

**PRELIMINARY APPROACH TOWARDS THE USE OF THE EGG  
PARASITOID, *TRICHOGRAMMATOIDEAE BACTRAE*  
NAGARAJA AGAINST COTTON BOLLWORMS IN EGYPTIAN  
COTTON FIELDS**

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**Abstract**

A trial was carried out to evaluate the efficiency of releasing namely egg parasitoid, *Trichogrammatoidea bactrae* Nagaraja to control the cotton bollworms; pink bollworm (PBW) and spiny bollworm (SBW), compared to insecticides, in cotton fields at Sakha Research Station, Kafr El-Sheikh Governorate for three successive cotton growing seasons 1999-2001. Highest rates of infestation in fallen cotton flower buds and/or squares reached 56, 56 and 62 % with CLW, SBW and PBW, respectively. Highest rates of infestation (44 and 40 %) were recorded in the green bolls infested with SBW and PBW, respectively. Parasitoid releases proved best results in reducing PBW infestations in the fallen cotton flower buds and/or squares and the green bolls compared with both insecticide and check treatments. The reduction attained 9.4, 39.4 and 7.7 % in the fallen cotton flower buds and/or squares, and 36.5, 41.7 and 25.4 % in the green bolls in seasons 1999, 2000 and 2001, respectively. In case of the SBW, the results varied from one treatment to another and from one season to another. Superior reduction figures of SBW infestation were achieved when the IGR (Ateroon) + parasitoid were alternatively applied compared with both the parasitoid releases and/or insecticide applications. The reduction reached 4.6, 27.9 and 63.7 % in the green bolls in seasons 1999, 2000 and 2001, respectively. Highest numbers of predators was recorded in *Trichogramma* released areas (47 %), followed by the control (34.8 %), the insecticidal treated areas were the least (17.6 %).

**INTRODUCTION**

Cotton is the cash and field crop in Egypt. Many arthropods, plant diseases and weeds are constrains to cotton production not only in Egypt but also in the cotton-cultivated areas. Of these, insect pests are the most serious and important limiting factors. The heavy use of these insecticides has not been without problems. They are not only expensive to purchase and apply but also their use has led to target pest resurgence, secondary pest outbreaks, development of pesticide resistant pest strains, disturbance of natural balance between pests and their natural enemies, poisoning of workers and contamination of the environment. For all these reasons there is always a

need to develop and implement Integrated Pest Management (IPM) programs for cotton in Egypt.

The pink bollworm (PBW), *Pectinophora gossypiella* (Saunds.) (Lepidoptera: Gelihiidae) is the principal pest of cotton in Egypt, as indicated by the fact that 84 percent of insecticides use on cotton is directed against this pest. The main period of infestation on cotton occurs between July and September. The economic threshold level (ETL) is 3-5 percent infestation of green bolls. Insecticides are applied at 15-to 21 days intervals, a total of three to four applications usually being sufficient to control the pest. Yield losses vary, from 4-7 percent in years of light infestation up to 30 percent in untreated cotton. The spiny bollworm (SBW), *Earias insulana* (Boisd.) (Lepidoptera: Noctuidae) is the most significant as a pest more or less in the southerly cotton growing areas, where it may be of equal importance to the pink bollworm (Moawad *et al.* 1991). The later usually competes with PBW when both species are existed in the same field.

The use of sex pheromones to control PBW in the cotton fields by mating disruption technique has been applied in Egypt for years. A major advantage of pheromones is that they do not affect population of beneficial insects and they may completely replace conventional insecticides for PBW control (El-Heneidy *et al.* 1987; Moawad *et al.* 1991; Nazir *et al.* 1996).

Natural suppression of insect pests form a major activity in crop fields and the key mortality factors of pests have been analyzed in various studies of important cotton pests to suggest that there is more than 65 % mortality of the cotton pests due to the action of various natural enemies.

