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EVALUATION OF VARIOUS HONEYBEE FORAGING ACTIVITIES FOR IDENTIFICATION OF POTENTIAL BEE PLANTS IN RIYADH, SAUDI ARABIA

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ABSTRACT

Foraging activities of honeybee, *Apis mellifera* L.) on various flowering plants were studied during the year, 2003 under Riyadh environmental conditions. The results of the study indicated *Ocimum basilicum, Borag officinolis, Portuloco spp., Eruca sativa, Helianthus annuus* L., *Pansia spp.* and *Eucalyptus rostrata* for spring season, *Ocimum basilicum, Portuloco spp., Helianthus annuus* L., and *Cucumis spp.* for summer season, *Portuloco spp., Ocimum basilicum, Helianthus annuus* L., *Leucaena leucocephala* and *Cynodon dactylon* for autumn season and *Brassica juncea, Helianthus annuus* L., *Eruca sativa, Acacia farmesiana* and *Acacia salicina* for winter season as most promising bee plants during their flowering periods in relation to various honeybee activities. Average various honeybee activities reached the maximum at 9-11 a.m. during spring, 7-9 a.m. during summer, 7-11 a.m. during autumn and 11 a.m. to 3 p.m. during winter. Weak correlation between various honeybee activities and temperature and relative humidity were also obtained.

1. INTRODUCTION

Flowering plants and honeybees have a special relationship in which both are benefited from each other. As honeybees get food and in turn facilitate their pollination process. Honeybees visit flowers to collect pollen and nectar. Pollens are the principle source of protein, fats, vitamins and minerals, which are essential for honeybee growth and development, repairing of worn out tissue and stimulating the development of hypopharyngeal glands. Nectar is the carbohydrate compounds mainly sucrose, fructose and glucose portion of the honeybee's food and is the raw material of honey **(Jones and Yates, 1991).**

Standard honey yield mainly depends on the availability of flora, which provide nectar and pollens in copious quantity year around. So for maximum honey production it becomes imperative to establish a balanced bee forage system where there is adequate bee forge for large parts of the season but there are "windows of times" during which the local bee forage is inadequate. These gaps can be filled with the identification and planting of suitable bee plants. The potential bee plants can be identified by recording activities of honeybees on different flowering plants.

During foraging activities, honeybees identify and differentiate among various flowers using odors and both intensity and odor quality effect the ability of honeybee to discriminate between floral perfumes **(Pham-Delegue *et al* 1986).** Honeybee forage by selecting flowers that have similar shape, colour and odor **(Chittka *et al* 1999).** Flowers are often accepted or rejected ultimately on the basis of their odors **(Dobson, 1994).** In Egypt, **Hussein *et al* (1992a)** recorded the main

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pollen sources, hours of maximum activity, number of collectors and associated weather factors. In Assiut region, Upper Egypt, 23 botanical species including field and forage crops, weeds, ornamental, vegetable and fruit plants were recorded as pollen flora for honeybee (**Hussein, 1982**). Honeybee foraging activities and flowering of some major and minor nectar and/or pollen source were studied (**Hussein *et al* 1992b**). According to **Rashad *et al* (1983 a&b)** foraging activities of honeybees reduce at temperature above 38°C on Egyptian clover and alfalfa.

Hussein, (1983) also studied species composition of pollen loads and their variation time of day in Upper Egypt. Maximum honeybee foraging activities were recorded during the months of August, July and September foraging activities remained minimum during December January and November (**Hussein *et al* 1992 a&b**). Peak foraging in relation to daytime was observed at 9a.m. during September, October and November, at 11a.m. during April, May, June, July and August, at 1p.m.during December, January, March and April while minimum foraging was recorded at 7a.m. in all months except October and November at 5p.m.(**Omar *et al* 1992 a & b**). Foraging activities of honeybees on different flowering plants were studied by **Rashad *et al* 1983a & b; and Omar *et al* 1994**). The effect of climatic factors on honeybee foraging activities was studied by **Rashad and Ewies (1980)**; **Hussein *et al* (1992 a&b)** and **Omar *et al* (1992a& b)**.

The aim of the present study is to record the foraging activities of honeybee on different types of flowering plants in Saudi Arabia to identify the most important bee plants in different seasons and to include them while establishing a balanced bee foraging system. There is dire need of such bee forage system in the kingdom where there is a main limiting factor in standard honey production is dearth of potential honey plants.

2. MATERIALS AND METHODS

The study was carried out at the Experimental Research Station Derab, College of Agriculture, King Saud University, Riyadh, Saudi Arabia during the year, 2003. Honeybee activities were studied on different flowering plants visited by bees, on weekly basis starting from 7a.m. to 5p.m. with two hours interval. Data was recorded for following factors using quadrate meter (1 m^2).

1. No. of bees/ m^2/min.
2. No. of bees collecting nectars/ m^2/min.
3. No. of bees collecting pollens/ m^2/min.
4. No. of bees collecting pollens and nectars/m^2/min.
5. No. of flowers visited by one bee/ m^2/min.
6. No. of bees visit one flower.

Inspection was made by naked eyes. The time was recorded using stop watch while the bees were counted using counter. Temperature and relative humidity were recorded continuously during the experimental work. The obtained data were statistically analyzed.

3. RESULTS AND DISCUSSION

3.1. General honey bee foraging activities on different plant species

Various honeybee foraging activities recorded on different flowering plants during four different seasons have been presented in the **Figs. 1(a,b), 2, 3 and 4**, respectively.

During spring season the activities were recorded on the following 25 flowering plants: *Cosmos bipinnatus*, *Prosopis juiflora*, *Portuloco spp.*, *Borag officinolis*, *Helianthus annuus* L., *Ocimum basilicum*, *Eucalyptus rostrata*, *Parkinsonia aculeate*, *Eruca sativa*, *Coriandym satvium*, *Leucaena leucocephala*, *Pansia spp.*, *Adhatoda vasica*, *Brassica juncea*, *Wedelia trilobata*, *Citrus limon*, *Raphanus sativus*, *Acacia farnesiana*, *Acacia ehrenbergiana*, *Allium cepa* L., Loshindi, *Cucumis spp.*, *Cucurbia pepo* L., *Acacia seyal* and. *Tecoma stans*.

