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APPROPRIATE DATES OF *Trichogramma evanescens* (WEST.) RELEASE TO CONTROL RICE STEM BORER, AND EFFECT OF SPRAYED CHEMICALS ON PARASITOID SURVIVAL

El-Habashy, M.M.

Rice Research and Training Center (RRTC), Field Crops Research Institute, Agricultural Research Center, Egypt.

ABSTRACT

A schedule was investigated to find out the most appropriate date (or dates) for releasing *Trichogramma evanescens* (West.) to control the rice stem borer, *Chilo agamemnon* Bles. in rice fields. Due to release, the average reductions in dead hearts were 54.11, 24.22 and 63.30 % with releases on 20 June, 5 July and 20 June + 5 July, respectively. The average reductions in white heads ranged from 28.35, to 81.67 % due to one, two or three releases. However, two releases on 5 July + 20 July or on 20 July + 5 August achieved a satisfactory borer control, resulting in 71.09 and 74.13 % reductions in white heads. In a large-scale experiment conducted in the farmers' fields (a total of 52 feddans at Dakahlia and Kafr El-Sheikh Governorates), the reductions in dead hearts were 87.33 % due to the parasitoid release compared to 58.97 % due to insecticide application, while those of white heads were 94.38 and 46.28 %, respectively. In a laboratory test, the chemicals (nutrients and fungicides), commonly used in rice cultivations, were found safe when sprayed onto the parasitoid confined in *Sitotroga cerealella* (Oliv.) eggs (enveloped or nonenveloped). Only the insecticide, Malathion was toxic; 17.89 and 100 % parasitoid mortality for the enveloped and nonenveloped parasitoid, respectively. When the emerging parasitoid adults were exposed to the chemicals, or even to tap water, all the emerging individuals were killed. These findings show the importance of releasing the parasitoid twice from early July to early August, and to avoid spraying any chemicals onto the emerging *T. evanescens* adults. In all cases, the insecticide applications should be completely forbidden in the release fields.

INTRODUCTION

Rice plants, in Egypt, are subject to infestation with several insect pests, but the most destructive one is the rice stem borer, *Chilo agamemnon* Bles. The growers use insecticides to control the pest earlier than needed when they watch the dead heart symptom which appears during the vegetative stage. Such insecticide applications are highly hazardous to natural enemies, from which is the egg-parasitoid, *Trichogramma* spp., that represent important biological elements to control stem borers in rice fields (Marub 1993, Asaady and Navai 1995, Sherif *et al* 2008).

There are two ways to enhance the population of *T. evanescens*. in rice fields in Egypt. The first way is by conserving the occurring population through avoidance (or minimizing) the use of pesticides. The second one is by mass-rearing the parasitoid to be released at proper rates and proper times. Sherif et al (2008) concluded that the most appropriate rate of *T. evanescens* release is 30,000 individuals / feddan, and to be released twice; 20 and 40 days after transplanting rice plants sown by the first week of May.

T. chilonis and *T. dendrolium* have provided better control for the Asian corn borer, *Ostrinia furnacalis* (Guenee) (Feng *et al* 1999, Tan 1999 and Wu *et al* 2001). The Indian meal moth, *Plodia interpunctella* was also controlled in food products located in retail stores by the release of *Trichogramma deion*. The bio-intensive program, including releasing *T. chilonis*, for controlling cotton insects gave best seed cotton yields in farmers fields and the highest net income (Anonymous 1999). *Trichogramma* release for control of the Asian corn borer has become one of the key techniques of integrated pest management of corn pests in China (Wang *et al* 2003).

To keep the rice ecosystem clean without the hazardous effect of insecticides, the option of using *Trichogramma* seems too much appropriate. Thus, the current study was conducted to find out the appropriate time and number of *Trichogramma* releases in rice fields to control the stem borer, *C. agamemnon*. Also, the effect of some chemicals on the mortality of the parasite was laboratory tested. On the large scale, the efficiency of insecticides (e.g. carbofuran) and biological control (e.g. *T. evanescens*) against the rice stem borer was compared.

MATERIALS AND METHODS

Experiments were conducted to find out the efficiency of *Trichogramma evanescens* (West.) to control the rice stem borer, *Chilo Agamemnon* (Bles.) as compared with the insecticides. Also, sensitivity of the parasitoid to applied chemicals in rice fields was investigated.

