

## Natural Biocontrolling Activity of *Phytomyza orobanchia* (Kalt.) against *Orobanche crenata* and Increasing its Beneficial Role by Field Releases of the Fly Adults

F. F. Shalaby\*, H. M. M. Ibrahim\*\* and E. E. Hassanein\*\*

\* Plant Protection Dept., Faculty of Agriculture, Moshtohor, Benha Branch, Zagazig University.

\*\* Weed Research Central Laboratory, Agricultural Research Center, Giza, Egypt.

### ABSTRACT

Total of 6000 *Orobanche crenata* capsules were collected throughout 2002/03 faba bean season from spikes picked in successive samples from many locations in Qalubiyah and Menoufiyah governorates, dissected and microscopically inspected for *Phytomyza orobanchia* infestations. Rates of infestation varied from 3 – 97 % in Qalubiyah and 18 – 96 % in Menoufiyah with seasonal means of 53.75 and 60.67 %, respectively. Highest seasonal mean infestation percentages were 70% occurred in Tukh and El – Khanka districts in Qalubiyah, and 83.5% in El-Bagour district (83.5%) in Menoufiyah governorate. Monthly mean infestation percentage was also highest during April reaching 91.3% in Qalubiyah and 89.2% in Menoufiyah. *P. orobanchia* fly adults (total 502 adults) were released in a faba bean field infested with *O. crenata* in successive numbers from February, 22<sup>nd</sup> to March 19<sup>th</sup> 2003. Fly releases caused considerable increase in the percentages of infested *O. crenata* capsules to 52% on March, 30<sup>th</sup>, being about 5 times of that in the control area (11 %). The last sample (of April, 13<sup>th</sup>) showed 70% infested capsules in the area of release opposed to 27% in the control area. The short distance (about 100 m) between the area of release and that of control confirmed poor flying activity of *P. orobanchia* fly adults. All data confirmed the very important role of *P. orobanchia* in reducing the seed bank of *Orobanche*, and this role can be greatly increased by releasing this beneficial fly.

**Key Words:** *Phytomyza orobanchia*, *Orobanche crenata*, biological control.

### INTRODUCTION

Broomrape, *Orobanche* spp. are the most serious fully parasitic weeds in Egypt, causing great losses in quantity and quality in yields of the heavily infested hosts such as faba bean, peas, lupine, carrots, cabbage and tomato. For controlling this weed, the applied use of bio-agents has to be considered in IPM programs. In this respect, the broomrape fly, *Phytomyza orobanchia* (Kalt.) may be considered as the main bio-agent against *Orobanche* spp. due to its mono-phagous habit, on one hand, and the active feeding of larvae on the immature seeds of *Orobanche* on the other hand. The rate of *Orobanche* seeds' reduction due to *P. orobanchia* infestation was estimated by 11% (Hammad *et al.* 1967 in Egypt), 21% (Alkhesraji and Abdel Wahid, 1988 in Iraq), 91.1% (Linke *et al.* 1990 in Syria) and 27% (Boughdad *et al.* 1997 in Morocco). The applied control of *Orobanche* by releasing *P. orobanchia* was investigated by Kleyueva and Pamuki (1982) in the former USSR, and Al-Eryan and Zaitoun (2001), Abu-Shal (2001) and Shalaby *et al.* (2002) in Egypt. The latter authors studied also the natural bio-controlling activity of *P. orobanchia* infesting broomrape capsules in different crops in 11 governorates covering lower and upper Egypt throughout 6 successive faba bean seasons (1996/97 – 2001/02).

The present study was carried out during 2002/03 faba bean season in two Egyptian governorates (Qalubiyah and Menoufiyah) to estimate the natural role of *P. orobanchia* against *Orobanche crenata*, in addition to releasing the fly adults in a faba bean field, aiming to reach high infestation rates in *O. crenata* capsules and subsequently, reducing the *O. crenata* seed bank in soil in order to reduce the rate of infestation by this parasitic weed in the same field in the subsequent season.