During summer the activities were recorded on the following 9 flowering plants: *Ocimum basilicum*, *Helianthus annuus* L., *Portuloco spp.*, *Cucumis spp.*, *Acacia spp.*, *Leucaena leucocephala*, *Acacia seyal*, *Medicage sativa* and *Eucalyptus rostrata* whereas, in autumn season honeybee activities were recorded on the followig 15 flowering plants; *Portuloco spp.*, *Ocimum basilicum*, *Helianthus annuus* L., *Leucaena leucocephala*, *Cynodon dactylon*, *Eruca sativa*, *Cucumis spp.*, *Brassica juncea*, *Prosopis juiflora*, *Acacia tortilis*, *Portulaca oleracca* L. *Tecoma stans*, *Acacica salicina*, *Zyziphus spp.* and *Acacia seyal*.

During winter season, the honeybee activities were recorded on the following 19 flowering plants including: *Brassica juncea*, *Helianthus annuus* L., *Eruca sativa*, *Acacia farnesiana*, *Acacia salicina*, *Ocimum basilicum*, *Leucaena leucocephala*, *Cosmos bipinnatus*, *Borag officinolis*, *Prosopis juiflora*, *Wedelia trilobata*, *Raphanus sativus*,. *Coriandym satvium*, *Tecoma stans*,

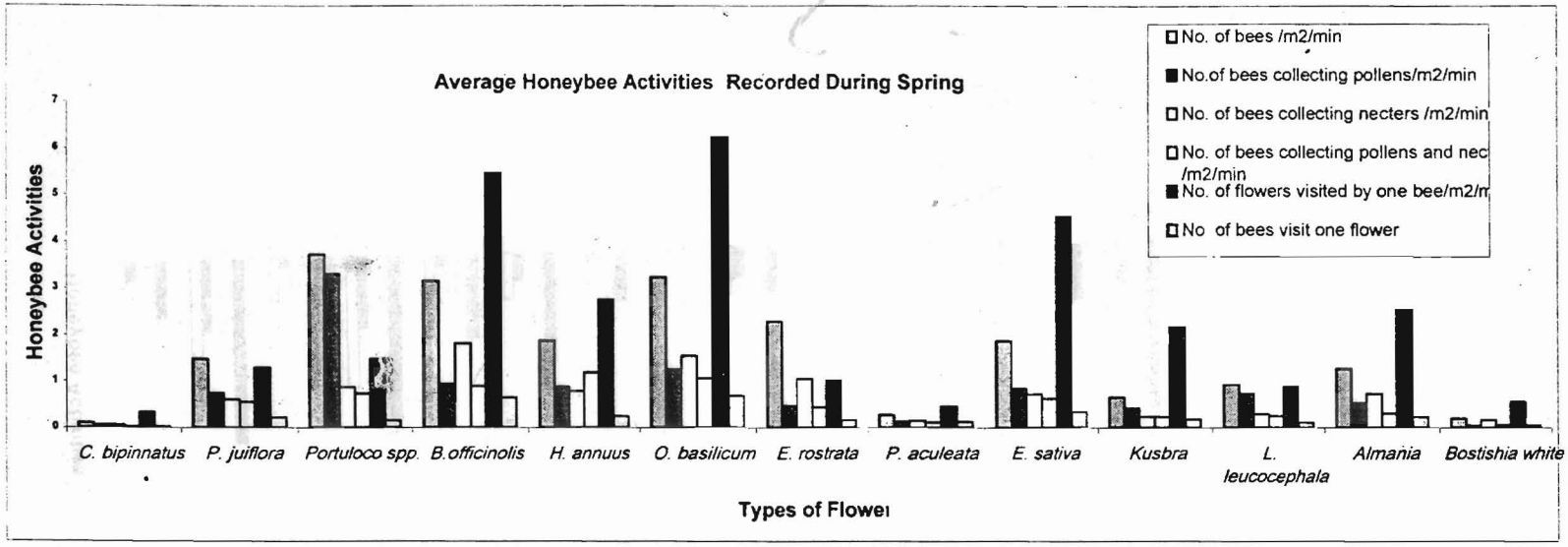

Figure 1a. Average honeybee activities recorded during spring, 2003 on various flowering plants