1. Field experiment:

This experiment was carried out at the experimental farm of Rice Research and Training Center (RRTC), Sakha, Kafr El-Sheikh Governorate during 2007 and 2008 rice seasons. The experiment aimed to finding out the appropriate schedule of releasing the egg-parasitoid, *T. evanescens* in rice fields to control the rice stem borer, *C. agamemnon* on Giza 178 rice cultivar, as a susceptible check to the rice stem borer (Anonymous 2007) was sown on 5 May, and transplanted one month later as recommended. All recommendations of rice cultivation were adopted but without any insecticides and fungicides. The experimental field was divided into ten plots (one feddan each), and the release was applied in the rice plots which were about 100 meter apart. The plots received *T. evanescens* at a rate of 30,000 parasitoids / fed / release (Sherif et al 2008).

To evaluate the percentages of dead hearts, a sample of 30 hills per plot (10 hills x 3 subsamples) was taken from each treatment two weeks after release. To evaluate the percentages of white heads, a sample of the same size was taken three weeks before harvest. Reductions of dead hearts and white heads (two main symptoms of rice stem borer) in the release plots were calculated on the basis of borer infestation in the check plot (with no release).

2. Laboratory experiment:

Rice growers spray several chemicals in rice fields during the growing season. Some of these chemicals are nutrients, and some others are pesticides. So, a laboratory experiment was conducted to find out the effect

of such chemicals on the survival of *Trichogramma* that could be released in the rice fields. Six treatments, in addition to a check, were practiced upon three forms of *T. evanescens* according to as follows:

1. Enveloped small paper (4 cm^2) glued on which the eggs of *S. cerealella* harbouring alive pupae of *T evanescens.*.
2. The same as the previous one, but the paper having *Sitotroga* eggs was not enveloped.
3. The emerging adults of *T. evanescens*.

The emerging numbers of *T. evanescens* adults from the six treatments were counted, and the reductions in the emergence due to chemical treatments were calculated as compared to the emergence in the check (untreated).

3. Large-scale fields treated with *T. evanescens* and insecticides:

To find out the efficiency of *T evanescens.* release versus insecticide application in large areas, rice fields at Dakahlia, Kafr El-Sheikh and Gharbia Governorates (total of 52 feddan) were assigned to this experiment. The fields were cultivated with four cultivars; Egyptian Yasmin, Giza 178, Hybrid 1 and Sakha 104. The fields were chosen to be sown within the first week of May and received the same cultural practices. The parasitoid, *T. evanescens* was released in the areas of 30, 8, 5, 7 and 2 feddans at Mansoura, Manzala, Talkha (Dakahlia Governorate), El-Reiad (Kafr El-Sheikh Governorate) and Kotor (Gharbia Governorate), respectively. The parasitoid was released twice; 20 July and 5 August, each at a rate of 30,000 parasitoids / feddan. At each location, an area of one feddan was assigned to the insecticide application; carbofuran (Furadan 10 G) at a rate of 2 kg / fed which is the conventional application of the growers, despite the recommended dose is 6 kg / fed. The chemical application was practiced twice., on 20 July (the same date of first parasitoid release), and on 5 August (the same date of second release) Percentages of dead hearts were evaluated at the areas treated with *T. evanescens*, treated with the parasite and check (untreated) areas two weeks after treatments. Percentages of white heads were evaluated three weeks prior to harvest.

RESULTS AND DISCUSSION

1. Field experiment:

Data presented in Table (1) show the rice stem borer, *Chilo Agamemnon* (Bles.) infestation, in forms of dead hearts, as influenced by date of *Trichogramma evanescens* (West.) release. In 2007 season, the check plot (no release) exhibited 3.17 % dead hearts, which were reduced to 1.76, 2.52 and 1.34 % when the parasitoid was released on 20 June, 5 July, and 20 June plus 5 July, respectively. The statistical analysis revealed highly significant differences among treatments. The corresponding calculated values of dead heart reductions were 44.48, 20.50 and 57.73 %. In 2008 season, almost the same trend was found with 63.73, 27.94 and 68.87 % reductions for the three dates of release, respectively with highly significant differences. As an average of both years, the borer infestation reductions were 54.11, 24.22 and 63.30 % when the release was practiced on 20 June, 5 July and 20 June plus 5 July. Similar results of rice stem borer infestation reduction due to the release of *Trichogramma* spp were reported in the

experiments. Inundative release of *T. japonicum* in plots of rice at Assam, India reduced the damage by stem borer, *Scirpophaga incertulas* by 54.90 % after fifty days from release (Borah 1994). Sherif *et al* (2008) reported 48.83 % dead heart reduction when the parasitoid was released in rice fields twice; 20 and 40 days after transplanting Giza 178.

