Egyptian Journal of Biological Pest Control, 21(1), 2011, 97-100

Biocontrol Agents Compared to Chemical insecticide for Controlling the Potato Tuber Moth, *Phthorimaea operculella* (Zeller) in the Newly Reclaimed Land in Egypt

Meabed[*] H. A. A.; Amany M. Rizk[*]; N. N. El Hefnawy[*] and M. M. El-Husseini[**]
Dept Sustainable Development, Environmental Studies and Research Institute, Minufiya Univ., Sadat City, Egypt.
[**] Dept.Econ. Entomol. and Pesticides, Fac. Agric., Cairo Univ., Giza, Egypt.
(Received: May 15, 2011and Accepted: June 19, 2011)

ABSTRACT

A study to investigate the effect of different releasing rates of the egg parasitoid, *Trichogramma evanescens* West. (40.000, 80.000 and 120.000 parasitoids/ fed.), two bio-insecticides (Tracer 24% SC 30 ml/100 L water, and Protecto 10% WP 300 gm/ fed), versus the recommended insecticide (Selecron72% 750 ml/ fed), against the potato tuber moth (PTM), *Phthorimaea operculella* (Zeller) was carried out on potato (*Solanum tuberosum* L.) under field conditions for the two successive seasons 2008 and 2009. The highest rate of wasp releasing (120,000 parasitoids/fed.) was the best treatment and most effective compared to the other tested treatments, resulting the lowest mean values of infested tubers (8.33 & 9.3), holes (11.33 & 14.00), developed pupae (9.67 & 12.00) and emerged moths (7.67 & 9.67) per 200 tubers, as well as highest yield (9.65 and 9.37 tons/fed.), with lowest value of losses due to PTM infestation (35.33 and 37.0 kg/ton) in 2008 and 2009 seasons, respectively. The bio-insecticide Protecto 10% (*Bacillus thuringiensis kurstaki*) gave moderate effect for minimizing the potato infestation. The natural compound Tracer 24% ranked third in reducing PTM infestation. The chemical insecticide, Selecron 72% ranked last for the same criteria. All treatments led to significantly, better criteria than the control.

Key words: Biocontrol agents, *Trichogramma evanescens, Bacillus thuringiensis, Phthorimaea operculella* (Zeller), potato, Egypt.

INTRODUCTION

Potato, *Solanum tuberosum* L. is a major food crop in many countries of the world. It occupies the forth place among the most important food crops all over the world, following wheat, rice and maize (Shady *et al.* 2007). In Egypt, potato is one of the most important vegetable crops. Its cultivated area was estimated by 197 thousand feddans in 2002. Potato also has a great importance as an export crop. It ranks the third among other field crops next to cotton and rice (Gomaa and Ibrahim 2003).

Potato is attacked by numerous insect pests, which reduce yield quantity and quality. The potato tuber moth (PTM) *Phthorimaea operculella* (Zeller) is considered the most destructive insect pest on both foliage and tubers, causing serious damage in the field and store in many countries (Kirkham 1995).

Extensive chemical pesticides applications for the insect pests' control lead to human poisonings, numerous other health problems, cause high destruction to beneficial organisms and induce development of new pests. To decrease pesticide use in plant protection, Integrated Pest Management (IPM) policies have been recently recommended by the Egyptian Ministry of Agriculture and Land Reclamation. Biological pest control is a corner stone in such IPM programs. The egg parasitoid, *Trichogramma evanescens* West. is widely used to control different lepidopteran pests worldwide which preserves the endemic natural enemy complex, reduces the need of additional treatments to control secondary pests and reduces environmental pollution caused by insecticides (Smith, 1996). PTM was controlled by *T. brasilensus* on tomato in Chile (Loo and Aguilera, 1983) and by *T. chilonis* in potato fields and stores in India (Pokharkar and Jogi, 2000). In Egypt, Agamy (2003) and Rizk (2010) evaluated different rates of *T. evanescens* releases against *Ph. operculella* in potato fields.

This study aimed to minimize PTM infestation under field conditions by releasing the egg parasitoid, *T. evanescens* at different rates in comparison with two bio-insecticides and a traditional chemical insecticide.

MATERIALS AND METHODS

Experiments were conducted at the farm of the Environmental Studies and Research Institute, Minufiya University, El Sadat City, Minufiya Governorate, Egypt. Randomized complete block design, with four replicates was used. Spunta potato variety was planted in the two successive seasons 2008 and 2009, as summer plantations. Planting date was 18 January in both seasons. Plot size was about 150 m^2. All plots received the recommended agricultural practices. Seven treatments were applied for controlling PTM on potato crop. Each treatment was separated by 300 meters from each other to avoid migration of *Trichogramma* from one site to another.