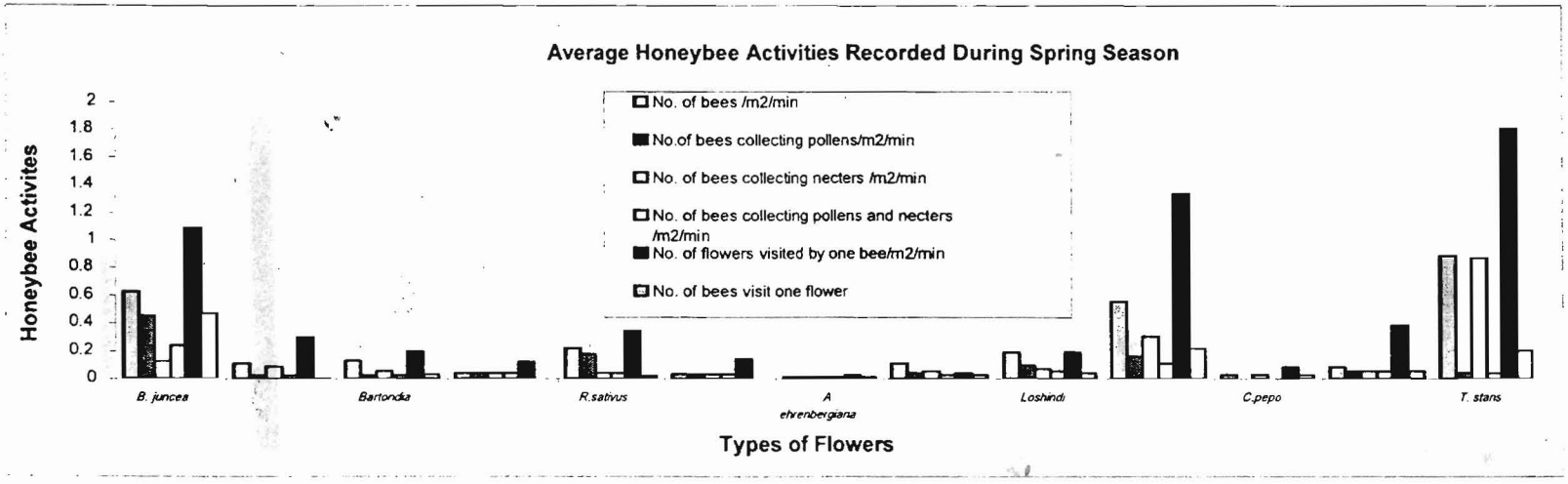

Figure 1b. Average honeybee activities recorded during spring, 2003 on various flowering plants

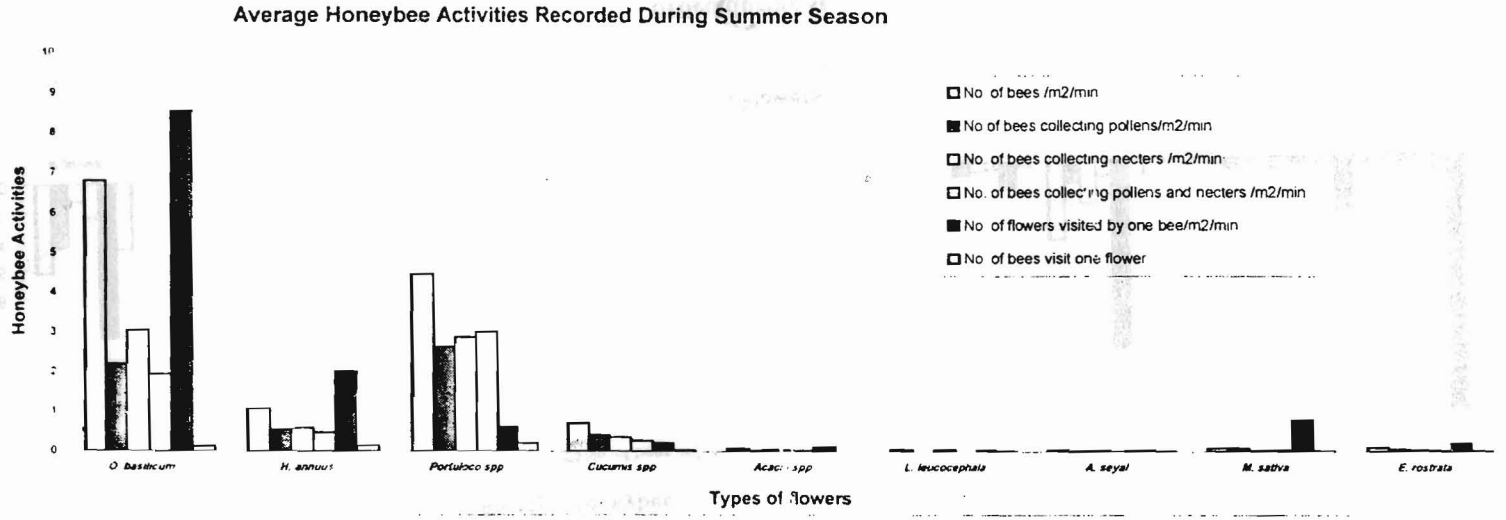

Figure 2. Average honeybee activities recorded during summer, 2003 on various flowering plants

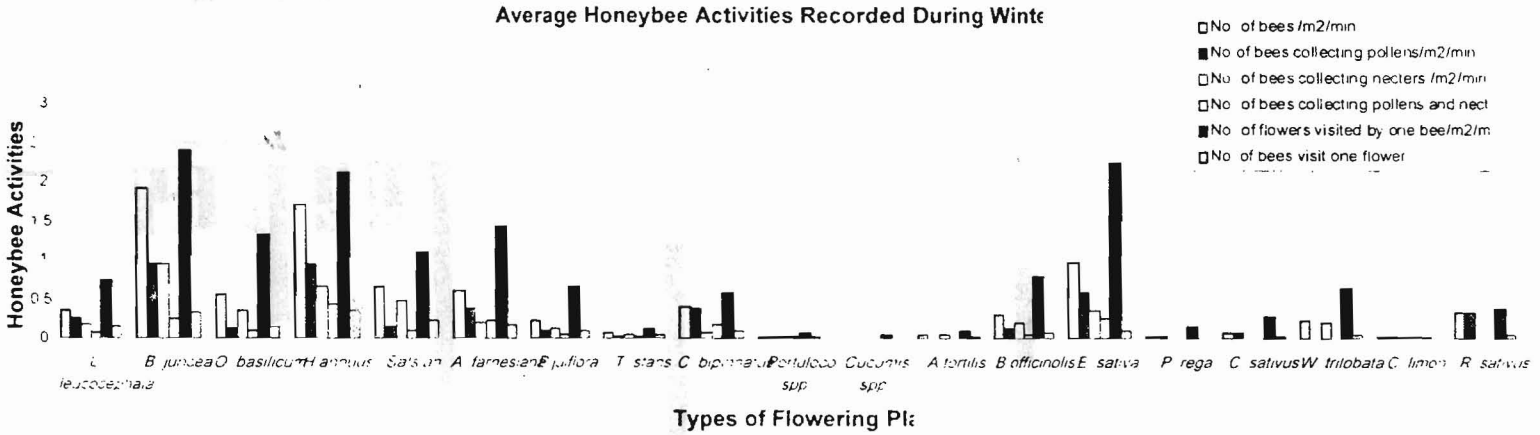

Figure 3. Average honeybee activities recorded during winter, 2003 on various flowering plants.