Table (1): Rice stem borer *C. agamemnon* infestation as influenced by schedule of *T. evanescens* release in rice fields.

Date of release	2007 season		2008 season		Average reduction %
	Dead heart %	Dead heart % reduction	Dead heart %	Dead heart % reduction	
Check (no release)	3.17 a*	----	4.08 a	----	----
20 June	1.76 b	44.48	1.48 c	63.73	54.11
5 July	2.52 a	20.50	2.94 b	27.94	24.22
20 June + 5 July	1.34 b	57.73	1.27 c	68.87	63.30
LSD 5 %	0.491		0.621		
1 %	0.672		0.940		
F	4.660**		5.320**		

***In a column, means followed by the same letter are not significantly different at the 5 % level.**

Data in Table (2) show the effect of *T. evanescens* release on the levels of borer infestation as white heads. In 2007 rice season, the check plot (with no release) suffered 12.57 % white heads. Releases on 20 June, 5 July, 20 July or 20 June + 5 July reduced the white heads to 6.30, 5.86, 6.52 and 7.89 % which means 49.88, 53.38, 48.13 and 37.23 % white head reductions, respectively. However, the greatest borer reductions were detected with three releases; 20 July + 5 August + 20 August (82.42 % reduction), 5 July + 20 July + 5 August (2.42 % reduction). In 2008 rice season, a similar trend was obtained. The highest borer reduction (80.91 %) was detected with three releases; 20 July + 5 August + 20 August followed by release on 20 June + 5 July + 20 July (77.55 % white head reduction), and then by two releases; 20 June + 5 July (72.80 % reduction). The average of both years of study show that the most appropriate dates of the parasitoid release to control the borer are: 20 July + 5 August (74.13 % reduction), 5 July + 20 July + 5 August (72.77), while the greatest borer reduction was obtained with the release of 20 July + 5 August + 20 August (81.67 %). From the applicable and economic point of view, two releases could be recommended to control the rice stem borer, particularly on 5 July + 20 July or on 20 July + 5 August (71.09 – 74.13 % borer reduction). Each release should contain 30,000 parasitoid individuals / fed. Similar reductions in white heads were obtained by Sherif *et al* (2008) who obtained 69.71 % white head reduction in stem borer infestation when *T. evanescens* was released twice (each at a rate of 30,000 parasitoids / fed); 20 and 40 days after transplanting the rice sown by the first week of May. Soliman and Ewaise (1997) obtained successful *C. agamemnon* control when *T. evanescens* was released in the rice fields at a rate of 28,000 parasitoids / fed.

The inundative release of *T. japonicum* during the panicle initiation resulted in a significant increase of parasitism on white stem borer (WSB), *Scirpophaga innotata* Walker eggs from 12 % before release to 32 % four days after release, resulting in lower WSB damage and a higher yield. (Anonymous 2005).

Table (2): Rice stem borer *C. agamemnon* infestation as influenced by schedule of *Trichogramma evanescens* release in rice fields

Date of release	2007 season		2008 season		Average reduction %
	White head %	White head % reduction	White head %	White head % reduction	
Check	12.57 a*	----	10.11 a	----	----
20 Jun.	6.30 bc	49.88	9.42 a	6.82	28.35
5 Jul.	5.86 bc	53.38	6.35 abc	37.19	45.29
20 Jul.	6.52 bc	48.13	8.23 ab	35.41	41.77
20 Jun. + 5 Jul.	7.89 abc	37.23	2.75 bc	72.80	55.02
5 Jul. + 20 Jul.	2.42 c	80.75	3.90 bc	61.42	71.09
20 Jul. + 5 Aug.	2.60 c	79.32	3.14 bc	68.94	74.13
20 Jun. + 5 Jul. + 20 Jul.	4.68 c	62.77	2.27 bc	77.55	70.16
5 Jul. + 20 Jul. + 5 Aug.	2.42 c	80.75	3.56 bc	64.79	72.77
20 Jul. + 5 Aug. 20 Aug.	2.21 c	82.42	1.93 c	80.91	81.67
LSD					
5 %	4.908		5.474		
1 %	6.724		7.499		
F	4.66**		3.492**		

