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Seasonal Abundance of Leafcutting Bees (*Megachile minutissima,* Megachilidae, Hymenoptera)

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Abstract: Solitary bees such as bees belong to Fam: Megachilidae are most efficient pollinators of alfalfa. Artificial nests of leafcutting bees are prepared during April to June of the years 2005, 2006 and 2007 and transferred to experimental farm to study the seasonal abundance. Samples of bees were taken by the sweeping net through the experimental field of alfalfa. Samples collected three times a day of work at 10am, 1pm and 3pm respectively. The collected samples were repeated every 7 to 10 days from the beginning of blooming till the end of the season. The results revealed that alfalfa Medicago *sativa* (L., 1753) had a blooming year in the experimental farm of about 8 weeks started from late March till end of May. During the blooming year *Meagchile minutissima* (Radoszkowski, 1876) visited and pollinated the alfalfa flowers. Observations also indicate that males of leafcutting bees start flying few days before females but there is no role for males in tripping of alfalfa flowers. Females start to visit alfalfa flowers not before 9 am, the maximum activity was at 1pm then there is no activity after 5pm.

Key words: Artificial nesting . alfalfa pollination . population dynamics . seed production

INTRODUCTION

Alfalfa flowers require visiting bees to trip the sexual column, there by providing pollination and subsequent pot and seed set. 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. Females of the alkali bee *Nomia melanderi* (Cockerell, 1906) and the alfalfa leaf-cutting bee *Megachile rotundata* (Fabricius, 1793*)* tripped 81% and 78% of visited flowers, respectively. Males of these species were significantly less effective (61% and 51%, respectively), but still significantly superior to the honey bee *Apis mellifera* (Linnaeus, 1758*)* (22% of visited flowers tripped). One candidate pollinator, *Osmia sanrafaelae* Parker 1985, shows promise (44% tripped), but not the congeneric *O. aglaia* (Sandhouse, 1939) (13% tripped) [1]. However, tripping done by a specialized group of bees which enter the flowers and press their keel by their own weight there by releasing male and female organs to distribute pollen and effect cross-pollination [2].

Leafcutting bees are main pollinator of alfalfa, the activity of these bees are regulated by both temperature and light intensity [3]. The number of flowers visited per trip, the time spent flying from flowers tripped per unit time are influenced by weather conditions (i.e., temperature and light intensity), agronomic practices (i.e., plant or flower density and irrigation) and alfalfa cultivar. Female visited from five flowers per minute under cool, partly cloudy weather conditions in a thin plant density, to 25 flowers per minute under hot, clear conditions in a thick plant density. Each flower visit averaged approximately four times longer under the first condition, but the percentage of flowers pollinated under both conditions was similar [4].

The flight activity of the bees, *Megachile nana* Bingham, 1897 and *Megachile flavipes* (Spinola, 1838) on alfalfa were affected by environmental factors, especially cessation of light intensity and solar radiation. Also, he found positively correlated with air temperature, light intensity, solar radiation, nectar sugar concentration and negatively with relative humidity. Path coefficient analysis revealed that the direct of solar radiation on *Megachile nana* (Bingham, 1897) and solar radiation and light intensity on *Megachile flavips* (Spinola, 1838) was pronounced. While the direct effect of other factors were negative or negligible, *M. nana* (Bingham, 1897) spent less time than *Megachile flavips* (Spinola, 1838) on average of (2.35 sec). However, the mean tripping efficiency was higher in the latter (89.5%) than the former (87.5%) [5]. The excessive high temperatures (40°C. or above) in the nesting media can kill eggs and early instar larvae. The poorly constructed shelters can act as heat traps and thus produce lethal temperatures. If nesting media is

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exposed to direct sunlight this can result in high cell temperatures. Cell temperatures below 4°C can cause immature mortality though he doubt if this occurs in the field [6].