### MATERIALS AND METHODS

#### I- Sampling and estimation of *P. orobanchia* infestation:

Throughout the period from January, 6<sup>th</sup> to April, 15<sup>th</sup>, 10 successive visits were paid to faba bean field in different villages of Qalubiyah and Menoufiyah governorates. In each visit, a random sample of *O. crenata* spikes was picked from each field, kept in a plastic bag and transported to the laboratory where those were left for 2 – 4 days to allow hatching of any *P. orobanchia* eggs. From spikes of each sample, a random sample of 100 capsules were separated to be, individually, dissected and thoroughly inspected under a binocular microscope. The numbers of capsules infested by *P. orobanchia* immature stages, and the numbers of larvae and pupae of this fly were counted and recorded. Finally the percentages of infested capsules were calculated.

## II- Field release of *P. orobanchia* fly adults in faba bean field:-

This work was conducted during 2002 / 03 faba bean season in the field of the Agricultural Research Center at Giza, in an area of about 2 feddans cultivated with faba bean and heavily infested with *O. crenata*. *P. orobanchia* pupae were separated from the infested *O. crenata*. Capsules that have been collected from Qalubiya and Menoufiya governorates, kept in glass vials provided with wet pieces of cotton and covered with muslin kept in position by rubber bands until adults' emergence. Just after emergence the resultant adults were released in successive numbers from February, 22<sup>nd</sup> to March, 19<sup>th</sup> in an area about 200m<sup>2</sup> laying on one side of the whole area. During the mentioned period, a total of 502 flies were released (Table, 1). Samples of *O. crenata* spikes were, randomly picked starting just before release (February, 22<sup>nd</sup>) until April, 14<sup>th</sup> (7 samples). Samples were also taken from the control area which was chosen on the opposite side (about 100 m far from the site of release). Samples of *O. crenata* spikes were taken to the laboratory of the Weed Research Central Laboratory where the percentages of infested *O. crenata* capsules by *P. orobanchia* were estimated, and the number of the fly larvae and pupae were recorded.

Table (1): Numbers of *P. orobanchia* fly adults released in a faba bean field at Giza during 2003 for controlling *O. crenata*.

Periods of release	Number of released flies
February: 22 <sup>nd</sup> - 25 <sup>th</sup>	61
March: 1 <sup>st</sup> - 5 <sup>th</sup>	119
8 <sup>th</sup> - 12 <sup>th</sup>	180
15 <sup>th</sup> - 19 <sup>th</sup>	142
Total	502

## RESULTS AND DISCUSSION

### I. Natural role of *P. orobanchia* against *O. crenata* in faba bean fields:-

#### A. Qalubiya Governorate:

As shown in Table (2), 7 successive visits were paid to Qalubiya governorate. Samples of *O. crenata* spikes were picked from broad bean fields in 17 villages belonging to 6 districts. All of the inspected samples showed different rates of infestation by *P. orobanchia* immature stages, ranging from 3% in capsules of the sample of Senhera village (Kaha district) on March, 10<sup>th</sup> to 97% in capsules from Aghour El-Kobra (Tukh district) on April, 15<sup>th</sup> 2003. From a total of 2400 inspected *O.crenata* capsules collected from Qalubiya, 1290 were found infested by *P. orobanchia* showing a seasonal mean of 53.75% infestation. This mean is higher than those recorded in the same governorate by Shalaby *et al.* (2002) for seasons 1997/98, 1998/99, 200 /01 and 2001/02 (13.33, 23.43 , 42.99 and 21.29 % , respectively), lower than that for season 1996/97 (66.67 % ) , and not far than that recorded for season 1999/00 (50.73 %).

By dissecting the 1290 infested capsules throughout the season, the total of 302 larvae and 691 pupae were counted (Total was 993 individuals). This total number of immature stages is normally lower than the total number of infested capsules due to the migration of larvae, starting from mid-March, from capsules to pupate in the stems or the subterranean parts of *O. crenata* spikes.

Comparing the mean percentages of infestation in different districts of Qalubiya governorate, Table (3) shows that the highest percentage was in Tukh and El-Khanka districts (70 %) and the lowest was in Shebin El-Kanater district (34 %). Regarding the monthly percentages of infested *O. crenata* capsules throughout the season, Fig (1) shows that this percentage started low (34.5%) during January, increased during February and March to almost equal percentages (51.75 & 49.33% ,respectively) and increased to reach the maximum percentage of 91.33% during April .

