frequency of these bees, and the foraging behavior and stability were obtained by counting the first 10 min. of each hour, from 7.00 to 18.00, on three different days. Africanized honey bees collected only pollen in male flowers of maize, with a peak frequency of 9.00 in 2009 and between 16.00 and 17.00 in 2010. The corn pollen was very collected by Africanized honey bees, an important food source for these bees.

Keywords: africanized honey bees, *Apis mellifera*, food source, corn pollen.

RESUMO. O pólen do milho como fonte de alimento para as abelhas. O presente experimento foi conduzido no campus do Centro Universitário Moura Lacerda, Ribeirão Preto, Estado de Sao Paulo, em 2009 e 2010, com o objetivo de verificar a atratividade do pólen do milho para as abelhas africanizadas *Apis mellifera*. A freqüência dessas abelhas, bem como o comportamento de forrageamento e a constância, foram obtidas por contagem nos primeiros 10 minutos de cada horário, das 7 às 18h, em três dias distintos. As abelhas africanizadas coletaram apenas pólen nas flores masculinas do milho, com um pico de frequência às 9h em 2009 e entre 16 e 17h, em 2010. O pólen do milho foi muito coletado pelas abelhas africanizadas, sendo uma importante fonte de alimento para essas abelhas.

Palavras-chave: abelhas africanizadas, *Apis mellifera*, fonte de alimento, pólen de milho.

Introduction

Approximately 67% of all flowering plants depend on bees for pollination, and these animals depend directly on the collection of pollen and nectar to feed their larvae and adults. Africanized honey bees *Apis mellifera* present intense foraging activity in collecting pollen from plants, accumulating several grain-of-pollen in their pollen basket, then forming pollen acorns. This gathering pollen occurs dynamically and general, providing the plant species, the greater dispersal of pollen grains-de-through pollination, contributing directly to the equilibrium of plant populations in natural ecosystems. This knowledge can help in the preservation of plant species of the studied regions, and encourage planting of native varieties that have potential as a bee proposal for sustainable beekeepers (COUTO; COUTO, 2006).

According to Funari et al. (2003), honey bees need protein, carbohydrates, minerals, lipids, vitamins and water to complete their development and growth, which are obtained by collecting pollen, nectar and water.

Pollen from these plants is a source of protein, minerals, lipids and vitamins and nectar provides energy. Pollen is collected from a wide variety of plants, and the chemical composition and nutritional value vary according to the source, and can present protein levels in the range of eight to 40%. Each year, a colony consumes 40-60 kg of pollen. During the first five or six days of adulthood, the workers consume large quantities of pollen for protein and amino acids that will ensure their full growth and development. The insufficient level of protein in the diet of bees is problematic, since the development of hypopharyngeal glands, responsible for training of food for the kids, is not complete. Therefore, the cycle of production and reproduction of the colony is affected (PEREIRA et al., 2006).

According Marchini et al. (2006), the importance of pollen to the colony is unquestionable, therefore depend on bees for their supply of protein, minerals and biological products used in its special power. Therefore, the production of honey, wax and royal jelly from an apiary is directly related to the amount of pollen needed to feed the hives. Bees, in the absence of pollen, they resort to their own source of reserve metabolizing tissues of their bodies to prolong their existence. By receiving feedstock, where pollen rapidly assimilate the key nutrients that were lost, restoring itself to normal.

Experiments demonstrate a need to feed an average of 145 mg of pollen to which a worker bee complete its life cycle. Thus, 10,000 workers (who form a small colony) consume 1.5 kg of pollen (HAYDAK, 1970).

According to Malerbo-Souza et al (2008), maize is a monoecious, with unisexual male and female flowers on the same individual and is characterized by anemophilus pollination. Plants pollinated by wind may also benefit from other pollinators such as insects that visit flowers for pollen and possibly nectar. The crude protein content of corn pollen is considered weak, around 15%, however, the male flowers of the tassels are much visited by bees *A. mellifera*, for pollen (WIESE, 2000).

So, this experiment was designed to evaluate the attractiveness of corn pollen for honeybees, in Ribeirão Preto, São Paulo State, in 2009 and 2010.

Material and methods

This experiment was conducted at the experimental area of the campus of Centro Universitário Moura Lacerda (CUML) in Ribeirão Preto, whose height is 620 meters, with the following geographic coordinates: 21°10'04" south latitude (S) and 47°46'23" west longitude (W), temperate and subtropical climate with average annual temperature around 21°C and average annual rainfall is 1,500 mm.