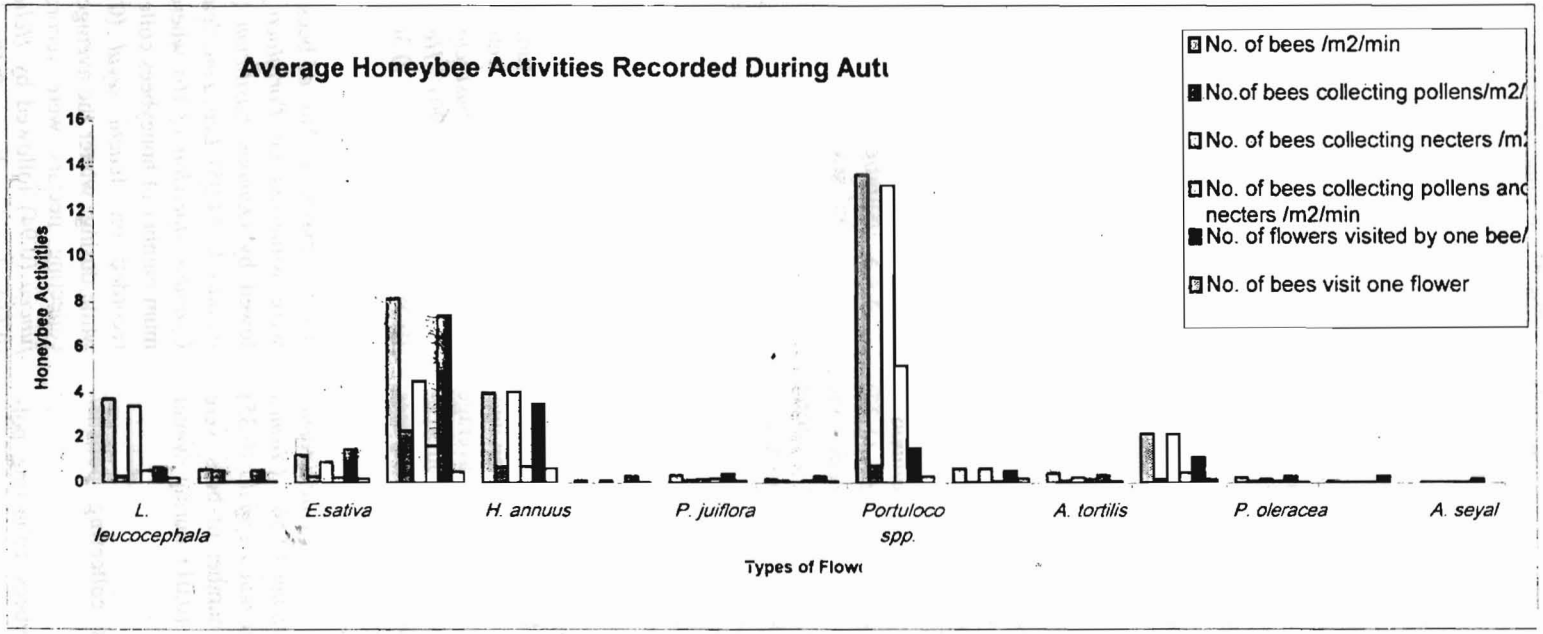

Figure 4. Average honeybee activities recorded during Autumn, 2003 on various flowering plants.

Acacia tortilis , Portuloco spp., Poinciana rega, Citrus limon and *Cucumis spp.* The general activities of honeybee workers were calculated regarding number of bees /m/min, number of bees collecting pollens/m/min., number of bees collecting nectars/m/min, number of bees collecting pollens and nectars/m/min., number of flowers visited by one bee/m/min. and number of bees visited one flower. The level of each honeybee activity on each flowering plant during the four seasons allover the year has been discussed below.

3.2. Some honeybee foraging activities on different plant species

3.2.1. Number of bees/m^2/min.

The results revealed that the average maximum Nos. of bees/m^2/min. were recorded on *Portuloco spp.* (3.75) followed by *Ocimum basilicum* (3.24), *Borag officinolis* (3.13). *Eucalyptus rostrata* (2.28), *Eruca sativa* (1.87), *Helianthus annuus* L. (1.8), *Prosopis juiflora* (1.48), *Pansia spp.* (1.27) whereas average minimum number of bees were recorded on *Acacia ehrenbergiana* (0.01) during spring season. During summer season the average maximum no. of honeybees were recorded on *Ocimum basilicum* (6.81) followed by *Portuloco spp.* (4.47), *Helianthus annuus* L. (1.10), *Cucumis spp.* (0.71), *Eucalyptus rostrata* (0.11) whereas average minimum number of bees were witnessed on *Acacia seyal* (0.04). In autumn average maximum No. of honeybees were recorded on *Portuloco spp.* (13.62) followed by *Ocimum basilicum* (8.15), *Helianthus annuus* L. (3.98), *Cynodon dactylon* (2.18), *Eruca sativa*(1.22) whereas average minimum number of bees were recorded on *Acacia seyal* (0.02) while average No. of honeybees remained maximum on *Brassica juncea* (1.92) followed by *Helianthus annuus* L. (1.71), *Eruca sativa* (0.98),*Acacia salicina* (0.66), *Acacia farnesiana* (0.61), *Ocimum basilicum* (0.56), *Cosmos bipinnatus* (0.40), *Leucaena leucocephala* (0.35) whereas average minimum number of bees were recorded on *Cucumis spp.* (0.01) during winter season.