#### 2. Menoufiya Governorate:

From January, 6<sup>th</sup> to April, 15<sup>th</sup> 2003, 36 samples of *O. crenata* spikes were, successively, collected from 15 villages representing 6 districts in Menoufiya governorate. In all the collected samples, rates of infestation by *P. orobanchia* ranged from 18 % in sample of Kafr El-Sheikh Khalil village (Shebin El-Kom district) on March, 10<sup>th</sup> to 96% in the sample collected from Babil village (Tala district) on April 15<sup>th</sup> 2003. From the total of 3600 inspected capsules throughout the season, 2184 were found infested by *P. orobanchia* immature stages indicating a seasonal mean of 60.67% infestation. This mean is higher than those recorded by Shalaby *et al.* (2002) in the same governorate for seasons 1997/98, 1999/00, 2000/01 and 2001/02 (52.33, 41.53, 50.47 and 47.16%, respectively), lower than that of season 1996/97 (73.06%) and almost equal to that

Table (2): Infestation rates to *O. crenata* capsules by *P. orobanchia* immature throughout 2002/03 faba bean season in Qalubiya governorate.

Sampling date	Locality	District	Total no. of capsules		% of Infestation	No. of counted		Total
			Inspected	Infested		Larvae	Pupae	
January: 20 <sup>th</sup>	Balaks	Qaliub	100	56	56	45	13	58
	Kaha	Kaha	100	13	13	4	9	13
Februar y: 17 <sup>th</sup>	El – Deir	Tukh	100	78	78	11	70	81
	Kafir – Hamza	El-Khanka	100	70	70	12	61	73
	Kafir-El Shoubak	Shebin El-Kanater	100	35	35	6	30	36
	Gezeiret Beli	Benha	100	24	24	22	2	24
March: 10 <sup>th</sup>	Senhera	Kaha	100	3	3	0	3	3
	Namoul	Tukh	100	38	38	11	24	35
	Tal Bany Tameem	Shebin El-Kanater	100	33	33	15	19	34
18 <sup>th</sup>	Benha	Benha	100	46	46	5	34	39
	Sindyoun	Qaliub	100	60	60	2	2	54
	El- Zahhar	Kaha	100	45	45	18	25	43
	El – Manzala	Tukh	100	68	68	4	59	63
24 <sup>th</sup>	Kaf El – Arab	Benha	100	39	39	6	33	39
	Sindyoun	Qaliub	100	36	36	5	25	30
	El- Zahhar	Kaha	100	51	51	17	33	50
	El – Manzala	Tukh	100	54	54	49	0	49
31 <sup>st</sup>	Kaf El – Arab	Benha	100	39	39	16	21	37
	Sindyoun	Qaliub	100	70	70	5	55	60
	Aghour El-Kobra	Tukh	100	85	85	22	57	79
	Beltan	Benha	100	73	73	9	33	42
April: 15 <sup>th</sup>	Terssa	Kaha	100	82	82	0	14	14
	Aghour El-Kobra	Tukh	100	97	97	17	6	23
	Beltan	Benha	100	95	95	1	13	14
Overall			2400	1290	53.75	302	691	993

Table (3): Seasonal infestation rates by *Phytomyza orobanchia* in *Orobanche crenata* capsules from different districts of two governorates during 2002/2003 faba bean season.

Qalubiya governorate				Menoufiya governorate			
District	Total no. of capsules		% of infestation	District	Total no. of capsules		% of infestation
	Inspected	Infested			Inspected	Infested	
Qaliub	400	222	55.5	Quesna	1000	595	59.5
Kaha	500	194	38.8	Berket El-Sabh	1000	566	56.6
Tukh	600	420	70	El-Shouhada	100	57	57
El-Khanka	100	70	70	Tala	600	409	68.17
Shebin El-Kanater	200	68	34	Shebin El-Kom	700	390	55.71
Benha	600	316	52.67	El-Bagour	200	167	83.5
Overall	2400	1290	53.75	Overall	3600	2184	60.67