Osmia cornuta (Latreille, 1805) flight activity began at 0740-1020 hours at 9-12°C and ended at 1800-1830, often after sunset. Females mark their nest entrance with secretions, probably from the mandibular glands and individuals with severed antennae are unable to recognize their nesting cavity [7]. *Megachile rotundata* (Fabricius, 1793) population dynamics and foraging behavior, as well as alfalfa bloom and pollination rates in have been studied in two fields in eastern Oregon. Despite marked differences in bee management, establishment was very similar in the two fields (0.5 females per nesting cavity) and lagged peak bloom by 2 wk. Pollination rates increased from 0-10% in the first 3 wk to 80-90% in week 4-5. By then, *Megchile rotundata* (Fabricius, 1793) females had difficulty finding untripped (nonpollinated) flowers and visited large numbers of already tripped or not fully matured flowers. *M. rotundata* (Fabricius, 1793) progeny mortality was very high (54-78%). Estimated seed yields were similar in both fields. We contend similar seed yields and improved bee production could be accomplished with smaller bee populations, better timed with alfalfa bloom [8]. Artificial nests were prepared and moved to the experimental field [9]. The present work is aimed to study the population abundance of leafcutting bees during the season and their relation with the blooming season of alfalfa. As a consequence getting high rates of alfalfa pollination and seed yields.

MATERIAL AND METHODS

Artificial nesting of *Megachile minutissima* (Radoszkowski, 1876): Artificial bee nests were prepared during the years 2004, 2005 and 2006 in March and transformed to natural nest sites in Tel El Kebir (30° 33′ 30′′N, 31° 56′ 13′′E) about 50 kilometers west of Ismailia on the Delta of River Nile [9]. The artificial which used for nesting bees were foam nests. The nests consist of 50 pieces of foam. Each piece was 50 cm length, 12 cm width and 2 cm thickness. In each piece of foam were 26 holes, the hole was 10 cm depth and 6 mm diameter. After sticking the foam pieces above each other holes were created in this block and the shelter was performed. Straws of paper tubes 10 cm in length and 5.2 mm internal diameter, one tube was putted in each hole. All foam nests were painted with black color for imitation of the natural nests. The artificial nests transferred to the natural nests sites in different villages of Tel El Kebir in April till the end of July of 2004, 2005 and 2006 (Fig. 1 and 2). By the end of June foam nests were collected from the natural nest sites and transferred to the experimental field for emergency of bees in the following year, the nests preserved and kept from any damage by other pests and ants.

Fig. 1: Foam pieces used for artificial nesting of leafcutting bees

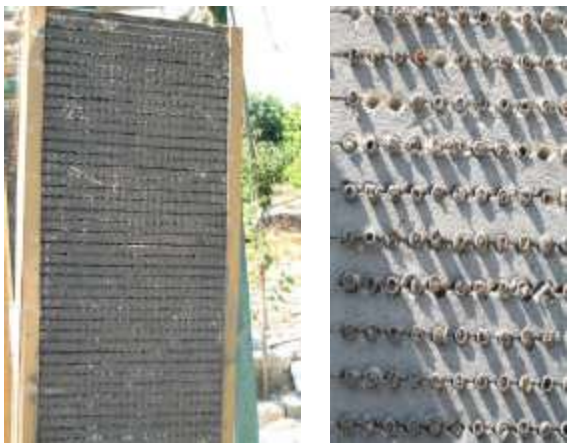

Fig. 2: Completer artificial nest of leafcutting bees

Experimental field preparation: In the beginning of October 2005, 2006 and 2007 the experimental field of bees research unit, Suez Canal University, Ismailia was prepared for alfalfa seed cultivation. The variety used was Ismailia 1 produced by Agricultural experimental station in Ismailia. The grown distance between plants

was 30cm and the total number of plant in the field was 1200 plants. Normal nitrogen fertilizer was added to the field. The experimental feld divided into three parts near to the nest (20m), near to the nest (30meters) and (far from the nest (40meters).