3.2.2. Number of bees collecting pollens/ m^2/min.

Maximum No. of honeybees collecting pollens/m^2/min. were witnessed on *Portuloco spp.* (3.30) followed by *Ocimum basilicum* (1.28), *Borag officinolis* (0.95), *Helianthus annuus* L. (0.89), *Eruca sativa* (0.83), *Prosopis juiflora* (0.74) whereas average minimum number of honeybees collecting pollens were recorded in *Acacia ehrenbergiana* (0.01) during spring season. During summer season more No. of honeybees recorded on *Portuloco spp.* (2.66) followed by *Ocimum basilicum* (2.22), *Helianthus annuus* L. (0.56), *Cucumis spp.* (0.41), whereas pollen collection remained nil on *Leucaena leucocephala*. In autumn season maximum No. of honeybees collecting pollen were recorded on *Ocimum basilicum* (2.30) followed by *Portuloco spp.* (0.77), *Helianthus annuus* L. (0.69), *Brassica juncea* (0.56), whereas nil on *Acacia seyal*. During winter the more No. of honeybees gathering pollens were recorded on *Helianthus annuus* L. (0.95) followed by *Brassica juncea* (0.94), *Eruca sativa* (0.59), *Acacia farnesiana* (0.38), *Cosmos bipinnatus* (0.37), *Raphanus sativus* (0.33) whereas in *Acacia tortilis*, *Wedelia trilobata*, and *Cucumis spp.* the bees collecting pollen remained nil

3.2.3. Number of bees collecting nectar/ m^2/min.

During spring season average maximum No. of bees collecting nectars were recorded on *Borag officinolis* (1.8) followed by *Ocimum basilicum* (1.55), *Eucalyptus rostrata* (1.06), *Portuloco spp.* (0.87), *Tecoma stans* (0.8) *Helianthus annuus L.* (0.79), *Eruca sativa* (0.73), *Pansia spp.* (0.73) whereas average minimum number of honeybees collecting nectars were recorded on *Acacia ehrenbergiana* (0.01). But in summer season the more average No. of bees collecting nectars were witmessed on *Ocimum basilicum* (3.06) followed by *Portuloco spp.* (2.90), *Helianthus annuus* (0.59), *Cucumis spp.* (0.36) whereas average minimum number of honeybees collecting nectars were noted on *Acacia seyal* (0.02). In autumn the average maximum No. of bees collecting nectars were witnessed on *Portuloco spp.* (13.15) followed by *Ocimum basilicum* (4.52), *Helianthus annuus* L. (4.05) *Leucaena leucocephala* (3.43), *Cynodon dactylon* (2.16) whereas average minimum number of honeybees collecting nectars were recorded on *Acacia seyal* (0.02), respectively while during winter the average high No. of bees collecting nectars were recorded on *Brassica juncea* (0.94) followed by *Helianthus annuus* L. (0.66), *Acacia salicina* (0.48), *Ocimum basilicum* (0.34), *Eruca sativa* (0.34) whereas in *Poinciana rega*, *Coriandym satvium* and *Raphanus sativus* nectar collection was recorded as nil.

3.2.4. Number of bees collecting pollens and nectars/m^2/min.

During spring season average maximun No. of bees collecting pollens and nectars were recorded on *Helianthus annuus* L. (1.19) followed by *Ocimum basilicum* (1.0), *Borag officinolis* (0.90), *Portuloco spp.* (0.73), *Eruca sativa* (0.63), *Prosopis juiflora* (0.5) whereas minimum average No. of honeybees gathering pollens and nectars together were witnessed on *Acacia ehrenbergiana* (0.01). In summer season the average No. of bees collecting pollens and nectars remained maximum on *Portuloco spp.* (3.02) followed by *Ocimum basilicum* (1.59), *Helianthus annuus* L. (0.48), *Cucumis spp.* (0.26) but on *Leucaena leucocephala* the pollen and nectar collecting honeybees remained nil. During autumn season more average No. of bees collecting pollens and nectars were found on *Portuloco spp.* (5.18) followed by *Ocimum basilicum* (1.62), *Helianthus annuus* L. (0.73), *Leucaena leucocephala* (0.55) whereas nil on *Acacia salicina* while in winter season high average No. of bees collecting pollens and nectars recorded on *Helianthus annuus* L. (0.42) followed by *Brassica juncea* (0.26), *Eruca sativa* (0.26), *Acacia farnesiana* (0.23 whereas nil on *Cucumis spp.*, *Acacia tortilis*, *Coriandym satvium Raphanus sativus* and *Wedelia trilobata*.

3.2.5. Number of flowers visited by one bee/ m^2/min.

The results showed that one honeybee visited average maximum number of *Ocimum basilicum* (6.24) flowers/m^2/min. followed by *Borag officinolis* (5.46), *Eruca sativa* (4.55), *Helianthus annuus* L. (2.75), *Pansia spp.* (2.55), *Coriandym satvium* (2.17), *Tecoma stans* (1.80), *Portuloco spp.* (1.48), *Cucumis spp.* (1.30), *Prosopis juiflora* (1.30), *Brassica juncea* (1.08) whereas average minimum number of flowers visited one bee were *Acacia ehrenbergiana* (0.02) during spring season. During summer one bee visited average maximum number of *Ocimum basilicum* (8.58) flowers followed by *Helianthus annuus* L. (2.02), *Medicage sativa* (0.80), *Portuloco spp.* (0.62), *Cucumis spp.* (0.22) whereas the average minimum number of bees visited *Acacia seyal* (0.04). In autumn season one bee visited average maximum number of *Ocimum basilicum* (7.40) flowers followed by *Helianthus annuus L.* (3.51), *Portuloco spp.* (1.54), *Eruca sativa* (1.51), *Cynodon dactylon* (1.14) whereas the average minimum number of bees visited *Acacia seyal* (0.02). During winter season one bee visited average maximum number of *Brassica juncea* (2.40) flowers/m^2/min. followed by *Eruca sativa* (2.26), *Helianthus annuus* L. (2.12), *Acacia farnesiana* (1.43), *Acacia salicina* (1.20) whereas average minimum number of flowers visited one bee were *Acacia tortilis* (0.01).

