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POLLINATORS OF LUPIN, *Lupinus termis* Forssk. AND THEIR EFFECT ON ITS YIELD

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ABSTRACT

The present investigation aimed to survey the insect pollinators of lupin (*Lupinus termis* Forssk.) and their effect on the yield during flowering periods of 2005/2006 and 2006/2007 seasons at Shalakan district, Kalubia Governorate.

Obtained results indicated that the total insect counts attained 17 species, belong to five orders; Hemiptera (2 species), Lepidoptera (2 species), Coleoptera (3 species), Diptera (6 species) and Hymenoptera (4 species). In particular, honeybees, *Apis mellifera* L. proved to be the most insect pollinators, constituting 14.66, and 18.59 % of the total insect count in the two seasons, respectively. The highest bee number was detected around mid seasons and at 12-2 p.m. Prevailing air temperature and R.H. % affected moderatly the occurrence of insect pollinators.

The presence of insect pollinators during the flowering period of lupin increased significantly most yield parameters such as the number of pods/plant, the number of seeds/pod, the number of seeds/plant and weight of seeds/plant. On the contrary, insect exclusion caused the inverse. As a result the estimated seed yield/feddan attained 1631.95, 868.8 and 1366.87 kg for open pallination, insect exclusion and honeybee pollination, respectively.

Key words: *coleoptera, hymenoptera,lupin , pollination, pollinators, seed yield.*

1. INTRODUCTION

In Egypt, lupin (*Lupinus termis* Forssk.) is one of the most important leguminous crops, It is used as a common good source of protein and industrial drugs. Insect pollinators play an essential role in increasing the productivity of field and horticultural crops, without displacing other necessary farm commodities. This role could be attributed to the efficiency of pollinating insects in increasing both self-fertilization (Pazy, 1984; Almeida and De Maltez, 1979) and cross pollination which promotes hybrid vigor (Langridge and Goodmann, 1985 and Yousif-Khalil *et al*, 1989).

The present work was carried out to survey insect pollinators of lupin along with their foraging behaviour. In addition, the effects of open pollination, insect exclusion and honeybee pollination on the yield parameters of lupin were also taken in account during the two successive seasons of 2005/2006 and 2006/2007.

2. MATERIALS AND METHODS

The present study was carried out at Shalakan district, Kalubia Governorate. The experiments were performed during the two successive agricultural winter seasons of 2005/2006 and 2006/2007 to survey insect pollinators of lupin and there effects on lupin yield.

2.1. Insect pollinators of lupin and their foraging behaviour

Seeds of lupin (*Lupinus termis* Forssk.) cultivar Giza 1 were planted in an area of half feddan on October 12, 2005 and on October 9, 2006 at Shalakan district. The crop was grown in rows 60 cm wide and seeds were sown in hills, 30 cm apart. One plant was left in each hill. Normal agricultural practices were applied without any insecticidal application.

Insects visiting lupin plants were collected during the flowering period which started from January 17 to February 28, 2006 and from January 15 to February 26, 2007. Surveyed insects were taken a day weekly at two-hour intervals, starting from 8 a.m. until 4 p.m., using a common insect net. Fifty double sweeps were made at each interval. The surveyed insects were started and identified to genera and species when possible, climatic factors including, ambient air temperature and relative humidity (R.H. %) were recorded at each interval.

The correlation coefficient values between the number of surveyed insects and each of

temperature degrees and RH % were calculated according to Snedecor (1957).

2.2. Effect of insect pollination on the yield of lupin

2.2.1. Experimental fields

To determine the effect of open pollination, insect exclusion and honeybee pollination on the yield of lupin, nine 1.5 × 1.5 m random plots cultivated with lupin were used as follows:

1. Three open plots were left for open pollination (as control) (A).
2. Three plots were covered with plastic screen cages 1.5 × 1.5 × 1.5 m to exclude all insect visit (B).
3. Three plots as in (B) but each was provided with honeybee nucleus. (honeybee pollination) (C).

2.2.2. The plastic screen cages

Wooden frame cage measuring 1.5 × 1.5 × 1.5 m was covered with plastic screen of 14 mesh/square inch and had a door to permit observation of plants and honeybees inside the cage, such cages were randomaly distributed on the cultivated area. The cages were placed on the field at the beginning of the flowering period until its end.

2.2.3. Honeybee nuclei

Three nuclei were used, each nucleus contained 2 combs, one of which contained sealed brood and the other contained stored honey, each nucleus was headed by sister mated queens (Carniolan hybrid). Sugar syrup (1^s:1^w) was used for out door artificial feeding and inside the cages when necessary.