***In a column, means followed by the same letter are not significantly different at the 5 % level.**

2. Laboratory experiment:

The effects of different chemicals; nutrients and pesticides on the survival of *T. evanescens* are shown in Table (3). In case of the enveloped parasitoid, 1565 adults emerged from the check paper (4 cm^2) having *Sitotroga* eggs harbouring the parasitoid pupae. The papers treated with water produced 1540 adults, which represents 1.60 % reduction as compared to the check. In case of zink sulphate treatment, 1505 adults emerged (with 3.83% reduction). The emerging numbers for sulphur, potassium sulphate, urea and Fuji-1 treatments were 1500, 1470 and 1455 parasitoid adults with 4.15, 6.07, 5.75 and 7.03 % reductions as compared to the check, respectively. However, the paper cards treated with the insecticide, Malathion produced for 1285 adults, which represents 17.89 % reduction.

When the paper having *T. evanescens* pupae were subjected to the abovementioned treatments without envelopes, values of reductions relatively increased; 1.27, 7.96, 6.37, 8.60, 6.37 and 9.24 % for the treatments of water, zink sulphate, sulphur, potassium sulphate, urea and Fuji-1, respectively. In case of Malathion, the treated cards without envelopes did not emerge to any of the parasitoid adults which means that this insecticide killed completely the pupae of *Trichogramma* before adult emergence.

On the other hand, when the emerging *T. evanescens* adults were treated with different chemicals, all parasitoid individuals were killed, even when treated with tap water.

These findings are in agreement with those of Suh *et al* (2000) who reported that all tested insecticides, with the exception of methoxyfenozide and tebufenozide, adversely affected *T. evanescens* emergence from *Helicoverpa zea* host eggs. The results of inundative releases of *T. evanescens* to control pests are sometimes variable. King *et al* (1984) reported that some of this variability could be attributed to the use of broadspectrum insecticides. In such concern, Bull and Coleman (1985) have shown that *Trichogramma* spp wasps are highly susceptible to most broadspectrum insecticides.

3. Lareg-scale fields treated with *T. evanescens* and insecticides:

Five rice fields of variable areas, sown at different locations, were assigned to compare the efficiency of *T. evanescens* release with that of insecticide treatment against the rice stem borer infestation (Tables 4 & 5). Mansoura, Manzala and Talkha (Dakahlia Governorate) fields suffered 10.22, 9.15 and 12.31 % dead hearts in case of check (untreated) fields. These levels were reduced to 1.10, 2.17 and 0.50 % dead hearts (with corresponding values of reductions of 89.24, 76.28 and 95.94 %, respectively) in case of *T. evanescens* release. When carbofuran (the recommended insecticide) was used at a rate of 4 kg / fed as the growers usually apply, the dead heart percentages were reduced to 5.23, 4.25 and 4.19 % (with corresponding values of reductions of 48.83, 53.55 and 65.96 %, respectively). The same trend was found at El-Riad (Kafr El-Sheikh) rice fields, which suffered 8.50 and Qutour (Gharbia) 2.10 % dead hearts in case of check, and were reduced to 1.30 & 0.20 % with *T. evanescens* release and to 3.21 and 0.75 % with insecticide application. The corresponding values of dead heart reduction were 84.71 & 90.48 in case of *T. evanescens*, and were 62.24 & 64.29 % in case of insecticide application. Over the locations, varieties and treated areas, the averages of dead hearts were 8.46, 1.05 and 3.53 % for the check, *T. evanescens* and insecticide treatments, respectively. Thus, the reductions due to *T. evanescens* release were greater (87.33 %) than that of insecticide treatment (58.97 %).