The role of natural enemies in controlling cotton pests is becoming increasingly recognized and one of the pest management parameters. Insecticide applications are not permitted on cotton between May and early July to allow populations of parasitoids and predators to become established (El-Heneidy *et al.* 1978). During this period, cotton leaf worm has been traditionally been controlled by hand picking of egg masses, although this is now practiced less frequently, unless there is a major outbreak, because it was found that sufficient control could usually be exercised by natural enemies (El-Heneidy *et al.* 1997).

Among certain natural enemies that are amenable to mass-production is the egg parasitoid, *Trichogramma* spp. It parasitizes successfully eggs of the cotton bollworms and drastically reduces their damage (Tuhan *et al.* 1987; Duyn *et al.* 1998). In the

frame of IPM, the utilization of bioagents has been seen to reduce the cost of protection by at least 65% and increase the efficiency of pest suppression (Kogan 1998).

The present study is a preliminary evaluation of using *Trichogramma*, compared to insecticides, against the cotton bollworm eggs in cotton fields in Egypt.

## MATERIALS AND METHODS

A trial was carried out to evaluate the efficiency of releasing the introduced egg parasitoid, *Trichogrammatoidea bactrae* Nagaraja (1994 NARP project report) to control the cotton bollworms; PBW and SBW at Sakha Research Station, Kafr El-Sheikh Governorate for three successive cotton growing seasons 1999-2001.

Three experimental plots, one feddan each, were cultivated with the recommended cotton variety (Giza 89).

- The first plot (A), received four parasitoid releases (25000 parasitoid/release/feddan) (El-Heneidy *et al.*, 1989). The releases were applied biweekly starting annually by mid-July, according to the infestation incidence. Release dates were almost during the 3<sup>rd</sup> week of July, 1<sup>st</sup> and 3<sup>rd</sup> weeks of August, and 1<sup>st</sup> week of September. The parasitoid was obtained from the mass rearing unit located at the Dept. of Biological Control, Agricultural Research Center, Giza.

- The second plot (B), located in the insecticide treated area at the research station and was applied (mostly four times, starting early July in 2-3 weeks intervals), according to the recommended conventional insecticidal program in cotton fields. Sprays were applied during the 2<sup>nd</sup> and 4<sup>th</sup> weeks of July and August annually.

- The third plot (C), (control) was located, about 500 m apart from the other experimental areas and left without any insecticidal treatments for two seasons and in the third season, parasitoid releases alternatively with spray of the Insect Growth Regulator (IGR) Ateroon, targeting the SBW, was applied. Application dates were 2<sup>nd</sup> and 4<sup>th</sup> weeks of August, and 2<sup>nd</sup> week of September 2001.

Experimental plots received regular cultural practices. No insecticides were used at all in the releasing areas (plot A and C) during the three seasons of the study.

Samples from the fallen squares, flower buds and green bolls (at least 50/sample from each) were collected weekly from the three sites starting early July up to early October. The samples were transferred to the laboratory in paper bags for inspection



and estimating the percentages of infestation with the target pests; PBW and/or SBW. The cotton leafworm (CLW), *Spodoptera littoralis* (Boisd.), a non-target pest/or host for *Trichogramma*, was counted accidentally when found. Direct inspection of the fallen flower buds and/or squares and dissection of the green bolls was the sampling procedure used for estimating the percentages of infestation (Abd El-Salam *et al.* 1991).

$$\text{Percentage of infestation} = \frac{\text{No. of infested buds or bolls}}{\text{Total no. of collected buds and bolls}} \times 100$$

Evaluation of different treatments in the experimental plots were estimated by their impacts on the rate of targeting pest infestations (Knutson, 1996 and Knutson *et al.* 1996). Besides, their impacts on the most common and abundant predators in the experimental cotton fields were also evaluated, but only in the third season (2000/2001) of the course of study.

Obtained data were recorded and statistically analyzed.