The population dynamics of *Megachile minutissima* (Radoszkowski, 1876) on alfalfa flowers: The experiment conducted at the experimental field of Bee research unit, Suez Canal University, Ismailia, Egypt. Artificial bee nests have been putted on the eastern part of the experimental field to be in the front of the sun rise in March of the years 2005, 2006 and 2007. The emergency of *Megachile minutissima* (Radoszkowski, 1876) started after the blooming of alfalfa flowers which occur normally around late of March. Samples of bees were taken by the sweeping net through the experimental field of alfalfa 25 double strokes by sweep net? Samples were taken three times a day of work at 10am, 1pm and 3pm respectively. The day of work was repeated every 7 to 10 days from the beginning of blooming till the end of the season. Numbers of bees were recorded and bees were released again into the field for keeping the population of bees till the end of the season.

However samples of *Megachile minutissima* (Radoszkowski, 1876) were taken from three different distances of bees from the artificial nest site 25 double strokes by sweep net? Theses distances were near to the nest (20m), near to the nest (30meters) and (far from the nest (40meters). In each area samples of bees were taken in the same times of the previous experiment. Number of bees was recorded and bees were released again.

Metrological Data at the time of the experiment: The high and low temperature and relative humidity from March to June have been recorded during Match untill July 2005, 2006 and 2007 using thermohygrograph.

RESULTS

The seasonal abundance of leafcutting bees: The seasonal abundance of leafcutting bees was different in the start and the end of the generation. For the season 2005, the bees start flying at the beginning of April and the season lasted until last day of May (Fig. 3). For the season 2006, the bees start flying at the med of April and lasted at the first day of June (Fig. 4). For the season 2007, the bees start flying at the med of March and the season lasted at med of May (Fig. 5). Studied nesting activities of *Megachile uniformis* (A.) 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 was started on April 10 in the two seasons 2001-2003 (female activity was from April 10 to June 6) 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 [10].

The daily abundance of leafcutting bees: The daily activity of bees have bee studies for three seasons from 2005, 2006 and 2007 The bee numbers increasing from 9 am morning to reach maximum numbers at 1 pm then the activity decrease till sun set (Table 1-3 and Fig. 6). However, the number of bees were so high in the distances so close to the nest than far. There are a linear relationships between the distance and the number of bees, increasing the desistance follow by decreasing of bees numbers (Table 1-3 and Fig. 7).

DISCUSSION

Alfalfa *Medicago sativa* (L., 1753) had a blooming season in the experimental farm of about 8 weeks started from late March till end of May. During the blooming season *Megachile minutissima* (Radoszkowski, 1876) visited and pollinated the alfalfa