Maize (*Zea mays*) was installed in February in both 2009 and in 2010, planting the second crop, in an area of 150 m^2 (10 x 15 m), 10 lines of 15 meters, spaced 90 cm between rows and 20 cm between plants (five plants per meter). The hybrid was used DOW 2d587.

The seeds were sown in holes with five to six seeds each. The fertilization was done with organic fertilizer (cow dung tanned), placed directly in the pits the basis of 300 g per pit. During the experiment was not implemented any type of pesticide. The culture remained under observation for three different days (8, 9 and April 13, 1999, 14, 15 and April 16, 2010).

The most frequent insects were collected and preserved in alcohol, properly labeled, and subsequently were identified by comparison with the entomological collection of the institution.

The frequency of the visitations of these insects, as well as the collection type (nectar and / or pollen), during the day, were obtained by counting in the first ten minutes of each hour, from 7:00 a.m. to 6:00 p.m., with three replications. Constancy (C) of these insects was obtained by the formula: C = (P x 100) / N, where P is the number of samples containing this species and N is the total number of collections performed (SILVEIRA-NETO et al., 1976).

Data were analyzed using analysis of variance in randomized ESTAT program, which includes the Tukey test to compare the means of all variables, regression analysis for orthogonal polynomials in REGPOL program to test each variable in time. The data were considered at 5% significance level.

Results and discussion

In 2009, the insects observed in male flowers of maize were Africanized bees *Apis mellifera* (Hymenoptera: Apidae) (97.13%), followed by beetles (1.03%), Diptera (0.70%), Lepidoptera (0, 54%), *Trigona spinipes* (Hymenoptera: Apidae) (0.40%) and *Tetragonisca angustula* (Hymenoptera: Apidae) (0.20%). In 2010, the insects observed in male flowers of maize were Africanized bees *A. mellifera* (94.66%), followed by bees *T. spinipes* (4.23%) and *Diabrotica speciosa* (Coleoptera: Chrysomelidae) (1.11%).

In 2009, honey bees *A. mellifera* collected only pollen in male flowers of maize. Through Polynomial Regression in time, was observed that these bees increased their frequency to 9:00 a.m., then decrease to 6:00 p.m., according the following equation: $\hat{Y} = - 16.03 + 21.63\ X - 1.21\ X^2$ ($F = 114.2589$ **, $R^2 = 28.59$) (Figure 1). However, in 2010, it was observed that these bees increased their frequency during the day, with a peak between 4:00 p.m. and 5:00 p.m., according the following equation: $\hat{Y} = - 7.92 + 3.27\ X$ ($F = 165.7963$ **, $R^2 = 0.6614$), where Y is the number of bees and X is the time of day.

In 2009, the temperature was highest in April, and the bees began to forage earlier, at 9:00 a.m. Already in 2010, the temperature was much lower in the days of the experiment, which also occurred in April, and the bees began to forage later, with a peak between 4:00 p.m. and 5:00 p.m.

Malerbo e Couto (1992) studied the activity of bees Africanized, Jaboticabal, São Paulo State, noted that about half of the pollen was collected in the field until 10:00 a.m.

With respect to foraging behavior, the bee *A. mellifera* (Figure 2) was observed collecting pollen in male flowers in the tassels. The bee approached the tassel, sat on it and with the help of mouthparts and legs removed the pollen. Subsequently, the bee transferred the appeal to the collected pollen basket. Moreover, it was observed during the visit behavior of cleansing the body, legs and wings, storing the pollen in the pollen basket. At the end of collection, the pollen basket had to be filled with pollen, ball-shaped yellowish.

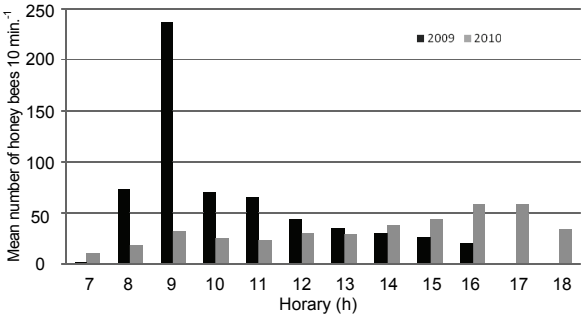

Figure 1. Mean number of honey bees *Apis mellifera* collected pollen of corn male flowers during 10 minutes at 7:00 a.m. to 6:00 p.m. on Ribeirão Preto, São Paulo State, Brazil.