## RESULTS AND DISCUSSIONS

### 1. Rate of Infestation

**1.1. Fallen Cotton Flower-buds and Squares:** Infestation in the fallen cotton flower buds and/or squares began always in all the experimental plots, A, B and C with CLW followed by SBW during the second half of July in the three seasons of study. The exception was the timing, when the infestation started about 7-10 days earlier in the all sites in the season 2000. The earliest incidence of PBW in the fallen cotton flower buds and/or squares in the experimental plots was first recorded during the last week of July, in season 2000.

Percentages of infestation ranged between 1-12.5, 1.5-3.8 and 1.2-2.4 % for CLW, SBW and PBW, respectively during the month of July in the three plots in the three seasons. Rates of infestation increased obviously during August. Although most of the parasitoid releases and the pesticide applications (2-3 applications) were applied during August, percentages of infestation increased during this month. They ranged between 8-23.6, 3.2-26 and 3.4-18.5 % for CLW, SBW and PBW, respectively during August in the three plots in the three seasons. Rates of SBW and PBW infestation continued their increase in the fallen cotton flower buds and/or squares during the month of September, while those of CLW declined to almost equal of that estimated earlier dur-

ing July. They ranged between 2-12, 17.3-46 and 4.7-30 % for CLW, SBW and PBW, respectively during September in the three plots in the three seasons.

Throughout the whole period of the study, highest rates of infestation in fallen cotton flower buds and squares reached (56 % CLW), in plot (A) by mid-August in season 2001, (56 % SBW), in plot (C) by mid-September in season 1999, and (62 % PBW), in plot (B) by late September in season 2000.

Monthly mean percentages of infested fallen cotton flower buds and/or squares in the experimental cotton fields at Sakha Research Station during the three cotton seasons 1999-2001 are summarized in Table 1. Generally, regardless to the treatments, rates of SBW infestation exceeded that of PBW by 54.7-79.2 % in all plots in all seasons. Highest means of infestation were recorded during August for CLW and during September for the two cotton bollworms.

Statistical analyses showed significant difference between PBW and SBW in plot (A) in the three seasons, in plot (B) in season 2000 and in plot (C) in seasons 2000 and 2001.

**1.2. Cotton Green Bolls:** Earliest infestation with cotton bollworms in the green bolls started with PBW (2 %) during the third week of July, only in the second cotton season 2000. In the other two cotton seasons, 1999 and 2001, infestation was recorded first with both SBW and PBW during the second week of August.

Percentage of infestation in the green bolls increased sharply during August. It ranged between 4-44 and 4-32 % for PBW and SBW, respectively in the three experimental plots in the three cotton seasons of the study. Rates of infestation continued their increase during September to reach the ranges of 8-44 and 8-40 % for PBW and SBW, respectively in the three plots.

Throughout the whole period of the present study, highest rates of infestation recorded in the green bolls attained (44 % PBW) in plot (C) by early September in season 2000 and by (40 % SBW) in plot (A) by mid September in the same season.

Monthly average percentages of infestation in the cotton green bolls at Sakha Research Station during the three cotton seasons; 1999-2001 are summarized in table 2. Generally, rates of SBW infestation exceeded that of PBW in plot (A). The opposite was recorded in plots (B and C) where the infestation with PBW was higher. Highest means of infestation with the two cotton bollworms: PBW and SBW were found during September in all seasons, particularly season 2000.