3.2.6. Number of bees visited one flower/min.

During spring season average maximum number of bees visited to one flower/ min. were recorded on *Ocimum basilicum* (0.69) followed by *Borag officinolis* (0.65), *Brassica juncea* (0.46), *Eruca sativa* (0.35), *Helianthus annuus* L. (0.26), *Prosopis juiflora* (0.23), *Tecoma stans* (0.2), *Coriandym satvium* (0.18) whereas the average minimum number of bees visited *Wedelia trilobata* (0.01). Average number of bees visits remained maximum on *Portuloco spp.* (0.22) followed by *Helianthus annuus* L. (0.15), *Ocimum basilicum* (0.13) whereas on *Acacia spp.* the No. of bees visitation on one flower/min. remained nil during summer season. In autumn season the average maximum number of bees visited to one flower/ min. remained maximum on *Helianthus annuus* L. (0.66) followed by *Ocimum basilicum* (0.51), *Portuloco spp.* (0.30), *Eruca sativa* (0.20) whereas on *Zyziphus spp.* and *Acacia seyal* the No. of bees visitation on one flower/min. remained nil. During winter season the average maximum number of bees visited to one flower/ min. witnessed on *Helianthus annuus* L. (0.35) followed by *Brassica juncea* (0.34), *Acacia salicina* (0.23), *Acacia farnesiana* (0.16), *Leucaena leucocephala* (0.16), *Ocimum basilicum* (0.15) whereas no visitation was recorded on *Poinciana rega* and *Coriandym satvium*.

Analysis of variance revealed that various flowering plants differ at some level of significance for mean average different honeybee activities recorded during spring season **(Table 1)**. Maximum mean average activities were witnessed on *Ocimum basilicum* and *Borag officinolis* which remained statistically at par with *Portuloco spp.*, *Eruca sativa*, *Helianthus annuus* L., *Pansia spp.* and *Eucalyptus rostrata* and different from rest of all flowering plants at $\alpha = 0.05$ and LSD= 1.49.

Analysis of variance calculated for different honeybee activities recorded during summer season indicated that various flowering plants differ at some level of significance for mean average honeybee activities **(Table 1)**. Maximum activities

Table 1. Means of all honey bee activities recorded on different flowering plant species during different seasons

No.	Flowering plant species	Honeybee activities during			
		Spring	Summer	Autumn	Winter
1	*Ocimum basilicum*	2.344	3.798	4.088	0.4407
2	*Portuloco spp.*	1.715	2.319	5.764	0.0315
3	*Helianthus annuus*	1.296	0.822	2.275	1.0407
4	*Leucaena leucocephala*	0.538	0.028	1.488	0.2906
5	*Cucumis spp.*	0.449	0.336	0.350	0.0130
6	*Acacia seyal*	0.115	0.025	0.046	-
7	*Eruca sativa*	1.496	-	0.736	0.7593
8	*Prosopis juiflora*	0.825	-	0.227	0.2116
9	*Tecoma stans*	0.643	-	0.132	0.0537
10	*Brassica juncea*	0.500	-	0.326	1.1370
11	*Eucalyptus rostrata*	o.912	0.088	-	-
12	*Borag officinolis*	2.161	-	-	0.370
13	*Coriandym satvium*	0.654	-	-	0.462
14	*Raphanus sativus*	0.142	-	-	0.1829
15	*Cosmos bipinnatus*	0.106	-	-	0.2880
16	*Wedelia trilobata*	0.092	-	-	0.1898
17	*Citrus limon*	0.050	-	-	0.0162
18	*Acacia farnesiana*	0.046	-	-	0.5079
19	*Acacia tortilis*	-	-	0.225	0.0370
20	*Acacia salicina*	-	-	0.088	0.4620
21	*Pansia spp.*	0.940	-	-	
22	*Parkinsonia aculeate*	0.217	-	-	
23	*Adhatoda vasica*	0.184	-	-	
24	*Loshindi spp.*	0.108	-	-	
25	*Allium cepa*	0.050	-	-	
26	*Cucurbita pepo*	0.027	-	-	
27	*Acacia ehrenbergiana*	0.016	-	-	
28	*Medicago sativa*	-	0.185	-	
29	*Acacia spp.*	-	0.055-	-	
30	*Cynodon dactylon*	-	-	1.047	
31	*Portulaca oleracca*	-	-	0.148	
32	*Zyziphus spp.*	-	-	0.083	
33	*Poinciana rega*	-	-	-	0.301
	L.S.D. at 0.05	1.490	0.795	2.071	0.547
	No. of flowering plant species	25	9	15	19

were recorded on *Ocimum basilicum* followed by *Portuloco spp.* and *Helianthus annuus* L. which remained statistically different whereas *Helianthus annuus* L., *Cucumis spp.*, *Medicage sativa Eucalyptus rostrata*, *Acacia spp.*, *Leucaena leucocephala* and *Acacia seyal* were found statistically similar to each other at $\alpha = 0.05$ and LSD= 2.071.

Analysis of variance presented that various flowering plants differ at some level of significance for overall average different honeybee activities recorded during Autumn (**Table 1**). Maximum activities were noted on *Portuloco spp.* which remained statistically at par with *Ocimum basilicum* whereas remaining flowering plants did not show any significant difference at $\alpha = 0.05$ and LSD= 2.071.

Analysis of variance showed that various flowering plants differ at some level of significance for mean average different honeybee activities recorded during winter (**Table 1**). Maximum mean average activities were witnessed on *Brassica juncea* and *Helianthus annuus* L. which remained statistically at par with *Eruca sativa* and differ significantly from rest of all flowering plants at $\alpha = 0.05$ and LSD= 0.547.

3.3. Honeybee foraging activities on *Ocimum basilicum* during daytimes in different seasons

Average honeybeeforaging activities at different intervals of the day, i.e. a7 a.m., 9 a.m., 11 a.m., 1 p.m. 3 p.m. and 5 p.m. were studied on *Ocimum basilicum* because its prese4nce during the entire four seasons.

3.3.1. Foraging activities during spring

Data recorded during spring season (**Table 2**) indicated significantly high number of bees/ m^2/min. on *Ocimum basilicum* at 11a.m., whereas significantly lower number of bees/m^2/min. were recorded at 7a.m. and 5p.m., which remained statistically at par with each other. Minimum pollen collecting activities were witnessed at 7a.m. which were gradually increased up to 11a.m. which remained as peak pollen collecting hour and, thereafter, activities significantly decreased upto 1p.m. and than again a boost was recorded at 3p.m. The peak nectar collecting activities were witnessed at 9a.m. but the results revealed collective maximum pollen and nectar collecting activities at 11a.m. The maximum No. of flowers visited by one bee were recorded at 5p.m. and maximum No. of bees visiting one flower recorded at 9a.m.