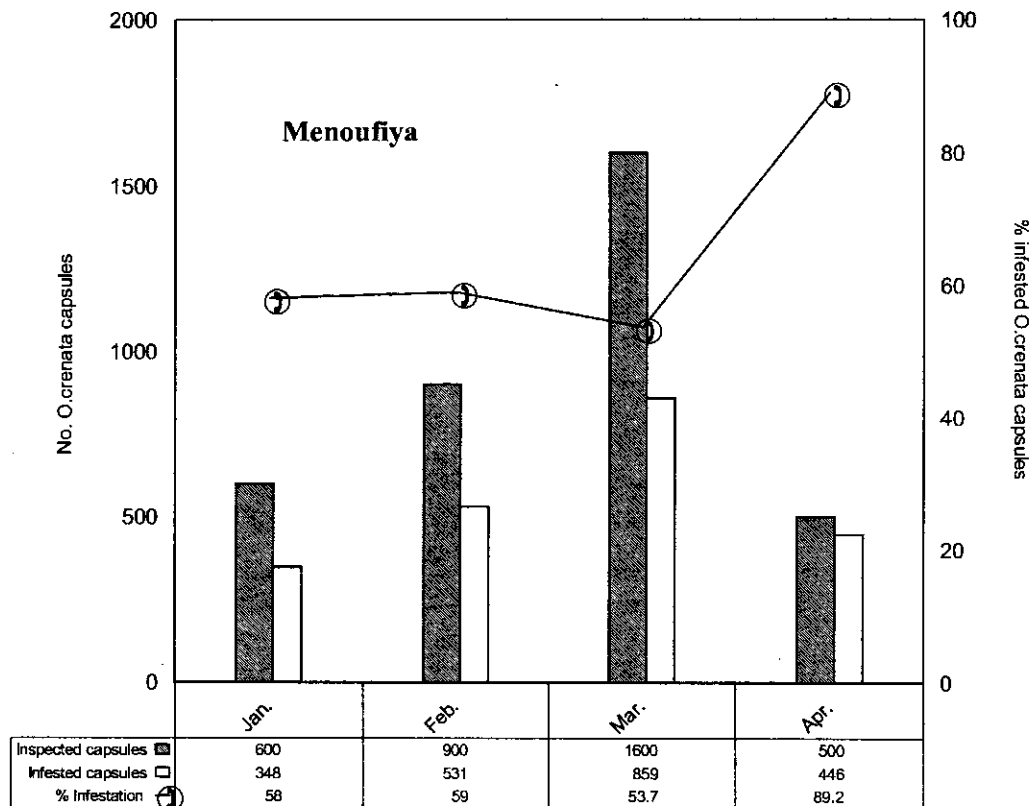
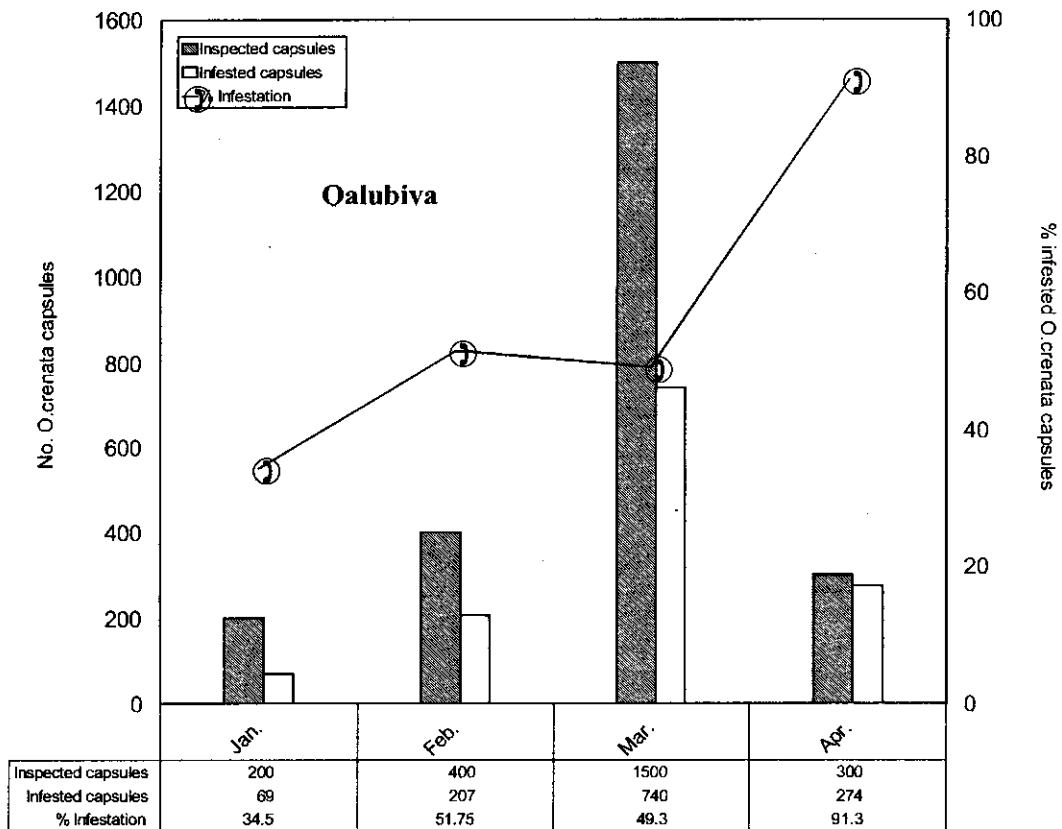