Table 1. Monthly mean percentages of infested fallen flower buds and squares in cotton experimental plots treated with *Trichogramma*, insecticides and IGR (Atroon) at Sakha Research Station, Kafr El-Sheikh Governorate during 1999 - 2001 cotton growing seasons

Month	Pest Species	Plot A			Plot B			Plot C					
		1999	2000	2001	Mean	1999	2000	2001	Mean	1999	2000	2001	Mean
July	PBW	0	1.2	0	0.4	0	2.4	0	0.8	0	2.4	0	0.8
	SBW	1.5	3.8	0	1.8	0	2.4	6	2.8	0	3.6	0	1.2
	CLW	1	10	0	3.7	1.3	13.2	3	5.8	12.5	6	0	6.2
August	PBW	3.4	10	6	6.5	3.6	18.5	7.2	9.6	6.8	9	6.4	7.4
	SBW	16.2	26	18	20.1	3.2	12.5	20.8	12.2	9.6	23	11.6	14.7
	CLW	15.4	8	23.6	15.7	19.2	12	17.2	16.1	17.6	13	18	16.2
September	PBW	14	12.7	4.7	10.5	11.8	30	6	15.9	12.5	28.3	5.3	15.4
	SBW	20.8	35.3	34	30	23.8	36	22.7	27.5	28.5	46	17.3	28.6
	CLW	10.5	0	2	4.2	12	1.3	8	7.1	9.3	4	6.7	6.7
General Mean	PBW	5.8	8	3.6	5.8	5.1	17	4.4	8.8	6.4	13.2	3.9	7.8
	SBW	12.8	21.7	17.3	17.3	9	17	14.5	13.5	12.7	24.2	9.6	15.5
	CLW	8.9	6	8.5	7.8	10.4	8.8	9.4	9.5	13.1	7.7	8.5	9.7

Plot A = Treated with *Trichogramma* (four releases)

Plot B = Treated with insecticides (four applications)

Plot C = Control in 1999 and 2000 and treated with *Trichogramma* + IGR in season 2001 (three times)

Table 2. Monthly mean percentages of infested green bolls in cotton experimental plots treated with *Trichogramma*, insecticides and IGR at Sakha Research Station, Kafr El-Sheikh Governorate during 1999 - 2001 cotton growing seasons

Month	Pest Species	Plot A			Plot B			Plot C					
		1999	2000	2001	Mean	1999	2000	2001	Mean	1999	2000	2001	Mean
July	PBW	0	1.2	0	0.4	0	2.4	2	1.5	0	1.2	0	0.4
	SBW	0	0	0	0	0	0	0	0	0	0	0	0
August	PBW	12.8	14	9.6	12.2	8	26	12	14.3	14.8	28.3	7.2	25.2
	SBW	14.8	20.5	16.4	17.2	1.6	13	9.6	8.1	4.8	7.2	5.6	5.9
September	PBW	15.3	21.8	16	17.7	20.8	32	29.5	27.4	29.5	33.8	27	30.1
	SBW	18	29	18.5	21.8	12	15	21	16	26.5	28.5	7	20.7
General Mean	PBW	9.4	12.3	8.5	10.1	9.6	20.1	14.5	14.7	14.8	21.1	11.4	15.8
	SBW	10.9	16.5	11.6	13	4.5	9.3	10.2	8	10.4	11.9	4.2	8.8

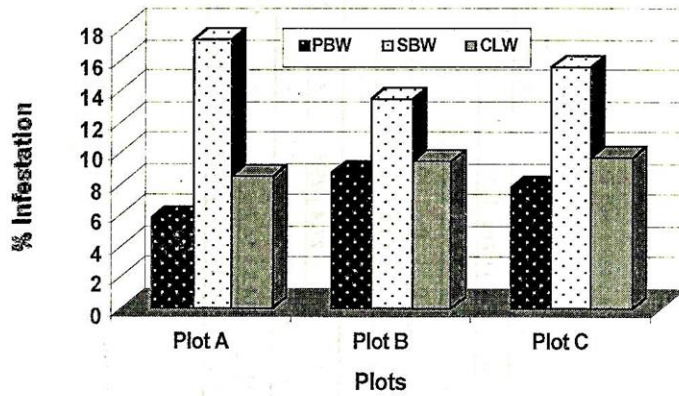
Plot A = Treated with *Trichogramma* (four releases)

Plot B = Treated with insecticides (four applications)