3.3.2. Foraging activities during summer

Average honeybee activities recorded on *Ocimum basilicum* at different interval of the day (**Table 3**) indicated that significantly high No. of bees/ m^2/min. were recorded at 9a.m. whereas the activities remained nil at 5p.m. Maximum pollen collecting activities were recorded at 9a.m. which decreased to nil at 3p.m. The peak nectar collecting activities were witnessed at 1p.m. but the results revealed collective maximum pollen and nectar collecting activities at 9a.m. The maximum No. of flowers visited by one bee were recorded at 1p.m. and maximum No. of bees visiting one flower recorded at 9a.m.

3.3.3. Foraging activities during autumn

Average honeybee activities recorded on *Ocimum basilicum* at different interval of the day (**Table 4**) indicated that significantly high No. of bees/ m^2/min. were recorded at 9a.m. followed by 11a.m. whereas significantly lower No. of bees/ m^2/min. were recorded at 5p.m. Maximum pollen collecting activities were also witnessed at 9a.m. which decreased to nil at 3 and 5p.m. The peak nectar collecting activities were witnessed at 3p.m. which remained statistically at par with nectar collection at 11a.m. but the results revealed collective maximum pollen and nectar collecting activities at 1p.m. The maximum No. of flowers visited by one bee were recorded at 1p.m. and maximum no. of bees visiting one flower recorded at 9a.m. and 3p.m. The results are consistent with the findings of **Omar *et al* (1992a)** recorded 9a.m. as peak honeybee activities hour during month of September, October and November.

3.3.4. Foraging activities during winter

Average honeybee activities recorded on *Ocimum basilicum* at different interval of the day (**Table 5**) indicated that significantly high No. of bees/ m^2/min. were recorded at 1p.m. whereas the number of bees recorded at 7a.m. and 5p.m. remained nil. The peak pollen collecting hour of the day was also 1p.m. which was statistically at par with 11a.m. whereas at 7a.m., 9a.m. and 5p.m. the activities remained nil. The peak nectar collecting activities were witnessed at 3p.m. but the results revealed collective maximum pollen and nectar collecting activities at 1p.m. The maximum No. of flowers visited by one bee were recorded at 3p.m. and maximum No. of bees visiting one flower recorded at 11a.m. and 1p.m.

Table 2. Different honeybee activities recorded on *Ocimum basilicum* at different times of the day during spring season (Means of 5 replicates)

Time	Different honeybee activities*					
	1	2	3	4	5	6
7 a.m.	1.80	0.60	1.40	0.60	2.00	0.40
9 a.m.	3.00	1.40	2.00	0.40	4.20	1.00
11 a.m.	4.20	3.60	0.40	2.20	5.80	0.60
1 p.m.	2.60	1.00	1.00	0.80	3.60	0.40
3 p.m.	3.00	2.40	0.60	1.80	9.40	0.60
5 p.m.	2.20	1.80	0.40	0.20	10.20	0.00
LSD at 0.05	1.02	0.73	0.60	0.86	1.33	0.25

*) The numbers of honeybee activities are similar to those reported in "Material and Methods"

Table 3. Different honeybee activities recorded on *Ocimum basilicum* at different times of the day during summer season (Means of 5 replicates)

Time	Different honeybee activities*					
	1	2	3	4	5	6
7 a.m.	5.00	3.00	2.25	2.00	3.50	0.00
9 a.m.	10.25	7.00	1.75	2.75	6.50	0.50
11a.m.	5.25	2.25	1.75	1.50	7.00	0.00
1 p.m.	4.24	0.50	2.50	0.75	16.50	0.00
3 p.m.	1.00	0.00	1.00	0.00	10.75	0.00
5 p.m.	0.00	0.00	0.00	0.00	0.00	0.00
LSD at 0.05	0.68	0.77	0.41	0.21	1.65	0.07

*) The numbers of honeybee activities are similar to those reported in "Material and Methods"

Table 4. Different honeybee activities recorded on *Ocimum basilicum* at different times of the day during autumn season (Means of 5 replicates)

Time	Different honeybee activities*					
	1	2	3	4	5	6
7 a.m.	9.75	9.25	1.00	1.25	4.00	1.00
9 a.m.	28.00	28.25	1.50	2.00	4.25	0.75
11a.m.	16.50	16.50	3.00	0.75	6.00	0.50
1 p.m.	8.25	1.25	1.75	4.75	12.00	0.25
3 p.m.	7.25	0.00	3.75	3.50	7.75	0.75
5 p.m.	0.25	0.00	0.25	0.00	5.75	0.00
LSD at 0.05	3.81	3.60	1.10	1.18	2.84	0.17

*) The numbers of honeybee activities are similar to those reported in "Material and Methods"

Table 5. Mean average different honeybee activities recorded on *Ocimum basilicum* at different times of the day during winter season (Means of 5 replicates)

Time	Different honeybee activities*					
	1	2	3	4	5	6
7 a.m.	0.00	0.00	0.00	0.00	0.00	0.00
9 a.m.	0.60	0.00	0.60	0.00	1.00	0.20
11a.m.	3.40	2.80	0.40	0.40	4.60	1.00
1 p.m.	4.60	3.40	0.80	1.00	6.60	1.00
3 p.m.	2.80	1.60	1.00	0.20	8.60	0.60
5 p.m.	0.00	0.00	0.00	0.00	0.00	0.00
LSD at 0.05	0.64	0.67	0.37	0.21	1.70	0.15

*) The numbers of honeybee activities are similar to those reported in "Material and Methods"

3.4. Correlations between honeybee foraging activities and weather factors

The honeybee activities were also correlation with temperature and relative humidity recorded during different seasons. During spring season the results showed a weak positive correlation between bee activities and temperature while a weak negative correlation with the relative humidity. In summer season results revealed a weak negative correlation between average bee activities and temperature whereas, a positive correlation with relative humidity. During autumn season temperature and relative humidity both presented very weak correlation with honeybee activities. Bee activities and temperature showed a weak positive correlation while a weak negative correlation with the relative humidity during winter season **(Table 6)**.

