

SUSTAINABLE USE OF LEAF CUTTING BEE HIVES FOR ALFALFA POLLINATION

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ABSTRACT - The pollination of plants is an important ecological service in natural and agricultural ecosystems. The majority of angiosperm plants rely on animals for pollination. The co-evolution of bees and flowers has resulted in special morphological adaptations for both insects and plants and the need of some plants for pollination by bees was absolute. One of the major forage crops in Egypt and in other parts of the world is alfalfa. The leafcutting bees, *Megachile rotunda*, are very important pollinators of alfalfa. Different natural nests have been found in the Eastern part of Egypt, but these nests are found under a high risk, due to the construction of new houses instead of old mud wall houses. Foam nests have been created from 2003 as hives for the conservation of bees, which were used for alfalfa pollination. Using leafcutting hives has resulted in a high alfalfa seed production. Easy to handle by farmers, hives are very easy for preservation, storage and reuse.

Key words: alfalfa, pollination, seed production, leaf cutting bees

REZUMAT – Folosirea durabilă a stupilor pentru albinele din familia *Megachilidae*, pentru polenizarea lucernei. Polenizarea plantelor reprezintă un important serviciu ecologic în ecosistemele naturale și agricole. Majoritatea angiospermelor au nevoie de insecte pentru polenizare. Evoluția consecutivă a albinelor și florilor a dus la adaptări morfologice speciale ale insectelor și plantelor. Unele plante au nevoie de polenizare prin intermediul albinelor. Una dintre principalele culturi furajere din Egipt și din alte părți ale lumii este lucerna. Albinele din familia *Megachilidae*, *Megachile rotunda*, reprezintă un polenizator foarte important al lucernei. În estul Egiptului, s-au găsit diferiți stupi naturali, care se află, în prezent, în pericol, din cauza construirii de noi locuințe, ce înlocuiesc vechile case din chirpici. Din anul 2003, au fost create adăposturi sub formă de stupi, pentru conservarea albinelor, care realizează polenizarea lucernei. Folosirea stupilor pentru albinele din familia *Megachilidae* a dus la creșterea producției de sămânță de lucernă. Ușor de

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mănuit de către fermieri, stupii sunt, de asemenea, ușor de păstrat, stocat și refolosit.

Cuvinte cheie: lucernă, polenizare, producție de sămânță, albine din familia *Megachilidae*

INTRODUCTION

One of the major problems that face most of the newly reclaimed areas is the relatively low production of crops, due to the lack of insect pollinators. The same problem is found also in certain areas of the old cultivated land, due to the wide use of pesticides. The mechanization of agriculture has affected the wild pollinators as well as the honey bee industry. In addition, the concrete houses have quickly replaced the old mud houses in the villages. Alfalfa, *Medicago sativa* (L 1753), is a high quality forage and green manure crop that originated in the Middle East. Varieties are available and are well adapted to reclaimed agricultural lands in Egypt. Solitary bees and bumblebees are the most efficient pollinators of alfalfa. Honey bee efficiency, on the other hand, is low after opening alfalfa flowers several times. Honey bee “learns” to collect nectar without tripping flowers, due to the specific structure of the alfalfa flower. For that reason, despite the abundance of honey bee in alfalfa fields, seed yield per hectare may be very poor when solitary bees and bumble bees are not present. For

instance, low alfalfa seed yields were recorded in the most agriculture-developed countries, which were the first to apply pesticides and the first to destroy the natural habitats of native solitary bees by introducing monocultures over vast areas. This soon has resulted in thinning the fauna of native pollinators and caused a drastic reduction in alfalfa seed yields. The problem was successfully overcome for the first time in USA and Canada with the domestication and utilization of the solitary bee *Megachile rotundata* (Fabricius, 1793) (Stephen, 1961; Bohart, 1962; Klostermeyer, 1964; Hobbs, 1965; Free, 1976). Alfalfa flowers require visiting bees to trip the sexual column, there by providing pollination and subsequent pod and seed set. However, tripping is done by a specialized group of bees, which enter the flowers and press their keel by their own weight by releasing male and female organs to distribute pollen and effect cross-pollination (Abrol, 1993). Natural nests of leafcutting bees have been found in the Eastern part of Egypt (*Figure 1*) but these nests are under a big risk, because most farmers change the old mud houses with new concrete houses (Kamel *et al.*, 2007). These areas have many natural nests of leafcutting bees, which are very important for alfalfa pollination in the world (Shebl *et al.*, 2009a).