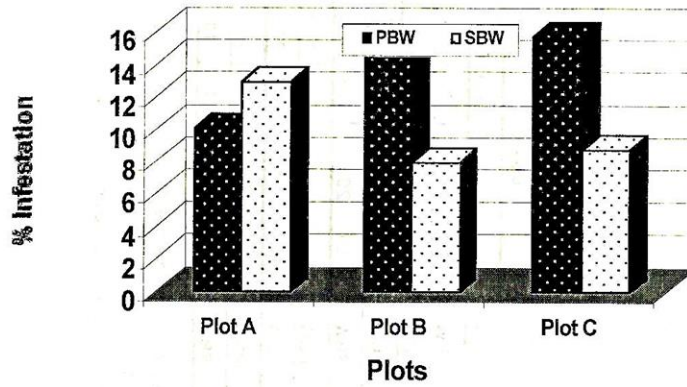
Plot C = Control in 1999 and 2000 and treated with *Trichogramma* + IGR in season 2001 (three times)



Fig.1. 3-year means of infestation percentages with cotton bollworms in three experimental cotton plots at Sakha Research Station seasons 1999-2001.



In the fallen cotton flower-buds and squares



In the cotton green bolls

Plot A =Treated with *Trichogramma*

Plot B =Treated with insecticides

Plot C = Control in 1999 and 2000 and treated with *Trichogramma* + IGR in season 2001.



Statistical analyses showed significant difference between PBW and SBW in plot (B), in season 2000 and in plots (A and C), in seasons 2000 and 2001.

## 2- Evaluation of Selected Treatments

Obtained results from plot (A), releases of the parasitoid *T. bactrae*, indicated that the parasitoid succeeded to reduce the rates of PBW infestation more than that of SBW in the three seasons, Tables 1 and 2 and Fig. 1. The reduction ranged between 54.7-79.2 and 3.8-26.7 % in the fallen cotton flower buds and/or squares and the green bolls, respectively in the respective plot. The relative low impact of the parasitoid releases, particularly in the green bolls maybe due to the low rate of *T. bactrae* used (25000 parasitoid/release/feddan). The reduction in PBW infestation was also greater during August than in September. These results maybe attributed to the impact of successive parasitoid releases (2-3 releases) against PBW during August and also to natural build up of bollworms infestation, particularly with PBW, towards the end of the cotton season, during September and October.

Obtained data from plot (B), insecticidal applications showed efficient results against SBW rates of infestation rather than the PBW in the first two seasons, particularly in the green bolls. Indirect effect of insecticidal applications might occur in the fallen cotton flower buds and/or squares. Rates of SBW infestation were 29.7-53.1 % lower than that of PBW. These results maybe due to the behavior of PBW larvae, which bore early into the green bolls and spend most of the larval stage (destructive stage) hiding inside the bolls and away from effect of insecticides.

Obtained results from plot (C), the control (check treatments) in the first two seasons and the use of IGR + parasitoid in the third season, demonstrated that SBW natural infestation was always 29.7- 63.2 % less than that of PBW. In addition, the use of IGR + parasitoid releases applied in the respective plot in the third season 2001, exhibited highest percentage of reduction in SBW infestation (63.2 %) compared with the first two seasons when no treatments were applied..

Generally, parasitoid releases (plot A) gave the best results in reducing PBW infestations in the fallen cotton flower buds and/or squares and the green bolls compared with the control. The reduction attained 9.4, 39.4 and 7.7 % in the fallen cotton flower buds and/or squares, and 36.5, 41.7 and 25.4 % in the green bolls in seasons 1999, 2000 and 2001, respectively. In case of the SBW, the results varied from one plot to another and from one season to another. Fallen flower buds and/or squares could be used as early monitoring of the rate of infestations in cotton fields. Superior

reductions in the rates of SBW infestation were achieved when the IGR + parasitoid were applied in plot (C) in the third season compared with both the parasitoid releases (plot A) and/or insecticidal applications (plot C). The reduction reached 4.6, 27.9 and 63.7 % in the green bolls in the above respective seasons.