The following yield parameters were recorded during the two successive seasons:

- Total number of flowers per plant
- Total number of pods per plant
-Mean percentage of pod set =

$$\frac{\text{Total number of pods}}{\text{Total number of flower/plant}} \times 100$$

- Mean number of seeds per pod
- Mean number of seeds per plant
- Mean weight of seeds per plant (g)
- Mean weight of 100 seeds (g)
- Estimated seed yield/feddan (4200 m^2) kg.

Data obtained were statistically analysed according to the methods of Snedecor (1957).

3. RESULTS AND DISCUSSION

3.1. Survey of lupin insect pollinators

Insect visitors of lupin were collected at two hour interval a day weekly from 8 a.m. to 4. p.m during the blooming periods of 2005/2006 and 2006/2007 seasons. These visitors were found belonging to five orders, *i.e.*, Hemiptera (2 species), Lepidoptera (2 species), Coleoptera (3 species), Diptera (6 species) and Hymenoptera (4 species) (Table 1).

Hemipterous insects, represented by *Oxycarenus hyalinipemnnis* and *Nezara viridula*, formed 4.02 and 6.20 % of the total visitors in the flowering periods of 2006 and 2007 seasons, respectively.

Lepidopterious insects, represented by *Syngrapha circumflexa* and *Polymatus baeticus* formed 4.24 and 4.93 % of the total insect count in the two seasons of the study, respectively. The *Syngrapha* sp. and *Polymatus baeticus were* more abundant at 12 noon to 2 p.m. (Table 2).

Coleopterous insects represented 6.77 and 7.16 % of the total catch in the two seasons respectively. This order was represented by 3 species *Coccinella undcimpunctata*, *Sitona lividipes* and *Tropinota squalida*.

Insects belonging to order Diptera represented 59.67, 53.44 % of the total collected insects in the two seasons, respectively (Table 1). Daily peak activity of flies on lupin flowers was detected at 12 noon in both seasons (Table 2). *Melanagromyza phaseoli* was the most abundant species, followed by *Phytomyza atricontis* and *Musca domestia*. The respective percentages of occurrence of the three species were 15.63, 13.69 and 12.20 % in 2006 and 13.26, 11.42 and 12.20 % in 2007 flowering season.

The total numbers of hymenopterus insects were 346 and 292 insects, representing 25.30 and 28.28 % of the total insect collected in the two seasons, respectively (Table 1). The surveyed insects were (4 species) *i.e.* honeybees, *Apis mellifera* (14.66 and 18.59 %); *Megachile submucida* (3.57 and 3.97 %); *Anthophora* sp. (3.13 and 2.90 %) and *Polistes gollicus* (3.94 and 2.81 %) of the total insect visitors in the two seasons, respectively. These results are similar to those of Wainwright (1978 a, b) Stoddard (1991) and Yousif-Khalil *et al.* (1992) who worked on varied plant species.

Data obtained showed that honey bees were the most abundant lupin visitors, being more active during the first half of February. The daily peak activity of honeybee on lupin blossoms was detected between 12.00 noon and 2 p.m. (Table 2).

Similar results were also reported by Voluzneve (1971); Stoddard (1991); and Wainwright (1978 a, b).

The correlation coefficient value between air temperature and the number of collected insects recorded 0.12 and 0.53 in the two seasons, respectively. Correlation coefficient values (r) between R.H % and the number of insect visitors

Table (1): Lupin insect visitors collected a day weekly during the flowering seasons of 2006 and 2007 at Kalubia Governorate .