Table (3): Effect of certain chemicals on the survival of *T. evanescens*

Treatment	Rate / one liter of water	With envelope		Without envelope		Direct spray on adults	
		No. of emerging parasitoids	% Reduction	No. of emerging parasitoids	% Reduction	No. of alive parasitoids	% Reduction
Check (untreated)	----	1565	----	1570	----	1560	----
Water	----	1540	1.60	1550	1.27	0	100
Zinkc sulphate	20 g	1505	3.83	1445	7.96	0	100
Sulphur	20 g	1500	4.15	1470	6.37	0	100
Potassium	20 g	1470	6.07	1435	8.60	0	100
sulphate	20 g	1475	5.75	1470	6.37	0	100
Urea	2.5 ml	1455	7.03	1425	9.24	0	100
Fuji-1	2 ml	1285	17.89	0	100.00	0	100
Malathion							

Table (4): Dead heart levels in rice fields due to rice stem borer, *C. agamemnon* infestation as influenced by *T. evanescens* and insecticide applications (2008).

Location	Variety	Area (feddan)	Check (untreated)	Treated with		Reduction % due to	
				Trichogramma	Insecticide	*Trichogramma*	Insecticide
Mansoura (Dakahlia)	Egyptian						
Manzala (Dakahlia)	Yasmin	30	10.22	1.10	5.23	89.24	48.83
Talkha (Dakahlia)	Giza 178	8	9.15	2.17	4.25	76.28	53.55
El-Riad (Kafr El-Sheikh)	Hybrid 1	5	12.31	0.50	4.19	95.94	65.96
Qutour (Gharbia)	Hybrid 1	7	8.50	1.30	3.21	84.71	62.24
	Sakha 104	2	2.10	0.20	0.75	90.48	64.29
Total / Average	--	52	8.46	1.05	3.53	87.33	58.97

Table (5): White head levels in rice fields due to rice stem borer, *C. agamemnon* infestation as influenced by *T. evanescens* and insecticide applications (2008).

Location	Variety	Area (feddan)	Check (untreated)	Treated with		Reduction % due to	
				Trichogramma	Insecticide	*Trichogramma*	Insecticide
Mansoura (Dakahlia)	Egyptian						
Manzala (Dakahlia)	Yasmin	30	14.09	0.60	8.11	95.74	42.44
Talkha (Dakahlia)	Giza 178	8	8.12	0.40	6.17	95.07	24.01
El-Riad (Kafr El-Sheikh)	Hybrid 1	5	20.25	0.40	7.32	98.02	63.85
Qutour (Gharbia)	Hybrid 1	7	16.33	2.00	8.15	87.75	50.09
	Sakha 104	2	6.41	0.30	3.14	95.32	51.01
Total / Average	--	52	13.04	0.74	6.58	94.38	46.28

The levels of white heads due to *T. evanescens* and insecticide applications are shown in Table (5). However, the percentages of white heads were too much higher than those of dead hearts, which could be explained that the tested cultivars are more sensitive to borer infestation at heading stage than at tillering stage. The levels of white heads in the check treatments were 14.09, 8.12, 20.25, 16.33 and 6.41 % at Mansoura, Manzala, Talkha, El-Riad and Kotor, respectively. The corresponding reductions were 95.74, 95.07, 98.02, 87.75 and 95.32 % in case of *T. evanescens* and were 42.44, 24.01, 63.85, 50.09 and 51.01 in case of carbofuran, respectively.

Over the locations, varieties and treated areas, the average white head level of 13.04 % at the check treatments was 13.4, and reduced by 94.38 % in case of *T. evanescens* and by 46.28 % in case of the insecticide (carbofuran).

Since the rice growers use sometimes foliar insecticides to control insect pests, it has become necessary to find ways to stop such practices to

conserve the natural enemies. Suh (2000) indicated that most of the foliar insecticide applications are toxic to many nontarget organisms, including predators and parasitoids.