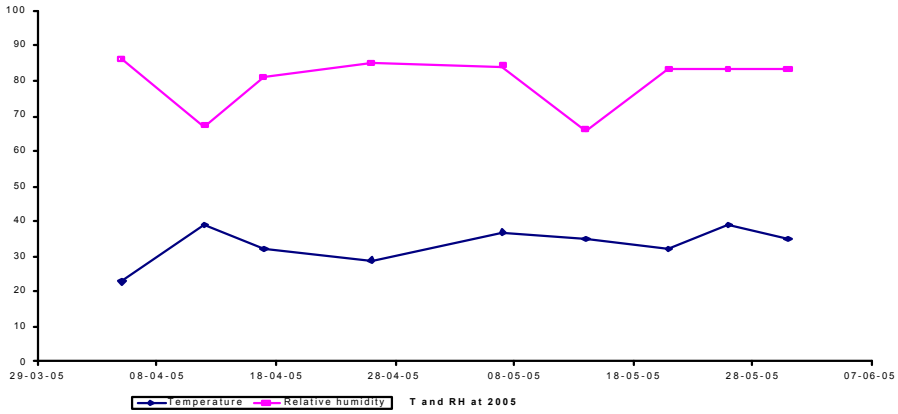

Fig. 3: Continued

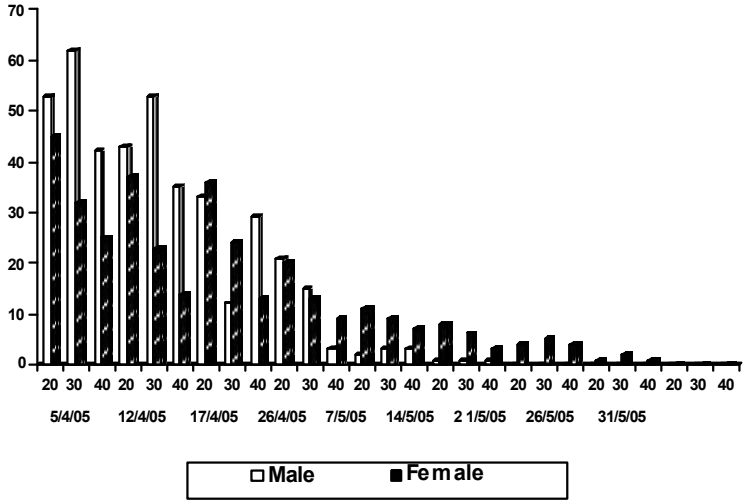

Fig. 3: Seasonal and daily activity, numbers of males, females and the total of *Megachile minutissima* (Radoszkowski, 1876) bees on alfalfa flowers at three different distances: the first distance (20 meter), second distance (30 meters) and third distance (40 meters), far from the shelters during 2005