Year	2006									2007								
Date / Insect	**17/1**	**24/1**	**31/1**	**7/2**	**14/2**	**21/2**	**28/2**	**Total**	**%**	**15/1**	**22/1**	**29/1**	**5/2**	**12/2**	**19/2**	**26/2**	**Total**	**%**
Order: Hemiptera																		
Oxycarenus hyalinipennis	-	3	7	6	1	1	-	18	1.34	2	4	6	5	-	2	2	21	2.03
Nezara viridula L.	3	4	1	5	9	7	7	36	2.68	3	5	7	4	8	10	6	43	4.16
Total Hemipterous insects	3	7	8	11	10	8	7	54	4.02	5	9	13	9	8	12	8	64	6.20
Order: Lepidoptera																		
***Syngrapha circumflexa* L.**	-	2	2	5	4	3	1	17	1.26	-	1	4	3	5	2	-	15	1.45
***Polymatus baeticus* L.**	4	3	7	10	6	8	2	40	2.98	-	5	9	8	12	2	-	36	3.48
Total lepidopterous insects	4	5	9	15	10	11	3	57	4.24	-	6	13	11	17	4	-	51	4.93
Order: Coleoptera																		
Coccinella undecimpunctata	3	7	11	4	6	6	10	47	3.50	-	4	9	7	8	3	2	33	3.19
Sitona lividipes	3	1	5	2	4	-	3	18	1.43	-	-	4	3	10	2	3	22	2.13
Tropinota squalida	6	6	4	5	2	3	-	26	1.93	-	-	4	5	3	7	-	19	1.84
Total Coleopterous insects	12	14	20	11	12	9	13	91	6.77	-	4	17	15	21	12	5	74	7.16
Order: Diptera																		
Syrphus corollae	4	4	5	9	13	7	6	48	3.57	-	2	7	6	11	3	10	39	3.78
Liriomyza congesta	13	18	15	12	19	20	22	119	8.85	12	11	10	7	6	17	15	78	7.55
Melanagromza phaseoli	32	23	46	44	28	23	14	210	15.63	12	18	24	19	21	16	17	137	13.26
Phytonyza atricontis	16	21	34	45	37	13	18	184	13.69	7	12	17	33	29	15	5	118	11.42
Musca domestica	14	26	15	21	44	20	24	164	12.20	15	21	29	12	19	8	22	126	12.20
***Sarcophaga* carnaria**	13	19	7	16	10	8	4	77	5.73	10	3	5	13	7	11	5	54	5.23
Total Dipterous insects	92	111	122	147	151	91	88	802	59.69	56	67	92	90	93	80	74	552	53.44
Order: Hymenoptera																		
Apis mellifera	4	22	35	58	39	17	22	197	14.66	21	17	28	36	47	19	24	192	18.59
Megachile submucida	6	2	4	10	14	5	7	48	3.57	-	5	7	11	7	9	2	41	3.97
***Anthophora* sp.**	3	4	5	8	13	7	2	42	3.13	-	4	5	13	6	2	-	30	2.90
Polistes gallicus	3	5	11	14	9	7	4	53	3.94	-	2	-	3	10	8	6	29	2.81
Total Hymenopterous insects	16	33	55	90	75	36	35	340	25.30	21	28	40	63	70	38	32	292	28.27
General Total	127	170	214	274	258	155	146	1344		82	114	175	188	209	146	119	1033	
Mean tem. (°C)	13.25	15.0	13.43	16.37	16.53	16.30	18.78	$r_1 = 0.12$		16.14	15.86	16.29	13.4	14.71	17.28	19.57	$r_1 = 0.53$	
Mean R.H. %	67.75	66.29	63.14	58.0	66.67	66.71	64.00	$r_2 = -0.64$		63.40	63.60	59.60	67.6	67.40	65.30	66.4	$r_2 = -0.28$	

r1= Correlation coefficient value between air temperature and the number of insects.

r2= Correlation coefficient value between air R. H. % and the number of insects

Table (2): Daily activity of lupin pollinators at two-hour intervals during the flowering seasons of 2006 and 2007.

Year	2006							2007						
Time of the day Insect species	8 a.m.	10	12	2	4	Total	%	8 a.m.	10	12	2	4	Total	%
Order: Hemiptera														
Oxycarenus hyalinipennis	-	3	8	5	2	18	1.34	-	2	6	12	1	21	2.03
Nezara viridula L.	4	6	12	9	5	36	2.68	5	7	9	16	6	43	4.16
Total Hemipterous insects	4	9	20	14	7	54	4.02	5	9	15	28	7	64	6.20
Order: Lepidoptera														
Syngrapha circumflexa	-	2	7	5	3	17	1.26	-	-	4	9	2	15	1.45
Polymatus baeticus	1	4	17	11	7	40	2.98	-	6	13	16	1	36	3.48
Total lepidopterous insects	1	6	24	16	10	57	4.24	-	6	17	25	3	51	4.93
Order: Coleoptera														
Coccinella undecimpunctata	4	11	18	10	4	47	3.50	-	3	18	7	5	33	3.19
Sitona lividipes	2	3	4	6	3	18	1.34	-	5	3	8	6	22	2.13
Tropinota squalida	-	3	8	9	6	26	1.93	-	-	3	12	4	19	1.84
Total Coleopterous insects	6	17	30	25	13	91	6.77	-	8	14	27	15	74	7.16
Order: Diptera														
Syrphus corollae	3	7	13	17	8	48	3.57	-	5	10	13	11	39	3.78
Liriomyza congesta	8	19	37	38	17	119	8.85	4	20	23	22	9	78	7.55
Melanagromza phaseoli	14	33	69	65	29	210	15.63	7	18	61	34	17	137	13.26
Phytonyza atricontis	9	28	50	57	40	184	13.69	5	13	36	39	25	118	11.42
Musca domestica	18	36	52	42	16	164	12.20	13	26	41	32	14	126	12.20
Sarcophaga carnaria	5	10	38	11	13	77	5.73	-	8	20	16	10	54	5.23
Total Dipterous insects	57	133	259	230	123	802	59.67	29	90	191	156	86	552	53.44
Order: Hymenoptera														
Apis mellifera	10	29	55	62	41	197	14.66	7	36	48	58	43	192	18.59
Megachile submucida	4	12	16	9	7	48	3.57	-	6	16	10	9	41	3.97
Anthophora sp.	3	7	14	14	4	42	3.13	-	7	8	12	3	30	2.90
Polistes gallicus	5	10	17	12	9	53	3.94	2	7	6	13	1	29	2.81
Total Hymenopterous insects	22	58	102	97	61	340	25.30	9	56	78	93	56	292	28.27
General Total						1344							1033	