4. DISCUSSION

The study was conducted to evaluate different foraging activities for the identification of potential bee plants for different seasons in order to establish a balanced bee foraging system. List of the plants with their relative importance in terms of bee activities has been provided in the **Table (1)**. for different seasons form where the most important bee plants can be selected such as *Ocimum basilicum, Borag officinolis, Portuloco spp., Eruca sativa, Helianthus annuus* L., *Pansia spp.* and *Eucalyptus rostrata* for spring season, *Ocimum basilicum, Portuloco spp., Helianthus annuus* L., and *Cucumis spp.* for summer season, *Portuloco spp., Ocimum basilicum, Helianthus annuus* L., *Leucaena leucocephala* and *Cynodon dactylon* for autumn season and *Brassica juncea, Helianthus annuus* L., *Eruca sativa, Acacia farmesiana* and *Acacia salicina* for winter season. **Hussain (1982)** also recorded 23-botanical species including field and forage crops, weeds, ornamental, vegetable and fruit plant as pollen flora for honeybee in Assiut region. **Hussein (1992b)** studied honeybee foraging activities and flowering plants of some major and minor nectar and/or pollen source in Egypt. Foraging activities of honeybees on different flowering plants were studied by **(Rashad *et al* 1983a & b Omar *et al* 1992a and Omar *et al* 1994).**

Average various honeybee activities remained different at different times of the day in all seasons with respect to temperature and relative humidity. Activities remained maximum at 9-11a.m. during spring, 7-9 a.m. during summer, 7-11 a.m. during autumn and 11 a.m. to 3 p.m. during winter. Like wise **Omar *et al* (1992a)** recorded peak foraging in relation to daytime at 9a.m. during September, October and November, at 11a.m. during April, May, June, July and August, at 1p.m.during December, January, March and April while minimum foraging was recorded at 7a.m. in all months except October and November at 5p.m. in Egypt. The effect of climatic factors on honeybee foraging activities was also studied by **Rashad and Ewies (1980), Hussein *et al* (1992 a & b) and Omar *et al* (1992b).**

Table 6. Correlation coefficient calculated for different honeybee activities during different seasons in relation with temperature and relative humidity.

Honeybee Activities	Correlation Coefficient							
	Spring		Summer		Autumn		Winter	
	Temp. (°C)	R.H. (%)	Temp. (°C)	R.H. (%)	Temp. (°C)	R.H. (%)	Temp. (°C)	R.H. (%)
No. of bees/m^2/min.	0.396	-0.022	-0.142	0.369	0.099	0.075	0.209	-0.321
No. of bees collecting pollens/ m^2/min.	0.360	-0.242	-0.220	0.469	0.083	-0.029	0.321	-0.454
No. of bees collecting nectars/ m^2/min.	0.017	0.464	0.188	0.363	-0.196	0.432	-0.155	0.225
No. of bees collecting both pollens and nectars/m^2/min.	0.385	-0.131	-0.134	0.247	0.005	0.130	-0.120	-0.022
No. of flowers visited by one bee/m^2/min.	0.406	-0.235	0.174	-0.116	-0.067	0.214	0.053	-0.066
No. of bees visited one flower/ min.	0.192	0.137	-0.345	0.584	-0.177	-0.081	0.094	-0.324

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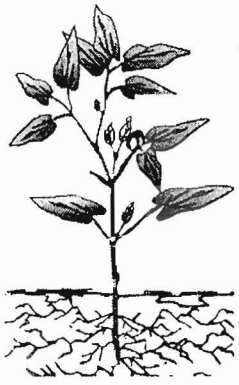

حوليات العلوم الزراعية
جامعة عين شمس، القاهرة
مجلد(٥٢)، عدد (٢)، ٤٨٧-٤٩٩، ٢٠٠٧

تقييم بعض أنشطة نحل العسل السارح لتعريف نباتات النحل المحتملة فى منطقة الرياض بالمملكة العربية السعودية

[٣٩]

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أجريت هذه الدراسة بهدف تقييم بعض أنشطة السروح في شغالات نحل العسل وتحديد أهم النباتات المزهرة التي تمد طوائف النحل بالرحيق وحبوب اللقاح تحت الظروف البيئية لمنطقة الرياض بالمملكة العربية السعودية خلال عام ٢٠٠٣ اعتمادا على المشاهدات العينية الحقلية مباشرة. وقد أظهرت الدراسة والنتائج وجود سبعة أنواع من النباتات خلال فصل الربيع وأربعة خلال فصل الصيف وخمسة خلال فصل الخريف وخمسة أيضا خلال فصل الشتاء وهي نباتات يعول عليها وواعدة كنباتات يمكن للنحل أن يعتمد عليها في غذائه أثناء فترات تزهيرها ، وقد تم تعريف هذه النباتات وسجلت في متن البحث .

وقد وجد أيضا أنه يصل متوسط نشاطات نحل العسل المختلفة في البيئة إلى أقصاها خلال الفترة من التاسعة إلى الحادية عشر صباحا خلال فصل الربيع ، ومن السابعة حتى التاسعة صباحا خلال فصل الصيف ، ومن السابعة حتى الحادية عشر صباحا في فصل الخريف بينما تتأخر كثيرا في فصل الشتاء لتكون خلال الفترة من الحادية عشر صباحا حتى الثالثة بعد الظهر . وقد أظهرت نتيجة التحليل الإحصائي للنتائج المتحصل عليها وجود ارتباط ضعيف بين النشاطات المختلفة لشغالات نحل العسل وكل من درجات الحرارة والرطوبة النسبية في البيئة.

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