Fig. (1): Monthly infestation rates by *Phytomyza orobanchia* to *Orobancha crenata* capsules in faba bean fields in Qalubiya and Menoufiya governorates during 2002/03 season.

## 2. Menoufiya Governorate:

From January, 6<sup>th</sup> to April, 15<sup>th</sup> 2003, 36 samples of *O. crenata* spikes were, successively, collected from 15 villages representing 6 districts in Menoufiya governorate. In all the collected samples, rates of infestation by *P. orobanchia* ranged from 18 % in sample of Kafr El-Sheikh Khalil village (Shebin El-Kom district) on March, 10<sup>th</sup> to 96% in the sample collected from Babil village (Tala district) on April 15<sup>th</sup> 2003. From the total of 3600 inspected capsules throughout the season, 2184 were found infested by *P. orobanchia* immature stages indicating a seasonal mean of 60.67% infestation. This mean is higher than those recorded by Shalaby *et al.* (2002) in the same governorate for seasons 1997/98, 1999/00, 2000/01 and 2001/02 (52.33, 41.53, 50.47 and 47.16%, respectively), lower than that of season 1996/97 (73.06%) and almost equal to that recorded for season 1998/99 (60%). Dissecting the infested capsules throughout the season revealed the presence of 655 larvae and 1077 pupae (total 1732 immature individuals) in these capsules (Table 4).

Regarding the percentages of infested capsules collected throughout the season from different districts, Table (3) shows that the highest seasonal mean infestation occurred in El-Bagour district (83.5%), followed by Tala (68.2%), and lowest in Shebin El-Kom district (55.7%), and followed by Berket El-Sabh (56.6%). As for the infestation percentages during the successive months of the season (Fig.1), it is clear that these percentages were around 56% during January, February and March, but increased to a maximum of 89.2% during April.

Table (4): Infestation rates by *P. orobanchia* immatures to *O. crenata* capsules throughout 2002/03 faba bean season in Menoufiya governorate.