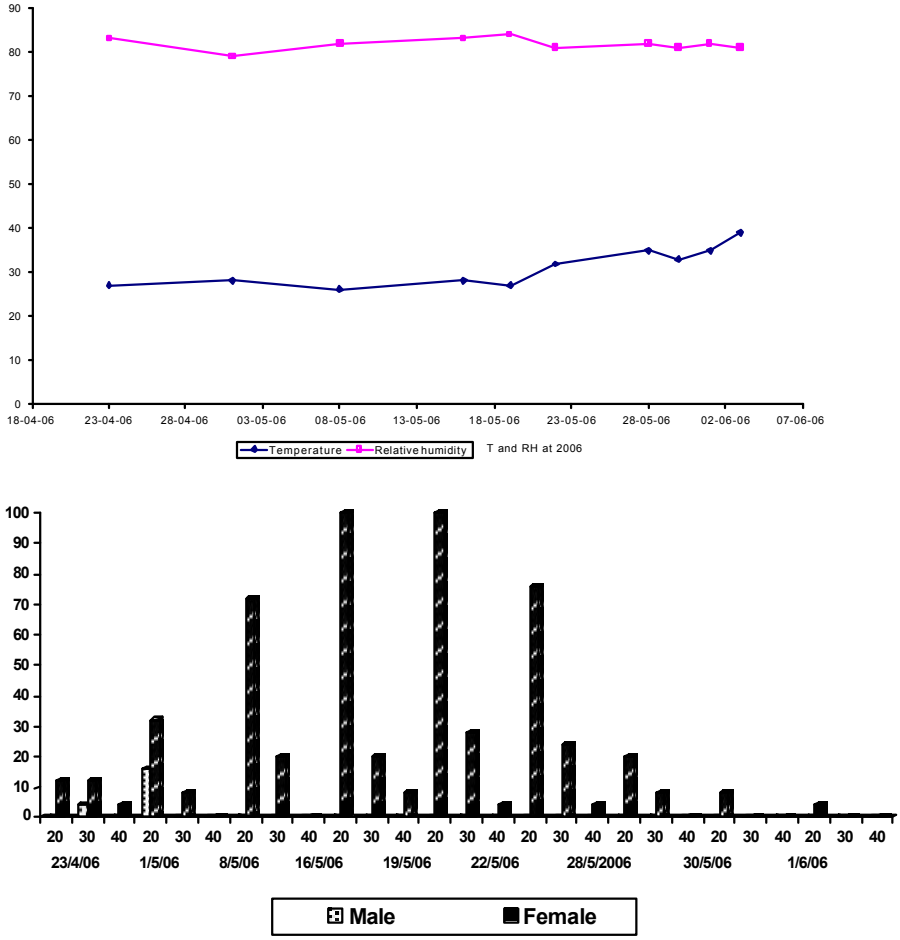

Fig. 4: Seasonal and daily activity, numbers of males, females and the total of *Megachile minutissima* (Radoszkowski, 1876) bees on alfalfa flowers at three different distances: the first distance (20 meter), second distance (30 meters) and third distance (40 meters), far from the shelters during 2006