Statistical analyses showed significant differences between plot (A) and the other two plots in both PBW and SBW rates of infestation in the fallen cotton flower buds and/or squares in the three seasons and only in the last two seasons in the green bolls.

Average means of the percentage of infestations with PBW and SBW in the three seasons and the three experimental plots were illustrated in fig. 1. Among the different treatments, comparative rates of reduction in the general means of the percentage of infestations:

- In the fallen cotton flower buds and/or squares, they attained 34.1, 25.6 and 11.4 % in PBW infestations when plots A&B, A&C, and C&B, respectively were compared and 22, 12.9, and 10.4 % in SBW infestations when plots B&A, B&C, and A&C, respectively were compared.

- In the green bolls, correspondent values were 31.3, 36.1, and 7 % in PBW when plots A&B, A&C, and C&B, respectively were compared and 38.5, 9.1, and 32.3 % in SBW when plots B&A, B&C, and C&A, respectively were compared.

Direct counts of the most common and abundant predators in the three experimental cotton plots were carried out only during season 2001. The counts included the coccinellids; *Coccinella* spp. and *Scymnus* spp., the staphilinid, *Paederus allierii* Koch., the chrysopid, *Chrysoperla carnea* S., and the anthocorids, *Orius* spp. Total number of predatory species / 25 cotton plants in the three experimental plots is illustrated in fig. 2. The highest number of the predators were recorded in plot (A) (47 %), followed by plot (C) (34.8 %), and lastly plot (B) (17.6 %). The predators were much safer in plot (A), where only another biocontrol agent was released, while the most harmful effect occurred in plot (C), where the chemical insecticides were applied. Among the counted predator species, the coccinellids were the dominant (78.1 %), particularly *Scymnus* spp. (68 %) and the chrysopid, *C. carnea* was the lowest (2.3 %).

In conclusion, the integration of using the egg parasitoid *T. bactrae* alternatively with IGRs showed superior reductions in the rates of infestation with the cotton bollworms, SBW and PBW in cotton fields. Promising results were achieved by releasing the egg parasitoid *T. bactrae* to control the bollworms, particularly the PBW. The outputs

of this study present a preliminary approach towards the evaluation of using the parasitoids as efficient biological control agents against the most serious cotton pests, the cotton bollworms. Further studies in this respect integrating different control methods are still needed for better results.

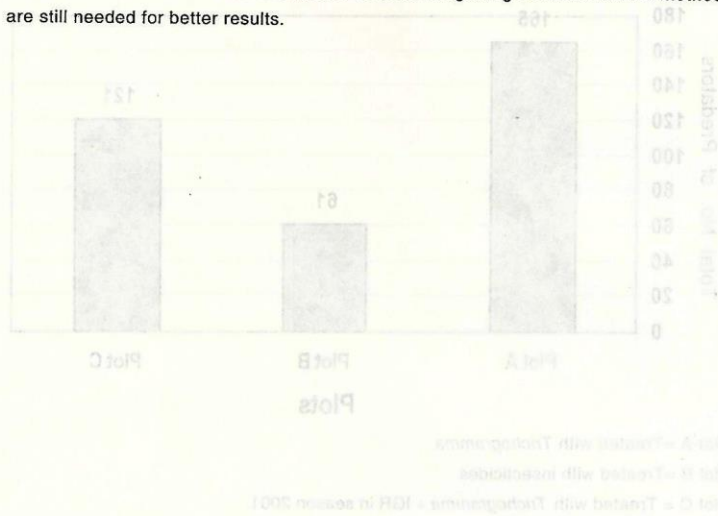
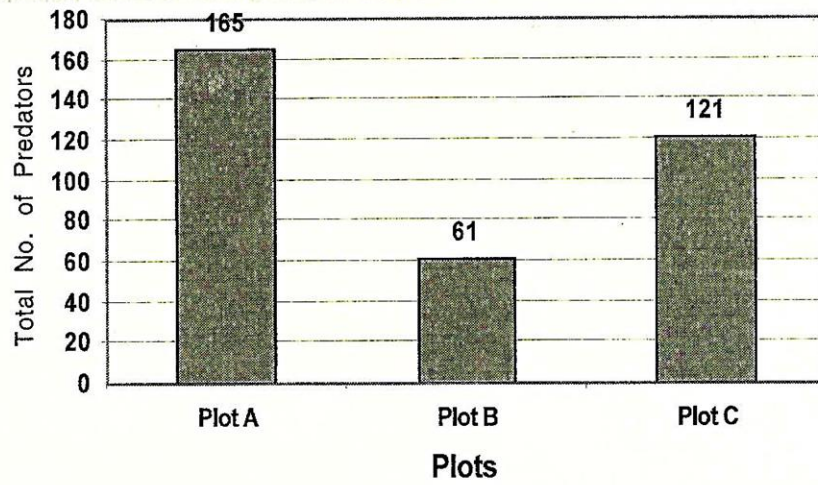