Sampling date	Locality	District	Total no. of capsules		% of infestation	No. of counted		Total	
			Inspected	Infested		Larvae	Pupae		
January	6 <sup>th</sup>	El-Irakiya	El-Shouhada	100	57	57	36	29	65
	13 <sup>th</sup>	Kafr El-Sheikh Ibrahim	Quesna	100	67	67	26	41	67
		Tukh Tambesha	Berket El-Sabh	100	34	34	12	22	34
		Berket El-Sabh	Berket El-Sabh	100	86	86	26	62	88
		Zorkan	Tala	100	47	47	13	36	49
		El-Meseilha	Shebin El-Kom	100	57	57	36	21	57
February	4 <sup>th</sup>	Arab El-Raml	Quesna	100	43	43	34	9	43
		Kafr El-Sheikh Ibrahim	Quesna	100	36	36	13	24	37
		Berket El-Sabh	Berket El-Sabh	100	43	43	28	15	43
		El-Ghoury	Berket El-Sabh	100	46	46	37	11	48
		Abu-Seneita	El-Bagour	100	87	87	59	34	93
	17 <sup>th</sup>	Arab El-Raml	Quesna	100	76	76	12	65	77
		Kafr El-Sheikh Ibrahim	Quesna	100	75	75	35	40	75
		Banas	Berket El-Sabh	100	45	45	24	21	45
March	10 <sup>th</sup>	Kafr El-Sheikh Ibrahim	Quesna	100	44	44	6	38	44
		Tukh Tambesha	Berket El-Sabh	100	52	52	7	45	52
		Kafr El-Sheikh Khalil	Shebin El-Kom	100	18	18	12	6	18
		Babil	Tala	100	70	70	7	63	70
	18 <sup>th</sup>	Arab El-Raml	Quesna	100	38	38	8	30	38
		Tukh Tambesha	Berket El-Sabh	100	60	60	9	34	43
		El-Kom El-Akhdar	Shebin El-Kom	100	49	49	16	28	44
		Babil	Tala	100	54	54	6	33	39
	24 <sup>th</sup>	Kafr El-Sheikh Ibrahim	Quesna	100	39	39	4	32	36
		Tukh Tambesha	Berket El-Sabh	100	72	72	46	13	59
		Betebes	Shebin El-Kom	100	31	31	19	7	26
		Babil	Tala	100	63	63	21	32	53
	31 <sup>st</sup>	Kafr El-Sheikh Ibrahim	Quesna	100	82	82	33	32	65
		Tukh Tambesha	Berket El-Sabh	100	46	46	9	23	32
	El-Kom El-Akhdar	Shebin El-Kom	100	62	62	5	55	60	
	Babil	Tala	100	79	79	3	69	72	
April	15 <sup>th</sup>	Kafr El-Sheikh Ibrahim	Quesna	100	95	95	0	20	20
		Tukh Tambesha	Berket El-Sabh	100	82	82	4	4	8
		EL-Batanoun	Shebin El-Kom	100	85	85	9	21	30
		El-Meseilha	Shebin El-Kom	100	88	88	0	9	9
		Babil	Tala	100	96	96	2	9	11
Overall				3600	2184	60.67	655	1007	1732

## II. Applied release of *P. orobanchia* adults to control *O. crenata*:

From data in Table (5), it could be confirmed that releasing flies of *P. orobanchia* in faba bean fields increased, considerably, the percentage of infested *O. crenata* capsules.

Just before release (February, 22<sup>nd</sup>), all the inspected *O. crenata* capsules were completely free from any *P. orobanchia* infestation, and the same figure remained in the control area in the subsequent sample which was collected 11 days after release, at the same time when 35.9% of the inspected capsules, from the area of release, were found infested by the fly larvae at a rate of one larva/ infested capsule. One week later (March, 12<sup>th</sup>) the percentages of infested capsules reached 20% in the control area opposed to 36% in the area of release, but the subsequent sample (March, 23<sup>rd</sup>) showed 16 and 64% infestations in the two areas, respectively indicating 4 times more in the percentages of infestation in the area of release (Table 5). This ratio between infestation percentages in the two areas increased to 1:5 (11&52%, respectively) among the fifth sample of March, 30<sup>th</sup>. While, the last sample (April, 13<sup>th</sup>) showed 27 and 70% infestation in the two areas, respectively. As a mean of all samples, the mean percentage of infestation was 15.08% in the control area, and this percentage increased by more than 3 times in the area of release (52.08%; Table, 5). Thus confirming the valuable role of releasing *P. orobanchia* for controlling the mentioned weed.

Some other results were in harmony with the present results. Kleyueva and Pamuki (1982), in the former USSR, indicated that distribution of 500-1000 diapauses *P. orobanchia* pupae in plastic bags/ha caused 96% *Orobanche* seeds reduction. More recently, Al-Eryan and Zaitoun (2001) reported that releasing *P. orobanchia* at the rate of 3 flies/spike led to 30% reduction in *Orobanche* seeds. While, Abu-Shal, (2001) found that releasing the flies at the same rate caused 72.8% reduction in broomrape seeds. For the same target, Shalaby *et al.* (2002) found that distributing 1798 diapauses *P. orobanchia* pupae (at the time of emergence) in one feddan cabbage field heavily invaded by *O. ramosa* increased the percentage of infested capsules to 61.3% opposed to 33.3% in the neighboring control field.

Table (5): Numbers and percentages of infested *O. crenata* capsules after releasing *P. orobanchia* fly adults in a faba bean field at Giza during 2003. (Start of release, February, 22<sup>nd</sup> 2003).