Table (3): Data of the *Lupinus termis* Forssk. yield as influenced by open-pollination (A), insect exclusion (B) and honeybee pollination (C) at Kalubia Governorate during 2006 and 2007 seasons.

Year	2006					2007				
Treatments	A	B	C	LSD		A	B	C	LSD	
				5 %	1%				5 %	1 %
Mean number of flowers/plant	131.93	132.72	127.29	-	-	133.63	124.03	129.48	-	-
Mean percentage of pod set	33.02	19.71	31.47	4.10	6.80	31.33	22.88	29.93	1.90	3.21
Mean number of pods/plant	42.48	26.26	39.77	3.12	5.18	41.97	25.93	38.72	3.50	5.81
Mean number of seeds/pod	3.19	1.80	2.82	0.70	1.20	3.17	2.22	2.77	0.67	1.11
Mean number of seeds/plant	84.6	40.77	64.73	6.20	10.30	87.60	38.17	67.24	6.15	10.54
Mean weight of seeds/plant (g)	33.33	16.07	25.50	2.44	4.06	34.49	18.85	26.15	1.90	3.10
Mean weight of 100 seeds (g)	37.35	31.30	34.02	-	-	36.15	29.14	32.75	-	-
Calculated seed yield/feddan (kg)	1601.80	856.9	1360.03	230.58	383.11	1662.1	880.7	1373.7	108.00	179.40

Two - year mean of seed yield/feddan (kg)

Treatments	A		B		C	
	Wt.	Control	Wt.	*Ratio %	Wt.	*Ratio %
Seed yield feddan (Kg)	1631.95	100 %	868.8	53.32	1366.87	83.76

* Based on control plot as 100 %

recorded –0.64 and – 0.28 in the two seasons, respectively.

3.2. Effect of insect pollination on the yield of lupin

3.2.1. Mean number of flowers

As shown in Table (3), the mean number of flowers per plant in the open pollinated, insect protected and honeybee supplied plots were 131.93, 132.72 and 127.29 flowers, in 2006; and 133.63, 124.03 and 129.48 flowers per plant in 2007, respectively without any significant differences.

3.2.2. Mean percentage of pod set

Data presented in Table (3), indicate that the mean percentage of pod set recorded 33.02, 19.71 and 31.47 % in 2006, and 31.33, 22.88 and 29.93 % in 2007season for open pollination, insect exclusion and honeybee pollination in the two seasons, respectively. Insect protected plots showed the least significant percentage of pod set in the two years of study, while the differences between open pollination and honeybee pollination were insignificant in both seasons. Similar results were reported by Almeida and De Maltez (1979), Kamler (1982), Yousif-Khalil *et al.* (1989) and Khater *et al.* (2003) who investigated varied leguminous crop.

3.2.3. Mean number of pods/plant

Results in Table (3), indicate that open pollinated plots produced the highest significant mean number of pods/plant in both seasons (42.48, and 41.97 pods), whereas insect excluded plots yielded the least significant mean number of pods/ plant (26.26 and 25.92 pods). On the other hand, the differences between honeybee provided plots and open pollinated plots were insignificant in both seasons. Similar conclusion was reached by Koltowski (1996 b) and Khater *et al.* (2003).

3.2.4. Mean number of seeds/pod

Obtained results indicated that the mean seeds/pod from open pollinated, insect excluded and honeybee pollinated plants recorded 3.19, 1.80 and 2.82 seeds/pod in 2006, and 3.17, 2.22 and 2.77 seeds/pod in 2007 season, respectively. Analysis of data cleared that insect exclusion acheived the least significant mean number of seeds/pod in 2006 (Table 3). The results partially agree with Koltowski (1996 b) and Richards (1997).