Figure 2. Africanized honey bee collecting pollen on corn male flowers in Ribeirão Preto, São Paulo State, Brazil, on 2010.

In 2009, the species of stingless bee *Trigona* sp. and *T. angustula* also were observed collecting pollen on the tassels of maize. However, the frequency of these bees was very low. In 2010, only the bee *T. spinipes* was observed collecting pollen on the tassels of maize, its frequency was also very low. These bees visited the tassels of maize from 12:00 a.m. to 5:00 p.m., with a peak frequency between 2:00 p.m. and 4:00 p.m..

Coleoptera *D. speciosa* collected pollen from 1:00 p.m. to 6:00 p.m., with oscillation frequency in this period. Other beetles were observed collecting a sweet secretion released by the anus of aphids (honeydew), existing in the tassels of maize. The Lepidoptera and Diptera were observed visiting the flowers, however, were not observed collecting food.

According to the Index of Constance, developed by Silveira-Neto et al. (1976), noted that just the bee *A. mellifera* was a constant species in the tassels of maize (86.11%). The other insect species have been accidental: Lepidoptera (19.44%), Diptera (13.89%), Coleoptera (16.67%), *Trigona* sp. (13.89%) and *T. angustula* (5.55%) in 2009. In 2010, it was observed that, again, only the bee *A. mellifera* was a constant species in the tassels of maize (100%). Stingless bees *T. spinipes* and beetles *D. speciosa* species were accidental (23.9 and 15.2% respectively), the tassels of maize.

According Sabugosa-Madeira et al. (2007), bees do not show great interest in the fields of corn plants when there are other good sources of pollen to ensure close and their livelihoods. However, the bees come to feed almost exclusively on corn pollen when in case of famine or when apiaries are located in areas with large plantations of corn (MAURIZIO; LOUVEAUX, 1965). These authors found apiaries in the area of the Landes, in France, satisfying about 90% of its needs for flowers with pollen from corn, extending this for almost a month until the end of August.

In a study of pollen loads of bees for a period of three years (2002-2004), found that corn pollen came to meet in a few weeks, 17% of the needs of the bees in the colonies studied representing approximately 0,5 kg. It was concluded that bees can forage crops up to 10 km and an average radius of 6km (not three as previously believed), which means that the floor of a beehive is around 113 km^2. Bee *A. mellifera* and other pollinators actively worked in this plant, using it as a source of pollen, although its content in protein (about 15%) be considered relatively low (SABUGOSA-MADEIRA et al., 2007).

According to Roulston et al. (2000), pollen grains have protein concentration from 2.5 to 61%. According to these authors, the variation of protein can not be directly related to the attraction of pollinators, since pollen species zoophiles is richer in protein than anemophilous species, such as corn and coconut.

Despite a probable relationship between the choice of the source of pollen collected by bees, and resource availability, color, odor and morphology of flowers (PERNAL; CURRIE, 2001), the preference of collection by bees because of the nutritional quality of pollen is still discussed (COOK et al., 2003). The pollen types may vary by region or time of year in which they are offered (MODRO et al., 2007). The variation of crude protein content of pollen also varies over the months of the year. Barreto et al. (2005) observed, in Fort Bragg, NC, in May and June, values of 20.3 and 20.0, respectively. Almeida-Muradian et al. (2005) found 20% of pollen produced in southern Brazil. According to Marchini et al. (2006), the percentages of protein in samples of pollen collected by *A. mellifera* showed the average protein content (21.58%). According Modro et al. (2007), the crude protein content of pollen, collected from two apiaries in Viçosa, Minas Gerais State, Brazil, were on average 28.27% and 23.73% respectively.

In the study area, maize was planted at harvest (October / November) and in the harvesting period (January-April). This continuity of planted area provides plenty of pollen and becomes a great alternative source of protein for the hives nearby. Malerbo and Couto (1992) noted, in Jaboticabal, São Paulo State, that bees were observed in male flowers of corn, collecting pollen from October to January, probably due to the planting season that locality.