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Figure 1 - Positions of natural leaf cutting bee nests, 1- 2 (Tel El-Kebir); 3-4 (El- Huseiniya)



RESULTS AND DISCUSSION

The goal of this research was to develop self-sufficiency and stable high yields in seed production for locally adapted, high quality alfalfa varieties for reclaimed lands. To attain this goal, management protocols for one or more native solitary bee species that pollinate clover and alfalfa must be developed.

Artificial bee nests were prepared in March 2006 and transformed to natural nest sites in Tel El Kebir and El- Huseiniya ($30^{\circ}33' 30''\text{N}$, $31^{\circ}56' 13''\text{E}$), about 50km west of Ismailia in the River Nile Delta (Kamel *et al.*, 2007) (Fig. 1). The natural nests were transferred to the experimental field by the end of July and August, for overwintering period. The artificial nests were preserved from any damage or attack of ants or any other pests during all seasons. The artificial nests, which were used for nesting bees, were prepared by using foam nests. Each hive consisted of 50 pieces of foam (50 cm length, 12 cm width and 2 cm thick). In each piece of foam, there were 26 holes (10

cm depth, 6 mm diameter). After sticking the foam pieces above each other, holes were created in this block and the hive was performed, paper tubes (10 cm in length; 5.2 mm internal diameter) being inserted in each hole. All hives were painted with black colour in order to imitate the natural nests (Figure 2). The artificial nests were transferred to the natural nest sites in different villages of Tel El Kebir, during April - end of July 2006.

Nesting activities of leaf cutting bees have first appeared just shortly after the emergence of females, i.e. during mating period and continued to the end of the activity season. The emergency of bees started in April (females' activity was during April-June). The female usually hovers around the nests to select suitable nesting site for herself. After selecting the nest, she started cleaning it before inhabiting it (Figure 3) (Shoukry *et al.*, 2007; Shebl *et al.*, 2008a). Using artificial nests showed good results and big variation between different hives was clear. This is easily explained because of different

localities of natural nests and different biotic factors, especially wind. The

obtained percentages of nesting were 32.04 % in 2005 and 48.3% in 2006.