Fig.2. Total number of predators/25 plants in three experimental cotton plots at Sakha Research Station season 2001.



Plot A =Treated with *Trichogramma*

Plot B =Treated with insecticides

Plot C = Treated with *Trichogramma* + IGR in season 2001.



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## دراسة أولية نحو استخدام طفيل البيض " التريكوجراما " ضد ديدان لوز القطن في حقول القطن المصرية

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أجريت محاولة لتقييم كفاءة إطلاق طفيل البيض المستورد " تريكوجراماتويدا بكترا " لمكافحة ديدان لوز القطن، دودة اللوز القرنفلية ودودة اللوز الشوكية بالمقارنة مع المبيدات في حقول القطن بمحطة بحوث سخا، محافظة كفر الشيخ لمدة ثلاث مواسم متعاقبة ١٩٩٩-٢٠٠١. بلغت أعلى نسب للإصابة في الأزهار والبراعم المتساقطة ٥٦،٥٦، ٦٢،٥٦٪ بدودة ورق القطن، وبدودة اللوز الشوكية، وبدودة اللوز القرنفلية، على التوالي. كما بلغت أعلى نسب للإصابة في اللوز الأخضر ٤٠،٤٤٪ بالقرنفلية والشوكية، على التوالي.

أعطى إطلاق الطفيل أفضل النتائج في خفض نسب الإصابة بالقرنفلية في الأزهار والبراعم المتساقطة وكذلك في اللوز الأخضر مقارنة بالمبيدات وبالكنترول. بلغ معدل الانخفاض ٣٩،٤، ٩،٤، ٣٩،٧٪ في الأزهار والبراعم المتساقطة و ٣٦،٥، ٤١،٧، ٤١،٧، ٢٥،٤٪ في اللوز الأخضر في المواسم ١٩٩٩، ٢٠٠٠، ٢٠٠١ على التوالي. اختلفت النتائج في حالة دودة اللوز الشوكية من معاملة لأخرى ومن موسم لآخر. تحقق أعلى انخفاض في معدلات الإصابة بالشوكية عند المعاملة بمانع الانسلاخ بالتبادل مع إطلاق الطفيل مقارنة بكل من إطلاق الطفيل والمبيدات كل على حدة. بلغ الانخفاض ٢٧،٩، ٤، ٦، ٢٧،٧٪ في اللوز الأخضر في المواسم ١٩٩٩، ٢٠٠٠، ٢٠٠١ على التوالي.

سجل أعلى تعداد للمفترسات (٤٧٪) في منطقة إطلاق الطفيل، تلاه المقارنة (٣٤،٨٪)، وأخيراً منطقة استخدام المبيدات (١٧،٦٪).