Sampling date	Control area				Area of release			
	No. of total capsules		No. of counted		No. of total capsules		No. of counted	
	inspected	infested	larvae	pupae	inspect	infested	larvae	pupae
<b>February:</b>								
22 <sup>nd</sup>	50	0	0	0				
<b>March:</b>								
5 <sup>th</sup>	100	0	0	0	78	28 (35.9%)	28	0
12 <sup>th</sup>	100	20 (20%)	17	3	100	36 (36%)	36	0
23 <sup>rd</sup>	100	16 (16%)	8	5	100	64 (64%)	19	19
30 <sup>th</sup>	100	11 (11%)	1	6	100	52 (52%)	8	5
<b>April:</b>								
7 <sup>th</sup>	100	24 (24%)	1	0	100	51 (51%)	0	2
13 <sup>th</sup>	100	27 (27%)	0	0	100	70 (70%)	18	4
Total	650	98	27	14	578	301	109	30
Mean inf. %		15.08				52.08		

\*Values between brackets indicate the percentages of infestation

As conclusion, data concerning the natural bio-controlling activity of *P. orobanchia* against *O. crenata* parasitizing faba bean plants in Qalubiya and Menoufiya governorates confirmed that this beneficial fly has a very important natural role in infesting *O. crenata* capsules and, consequently, consuming considerable amounts of the immature seeds of this weed, leading to reduction in the *Orobanche* seed bank in soil and, subsequently, reducing the rate of infestation in the subsequent season. This beneficial role varied, in each of the two governorates, between different districts and even between different locations in the same district. It could be also noticed that highest activity of this fly occurred by moving towards the end of the season.

Data on the applied release of flies confirmed that releasing of *P. orobanchia* fly adults is very important for increasing the natural bio-controlling activity against *Orobanche*. In one of the collected samples after

release, the rate of infestation by *P. orobanchia* in the releasing area was about 5 times of that in the control area. By the end the season, the percentage of infestation in the releasing area (70%) was about three times more than that in the control area (27%). Although the distance between the area of release and that of the control was only about 100 m, data revealed high variation in percentage of infestation between the two areas. Thus indicating the poor flying activity of the fly adults which, mostly, mate and reproduce in the same area of release. Thus, it gives a good interpretation for the great variations in percentages of infestation by *P. orobanchia* in *Orobanche* capsules between different locations that lie in the vicinity to each other.

### ACKNOWLEDGEMENT

The presented work was carried out in the Weed Research Central Laboratory, ARC under the umbrella of the Nile Valley Program for Wild Oats Project financed by the European Union to which the authors express their deep thanks and gratitude for supporting this work.

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### فاعلية ذبابة الهالوك في خفض محصول بذور الهالوك تحت ظروف الإختبارات نصف الحقلية

فوزى فائق شلبي ، هاشم محمد محمد إبراهيم والحسانين الشربيني حسانين  
قسم وقاية النبات، كلية الزراعة بمشتر، فرع بنها، جامعة الزقازيق، مشتر، مصر.  
المعمل المركزي لبحوث الحشائش، مركز البحوث الزراعية، الجيزة، مصر.

بلغ متوسط نسبة إصابة كبسولات حشيشة الهالوك بذبابة الهالوك ٥٣.٧٥ % (٣-٩٧) في حقول الفول خلال موسم ٢٠٠٢/٢٠٠٣ في قرى محافظة القليوبية، مقابل ٦٠.٦٧ % (١٨-٩٦) في قرى محافظة المنوفية. وبلغ أعلى متوسط إصابة خلال الموسم بمركزى طوخ وشبين القناطر (٧٠%) بمحافظة القليوبية، مقابل ٨٣.٥% بمركز الباجور بمحافظة المنوفية. أحدث إطلاق ٥.٢ حشرة كاملة حديثة الخروج لذبابة الهالوك بحقل مصاب بحشيشة الهالوك بالجيزة زيادات واضحة في نسبة إصابة كبسولات هذه الحشيشة بالذباب بلغت ٣-٥ أضعاف نسب الإصابة في المقارنة. وقد أكدت جميع النتائج الدور البيولوجي الهام لذباب الهالوك في القضاء على بذور الهالوك وخفض رصيدها بالتربة، كما تؤكد زيادة هذا الدور الحيوى بإطلاق الحشرات الكاملة لهذه الذبابة.