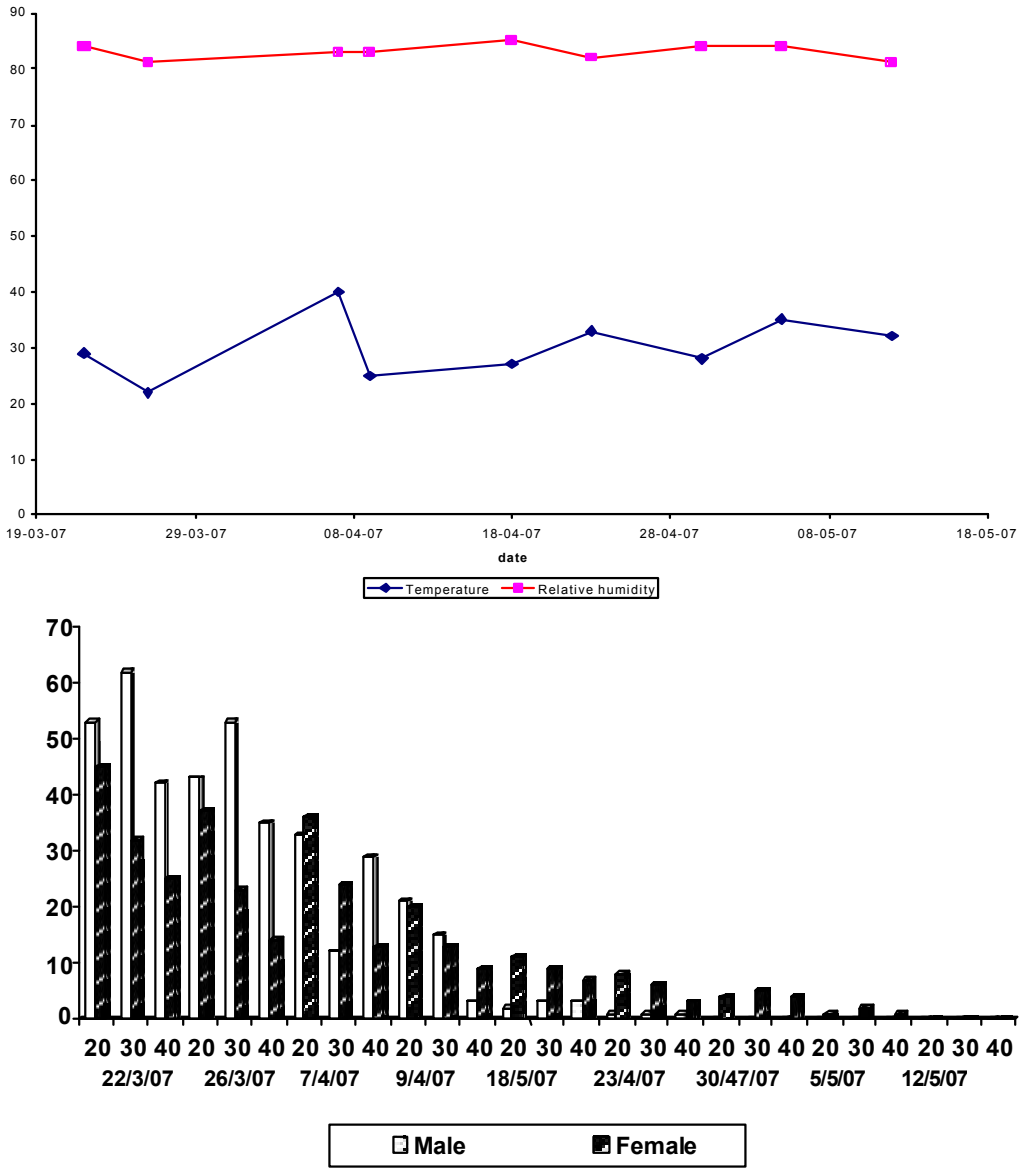

Fig. 5: Seasonal and daily activity, numbers of males, females and the total of *Megachile minutissima* (Radoszkowski, 1876) bees on alfalfa flowers at three different distances: the first distance (20 meter), second distance (30 meters) and third distance (40 meters), far from the shelters during 2007

flowers. Observations indicated that males of leafcutting bees start flying few days before females but there is no role for males in tripping of alfalfa flowers. By this way male has no efficiency in pollination of alfalfa [1]. Moreover, the numbers of males and were less the in the season 2006 (Fig. 4). This is due to the strong wind in the spring of 2006 destroy some artificial nests. Bees start to visit alfalfa flowers around 9 am, the number of bees were increased considerably at 10 am. bees were more active during 1 pm (Fig. 6).

The temperature and light intensity influence the beginning of flight of males and females. They start foraging under conditions of low temperature and high light intensity or vice versa. By adapting to new conditions, the bee has become more widely used to pollinate alfalfa. Peak flight occurs during midday and at high temperatures. Decreasing light intensity appears to be the main factor that ends daily foraging, even though summer temperatures during early evening are often above 20°C. The females spend the night in the nest, faced in ward. As temperatures rise in the morning, they turn around and face the entrance but do not come out and fly until the temperature exceeds 20°C and the sun's radiation reaches 0.7 langley. Bees

Table 1: Total number of bees on different times and distances in 2005

		First distance 20 m		Second distance 30 m		Third distance 40 m		Total	
Time		No	%	No	%	No	%	No	%
	10 am	76	9.9	65	8.5	75	9.9	216	28.3
	1 pm	169	22.1	102	13.3	65	8.5	336	43.9
	3 pm	71	9.3	92	12.0	50	6.5	213	27.8
Total		316	41.3	259	33.8	190	24.9	765	100.0

Table 2: Total number of bees on different times and distances in 2006

		First distance 20 m		Second distance 30 m		Third distance 40 m		Total	
Time		No	%	No	%	No	%	No	%
	10 am	136	23.8	52	9.1	0	0.0	188	32.9
	1 pm	200	34.9	52	9.1	20	3.5	272	47.5
	3 pm	92	16.1	20	3.5	0	0.0	112	19.6
Total		428	74.8	124	21.7	20	3.5	572	100.0

Table 3: Total number of bees on different times and distances in 2007

		First distance 20 m		Second distance 30 m		Third distance 40 m		Total	
Time		No	%	No	%	No	%	No	%
	10 am	290	19.4	225	15.1	151	10.1	666	44.6
	1 pm	308	20.6	220	14.7	118	7.9	646	43.2
	3 pm	79	5.3	62	4.1	42	2.8	183	12.2
Total		677	45.3	507	33.9	311	20.8	1495	100.0