Conclusion

Africanized honey bees *Apis mellifera* collect pollen in male flowers of maize, showing differences in peak frequency between the years studied. The corn pollen is very collected by Africanized honey bees, as important food source for these bees.

References

ALMEIDA-MURADIAN, L. B.; PAMPLONA, L. C.; COIMBRA, S.; BARTH, O. M. Chemical composition and botanical evaluation of dried bee pollen pellets. **Journal of Food Composition and Analysis**, v. 18, n. 7, p. 105-111, 2005.

BARRETO, L. M. R. C.; FUNARI, S. R. C.; ORSI, R. O. Composição e qualidade do pólen apícola proveniente de sete estados brasileiros e do Distrito Federal. **Boletim da Indústria Animal**, v. 62, n. 2, p. 167-175, 2005.

COOK, S. M.; AWMACK, C. S.; MURRAY, D. A.; WILLIAMS, I. H. Are honey bees foraging preferences affected by pollen amino acid composition? **Ecological Entomology**, v. 28, n. 2, p. 622-627, 2003.

COUTO, R. H. N.; COUTO L. A. **Apicultura**: manejo e produtos. 3. ed. Jaboticabal: Funep, 2006.

FUNARI, S. R. C.; ROCHA, H. C.; SFORCIN, J. M.; CURI, P. R.; FUNARI, A. R. M.; OLIVEIRA ORSI, R. Efeitos da coleta de pólen no desenvolvimento de colônias e na composição bromatológica de pupas de *Apis mellifera*. **Archivos Latinoamericanos de Produccion Animal**, v. 11, n. 2, p. 80-86, 2003.

HAYDAK, M. H. Honey bee nutrition. **Annual Review of Entomology**, v. 15, n. 1, p. 143-153, 1970.

MALERBO, D. T. S.; COUTO, R. H. N. Flora apícola e desenvolvimento de colméias de *Apis mellifera* em área agrícola na região da Jaboticabal, SP. **Científica**, v. 2, n. 20, p. 351-358, 1992.

MALERBO-SOUZA, D. T.; TOLEDO, V. A. A.; PINTO, A. S. **Ecologia da polinização**. Piracicaba: CP2, 2008.

MARCHINI, L. C.; REIS, V. D. A.; MORETI, A. C. C. C. Composição físico-química de amostras de pólen coletado por abelhas africanizadas *Apis mellifera* (Hymenoptera: Apidae) em Piracicaba, Estado de São Paulo. **Ciência Rural**, v. 36, n. 3, p. 949-953, 2006.

MAURIZIO, A.; LOUVEAUX, J. **Pollens de plantes mellifères d'Éurope**. Paris: INRA, 1965.

MODRO, A. F. H.; MESSAGE, D.; LUZ, C. F. P.; NETO, J. A. A. M. Composição e qualidade de pólen apícola coletado em Minas Gerais. **Pesquisa Agropecuária Brasileira**, v. 42, n. 8, p. 1057-1065, 2007.

PEREIRA, F. M.; FREITAS, B. M.; VIEIRA-NETO, J. M.; LOPES, M. T. R.; BARBOSA, A. L.; CAMARGO, R. C. R. Desenvolvimento de colônias de abelhas com diferentes alimentos protéicos. **Pesquisa Agropecuária Brasileira**, v. 41, n. 1, p. 1-7, 2006.

PERNAL, S. F.; CURRIE, R. W. The influence of pollen quality on foraging behavior in honeybees (*Apis mellifera* L.). **Behavior Ecology and Sociobiology**, v. 51, n. 1, p. 53-68, 2001.

ROULSTON, T. H.; CANE, J. H.; BUCHMANN, S. L. What governs protein content of pollen: pollinator preferences, pollen-pistil interactions, or phylogeny? **Ecological Monographs**, v. 70, n. 4, p. 617-627, 2000.

SABUGOSA-MADEIRA, B.; ABREU, I.; RIBEIRO, H.; CUNHA, M. Bt Transgenic maize pollen and silent poisoning of the hive. **Journal of Apicultural Research**, v. 46, n. 1, p. 57-58, 2007.

SILVEIRA-NETO, S.; NAKANO, O.; BARBIN, D.; VILLA NOVA, N. A. **Manual de ecologia dos insetos**. São Paulo: Agronômica Ceres, 1976.

WIESE, H. **Novo manual de apicultura**. Guaiba: Agropecuária, 2000.

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