Rice yield, and cost of stem bore control either by *T. evanescens* or by insecticide (Furadan) are presented in Table (6). In all cases, rice varieties treated with *T. evanescens* yielded more than those treated with the insecticide, 3.20, 4.10, 5.60, 5.40, and 4.10 t / fed for the parasitoid, and 2.40, 3.30, 4.80, 4.60, and 4.00 t / fed for chemical control, respectively. This shows the efficiency of the new technique (biological control) to control the rice stem borer as compared to the conventional technique (chemical control). One more advantage for the biological control is the cost of application per feddan. Data in Table (6) show that the cost of one feddan by *T. evanescens* is only 30 L.E. throughout the rice season(including two releases), while that of chemical control is 120 L.E. (for 4 kg Furadan). The latter insecticide was usually used by the rice growers. However, the recommended dose of Furadan is 6 kg / fed / application which equals 180 L.E. in average. Sometimes, the growers may need two Furadan applications, which doubles the cost for 360 L.E. / feddan / season.

Table (6): Rice yield of different varieties as influenced by type of rice stem borer control, and of pest control

Location	Variety	Yield (t / fed)	
		Trichogramma	**Insecticide**
Mansoura (Dakahlia)	Egyptian Yasmin	3.20	2.40
Manzala (Dakahlia)	Giza 178	4.10	3.30
Talkha (Dakahlia)	Hybrid 1	5.60	4.80
El-Riad (Kafr El-Sheikh)	Hybrid 1	5.40	4.60
Qutour (Gharbia)	Sakha 104	4.10	4.00
Pest control cost (L.E. / fed)	--	30	120*

- **Two applications of Furadan (each at a rate of 2 kg / fed). These doses are less than the recommended dose; 6 kg / fed / application.**

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المواعيد المناسبة لإطلاق طفيل التريكوجراما لمكافحة ثاقبة ساق الأرز وتأثير رش بعض المركبات الكيماوية على حياة الطفيل

محمود محمد الحبشى
مركز البحوث والتدريب فى الأرز ، معهد بحوث المحاصيل الحقلية ، مركز البحوث الزراعية ، مصر

أطلق طفيل التريكوجراما فى مواعيد مختلفة فى حقول الأرز لمكافحة ثاقبة ساق الأرز. إنخفضت نسبة الإصابة بالقلوب الميتة بمقدار ٥٤,١١ ، ٢٤,٢٢ ، ٦٣,٣٠ % عند إطلاق الطفيل فى ٢٠ يونيو ، ٥ يوليو ، ٢٠ يونيو + ٥ يوليو. كما تراوح الخفض فى نسبة الإصابة بالسنابل البيضاء من ٢٨,٣٥ إلى ٨١,٦٧ % نتيجة إطلاق الطفيل مرة أو مرتين أو ثلاث مرات. ويعتبر إطلاق الطفيل مرتان فى ٥ يوليو ثم ٢٠ يوليو أو فى ٢٠ يوليو ثم فى ٥ أغسطس هى أكثر المواعيد المناسبة لخفض نسبة الإصابة بالسنابل البيضاء بطريقة فعالة.

وفى تجربة موسعة (٥٢ فدان) أجريت فى محافظات الدقهلية وكفر الشيخ والغربية ، ثبت أن إطلاق الطفيل أكثر فعالية فى خفض الإصابة من استخدام المبيدات الحشرية حيث كانت نسبة الخفض فى القلوب الميتة ٨٧,٣٣ ، ٥٨,٩٧ % وفى السنابل البيضاء ٩٤,٣٨ ، ٤٦,٢٨ % لكل من الطفيل والمبيدات على التوالى.. وفى تجربة معملية لاختبار تأثير الكيماويات الشائع رشها فى حقول الأرز سواء كانت أسمدة ورقية أو مبيدات فطرية ، لم يكن لهذه المواد تأثير ضار على الطفيل سواء داخل المظروف أو بدونه ، بينما أدى مبيد الملاثيون إلى قتل ١٧ % من الطفيل إذا عومل داخل المظروف ، بينما ماتت جميع الطفيليات التى كانت بدون مظروف. أما المعاملات التى تجرى على الطفيل بعد خروجه من طور العذراء ، فلقد أدت جميعها إلى موت جميع الأفراد.

وعلى هذا فإن إطلاق الطفيل فى المواعيد المناسبة ، وكذا تفادى استخدام كيماويات فى حقول الأرز بعد خروج الطفيل من طور العذراء (من الكروت المثبتة فى النباتات) هى عوامل أساسية لنجاح استخدام طفيل التريكوجراما فى حقول الأرز.