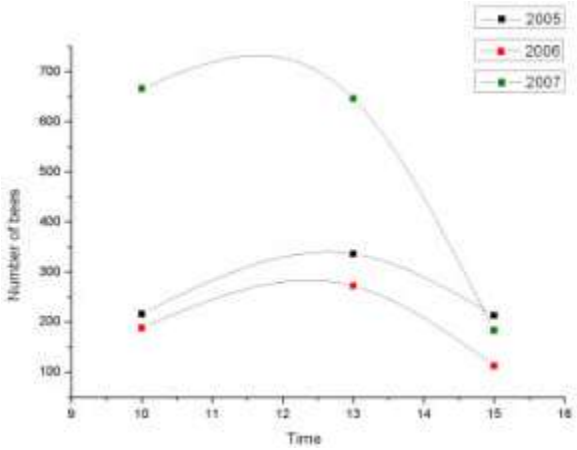

Fig. 6: The total number of bees at three times per day at 2005, 2006 and 2007

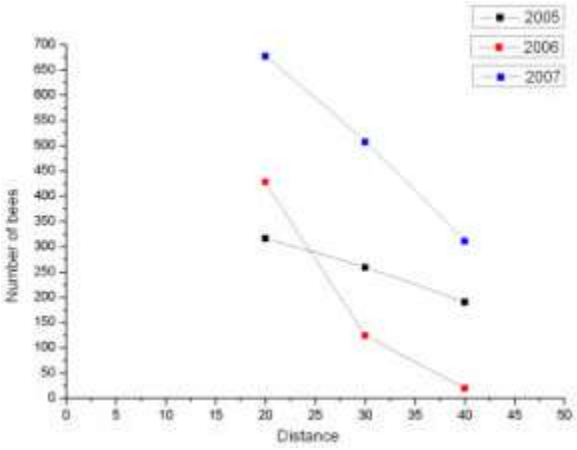

Fig. 7: The total number of bees at three distances from the nest at 2005, 2006 and 2007

foraged at 1075 lux when the temperature was 25°C but needed 6450 lux at 17°C. Bees stopped foraging in the evening when radiation dropped to 0.3 langley and also stopped if clouds reduced radiations to that level of Leafcutter bees fly approximately ¼ mile to find food [11]. Alfalfa flower production in commercial fields declines exponentially over the season (after an initial burst of bloom). In addition, standing crop of open flowers declines exponentially at a more rapid rate than open flower production, suggesting that the decline

in standing crop of flowers is due in part to increasing pollinator activity. The more rapid decline in open flowers per raceme close to bee shelters was consistent with this interpretation. The model of alfalfa pollination predicts a similar decline in flower standing crop of open flowers decreases and thus pollination was completed sooner. An exponential decline was standing crop of open flowers provides an explanation for the advantage of using large numbers of bees to pollinate alfalfa rapidly [12]. The impact of flower abundance and pollinator movement on seed or fruit yield is economic importance and may have implications for crop pollinator management. Field observations of within versus between plant movement of the pollinator, *Megachile rotundata* (F.) (Megachilidae), indicate that the bees visit more flowers per raceme when standing crop is high than when standing crop is low [13]. Figure 7 shows that increasing distance from the nest follows by decreasing number of bees.

Number of open flowers and nectar availability declined more rapidly close to bee shelters than at a distance from them. Interrupted the rapid decline in floral resources partly as a result of steady pollination over time [14]. The bee patterns of abundance and distribution vary on many scales across years, that patterns were not consistent between years and raised questions as to what this implies about bee-plant host relationships (15). Study the seasonal abundance and plant-pollinators relationship of lefacutting bees and other bee pollinators need more and more work to understand a lot of questions about it.

CONCLUSION

Leafcutting bees consider as one of the most important pollinator of leafcutting bees world wide. The emergency of leafcutting bees from artificial nests synchronized with the alfalfa blooming seasons in Ismailia, Egypt. The leafcutting bees activity was varied at different three times per day but the maximum activity was at 1pm. The number of bees decreased by increasing the distance from the artificial nests. So if the farmers use alfalfa leafcutting bees artificial nests it is recommended to distribute the nests to cover the whole field instead of putting the artificial nests in one site of the field.

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