3.2.5. Mean number of seeds/plant

As shown in Table (3), open pollination yielded the highest significant mean number of seeds/plant, recording 84.60 and 87.60 seeds in the two seasons, respectively. Insect prevention induced the least significant one (40.77 and 38.17 seeds) in both seasons. These results are in accordance with those of Somerville (1994), Koltowski (1996 a & b) and Khater *et al.* (2003).

3.2.6. Mean weight of seeds/plant

Results in Table (3) indicate that open pollination produced the highest significant mean weight of seeds/plant recording 33.33 and 37.49 g in both seasons, respectively. On the other hand, insect exclusion induced the least significant values (16.07 and 18.85 g.) in the two years. These results agree with Mesqaida *et al.*,(1992) and Khater *et al.*, (2003).

3.2.7. Mean weight of 100 seeds

The mean weight of 100 seeds resulted from open pollinated, insect exclusion and honeybee pollinated plots recorded 37.35, 31.30 and 34.02g in 2006, and 36.15, 29.14 and 32.75 g in 2007 season, respectively. The differences between treatments were insiginificant (Tale 3). These results agree with Mesqaide *et al.*, (1992) and Khater *et al.* ,(2003).

3.2.8. Estimated seed yield /feddan

As shown in Table (3), the calculated seed yield/feddan from open pollination, insect exclusion and honeybee pollination recorded 1601.8, 856.9 and 1360.03 kg in 2006; and 1662.1, 880.7 and 1375.7 kg in 2007 seasons, respectively. Open pollination induced the highest significant calculated seed yield/fed., meanwhile, insect exclusion was the least. The two years mean seed yield/fed., recorded 1631.95, 868.8 and 1366.87 kg. for the three treatments, respectively.

Honeybee pollination yielded as 83.76 % as the seed yield of the control (open pollination), whereas insect exclusion yield as 53.32 % as that of the control. These results are in parallel with those of Langridge and Goodmann (1985); Williams (1987); Koltowski (1996 b) and Khater *et al.* (2003).

Generally, it could be concluded that insect pollination is very important for high yield crop production and the presence of honeybee colonies is very necessary to ensure adequate pollination.

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ملقحات الترمس وتأثيرها على المحصول

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ملخص

تم إجراء هذه الدراسة بهدف تحديد وتعريف الحشرات الزائرة لنباتات الترمس أثناء فترة التزهير خلال موسمي ٢٠٠٥/٢٠٠٦، و ٢٠٠٦/٢٠٠٧ بناحية شلقان بمحافظة القلوبية.

أوضحت النتائج أن الحشرات الزائرة لأزهار الترمس شملت ١٧ نوعا تتبع خمس رتب هى نصفية الأجنحة (نوعان)، حرشفية الأجنحة (نوعان)، غمديه الأجنحة (ثلاثة أنواع)، ثنائية الأجنحة (ستة أنواع) وغشائية الأجنحة (أربعة أنواع).

كان نحل العسل الأعلى تواجدا مقارنة بأنواع الملقحات الأخرى حيث بلغت نسبة تواجده ١٤,٦٦% ، ١٨,٥٩ % خلال موسمي الدراسة ،على الترتيب. وكان أعلى تواجد للنحل فى منتصف موسم التزهير ما بين الساعة ١٢-٢ ظهرا خلال ساعات النهار.

ولقد اتضح وجود تأثيرا متوسطا لدرجات الحرارة (موجبا) ونسبة الرطوبة (سالبا) على تعداد الحشرات الزائرة لأزهار نباتات الترمس.

وبدراسة تأثير التلقيح المفتوح والتلقيح بنحل العسل والعزل الحشري على محصول نبات الترمس في منطقة الدراسة اتضح أن التلقيح المفتوح كان الأعلى معنويا، بينما كان العزل الحشري الأقل معنويا في حين كان التلقيح بنحل العسل منفردا وسط بين المعاملتين، حيث بلغ محصول الفدان من البذرة ١٦٣١,٩٥، و ٨٦٨,٨، و ١٣٦٦ كجم كمتوسط لموسمي الدراسة للمعاملات المتروكة للتلقيح المفتوح والمعزولة حشريا وتلك التي لقحت بنحل العسل على الترتيب.

المجلة العلمية لكلية الزراعة – جامعة القاهرة – المجلد (٦٠) العدد الثالث (يوليو ٢٠٠٩):٢٧٥-٢٨١.