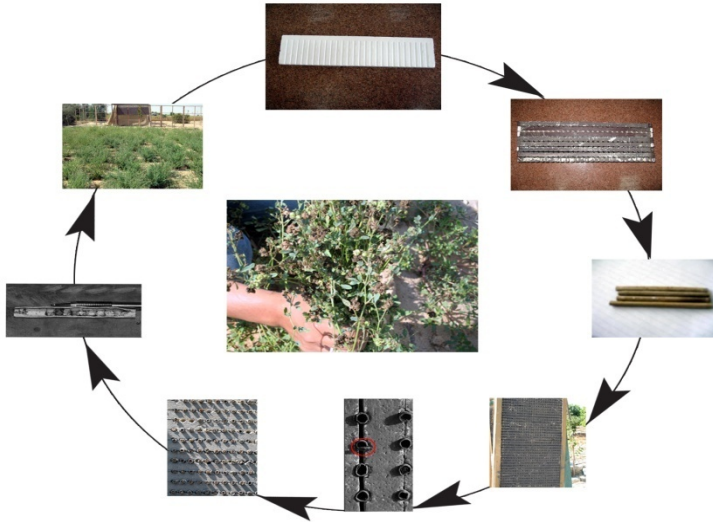


Figure 2 -The manufacture processing of leaf cutting bees hives

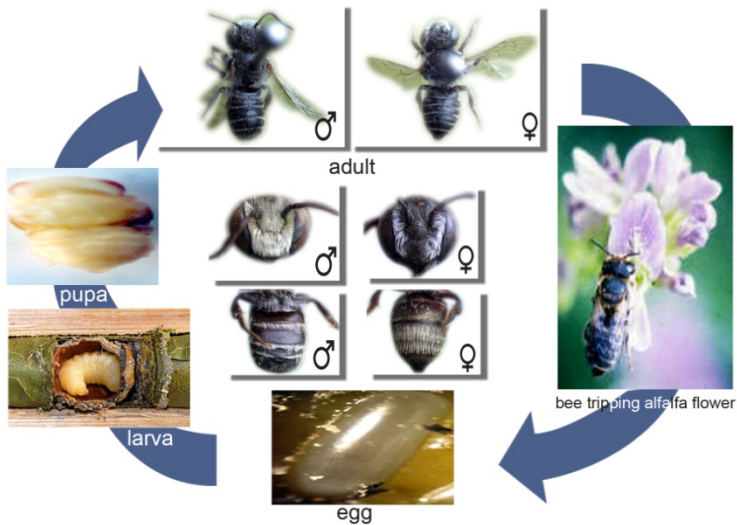


Figure 3 – Leaf cutting bee life cycle

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Alfalfa, *Medicago sativa*, had a blooming period in the experimental farm of about 8 weeks from late March until the end of May. During the blooming period, leaf cutting bees visit and pollinate the alfalfa flowers. Observations indicated that the males of leaf cutting bees start flying a few days before the females, but there is no role for the males in the tripping of alfalfa flowers (Figure 3). Female bees have special characters on the ventral side on abdomen, group of hairs (scopa) for collecting pollens from alfalfa flowers. This character lacks in males and other bees (honey bees have the scopa on the hind leg) (Figure 3). Therefore, the male has no efficiency in the pollination of alfalfa (Cane, 2002). Bees start to visit alfalfa flowers around 9 a.m., the number of bees increasing considerably at 10 a.m.; bees are most active around 1 p.m. (Figure 4).

The influence of temperature and light intensity at the beginning of the

flight of males and females was studied. Bees start foraging under conditions of low temperature and high light intensity or vice versa. Females spend the night in the nest, faced inward. As temperature rises in the morning, they turn around and face the entrance but do not come out and fly only when the temperature exceeds 20°C. Bees stopped foraging in the evening. Bees fly approximately ¼ mile to find food (Peterowski, 1991).

Our results have indicated that there were no significant differences between the average numbers of flowers per inflorescence per plant; as concerns the number of pods, significant differences between the treatments were found. The maximum high production of alfalfa seeds was found in plants close to the nest, then production decreased due to the distance from artificial nests (Shebl *et al.*, 2008b, Shebl *et al.*, 2009b).

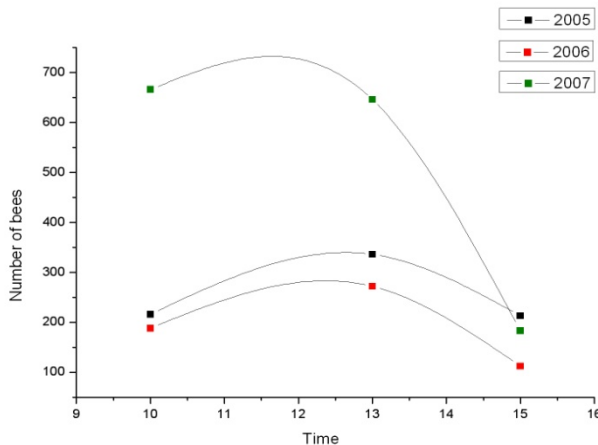


Figure 4 - The total number of bees three times per day, in 2005, 2006 and 2007

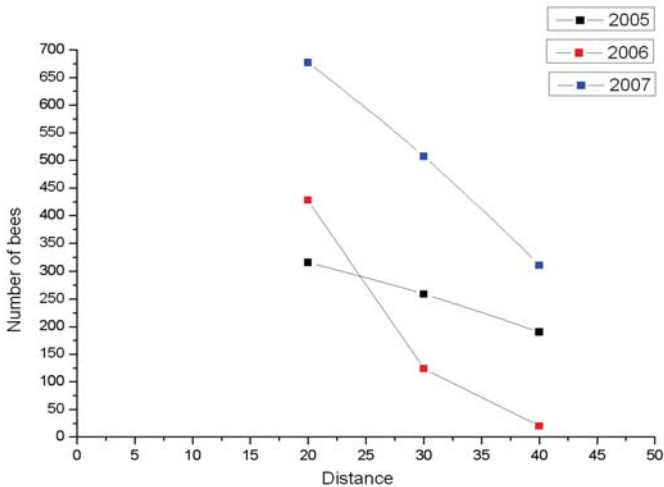


Figure 5 - The total number of bees at three distances from the nest, in 2005, 2006 and 2007

The impact of flower abundance and pollinator movement on seed or fruit yield has an economic importance and may have implications for crop pollinator management. The number of open flowers and nectar availability declined more rapidly close to bee shelters than at distance. The rapid decline in floral resources was partly interrupted because of steady pollination over time (Strickler and Freitas, 1999) (Figure 5).

CONCLUSIONS

Relying on honeybees for crop pollination may lead to the decrease of seed production. It is mandatory to search for other bee pollinators; conservation of wild bees will solve this problem.

Using and conserving leaf cutting bees will increase alfalfa seed production.

Using artificial hives are recommended to farmers for many reasons: easy to handle, storage and reuse. In addition, using hives could help for keeping bees in nature and saving them from disappearance.

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