T. evanescens was reared on the grain moth,

Sitotroga cerealella eggs, according to the method described by Hassan (1995). Releasing rates in cards included about 1000, 2000 and 3000 parasitized eggs/card. Each card contained 2-age groups, allowing successive adults' emergence of *Trichogramma* along a period of one week post card installation in the field. The cards were distributed at the rate of 40 cards/ fed. for each releasing rate (40.000, 80.000 and 120.000 parasitoids/ fed./release). The releasing cards were placed at the plant heart and by 10 meter distance among releasing points at 10 day intervals. The first date for wasp's releasing was determined by occurrence of the first PTM male moth in the PTM pheromone trap.

Treatments and releasing rates

1- Four releases of *Trichogramma*, at the rate of 120.000 parasitoids/fed. (T1).
2- Four releases *Trichogramma*, at the rate of 80.000 parasitoids/fed. (T2).
3- Four releases of *Trichogramma*, at the rate of 40,000 parasitoids/fed. (T3).
4- Spinosad 24%SC (Tracer), at the rate of 30 ml/100 L water (T4). Tracer is a metabolite of the Actinomycete, *Succharopolyspora spinosa*. It is a naturally occurring mixture of two active spinosyns (spinosyn A & D).
5- Protecto (WP) 10%, at the rate of 300 gm/ fed. (T5). Protecto is a commercial product formulation contains $32x10^6$ IU/mg of *B. thuringiensis* subsp. *kurstaki*.
6- Selecron 72 %, at the rate of 750 ml/ fed. (T6).

Volume of spray was 200 L /fed and each compound was applied three times at 10 day intervals. Treatments were applied just by trapping the first male of PTM moth in the pheromone traps in the field (around March 4th in 2008 and 2009 seasons).

Assessment

At harvest, 200 tubers were randomly collected from each treatment (4 replicates/ treatment) and inspected to count surface hole infestation, number of infested tubers and to assess the relative effect of the treatments on the infestation rate and produced yield. Tubers were placed on sand inside cages (50 x 50 x 50 cm) to count both the developed pupae and the emerged moths.

Obtained results were subjected to the analysis of variance test (ANOVA) and LSD at 5% probability level to compare the differences among means according to Senedecor and Cochran (1973).

RESULTS AND DISCUSSION

Results in tables (1 and 2) show the effect of different *Trichogramma* releasing rates and the two bio-insecticides compared to the chemical insecticide Selecron for minimizing the PTM damage at harvest in 2008 and 2009 seasons.

Infestation rates were represented by the mean numbers of infested tubers, holes, developed pupae and emerged moths / 200 tubers, as well as losses of yield due to infestation (kg/ ton) and potato tuber yield (ton/ fed.) for all the tested treatments. The two seasons' data indicated highly significant differences between the control and different treatments.

As shown in table (1), treatment by 4 *Trichogramma* releases (120,000 parasitoids/fed.) was the best and most effective for reducing the PTM damage, as well as led to highest tuber yield (9.65 tons/ fed.). The same treatment resulted to the lowest mean numbers of infested tubers and holes (8.33 &11.33/200 tubers, respectively). On the other hand, this treatment gave the lowest mean values of losses due to infestation (35.33kg/ ton.). The highest yield recorded by this treatment may be attributed to early foliage protection, increasing the natural role of *Trichogramma* by extensive number of releases, which gave their effect early and continued up to the end of the season. The treatment with *Trichogramma* releases of 80.000 parasitoids/ fed. ranked second in its efficacy for decreasing the mean numbers of infested tubers and holes, as well as for increasing mean values of tuber yield with a low mean of losses due to infestation.

The bio-insecticide tracer (Spinosad) showed the third rank for protection related to the same criteria. While the other bio-insecticide, Protecto, gave relatively moderate effect. On the contrary, the recommended chemical insecticide was the least effective treatment for reducing PTM infestation, recording relatively high mean values of infested tubers and holes, with a relatively low value of tuber yield/fed. and a high value of yield losses due to infestation, in spite of the recorded values of criteria were significantly much better than those recorded from the control.

Tubers infestation rate was expressed as mean numbers of infested tubers (as infested tuber showing one or more surface holes) and furthermore as emerged moths from the harvested tuber, which cause the new infestation of the next generation of the pest in the field or storage.

Regarding the mean number of PTM pupae resulted from 200 tubers, it is clear from table (1) that all treatments caused significant reductions in these traits compared to the control. Statistical analysis indicated that the 4 releases of the parasitoid at the rate of 120,000 individuals/fed. was the most effective to minimize the mean number of developed pupae compared with the other tested treatments. It recorded the lowest mean number of pupae (9.67/ 200 tubers), while the highest mean (43 pupae) was recorded by the chemical insecticide

Selecron. The bio-insecticide Protecto gave moderate effect for same criterion (14.67 pupae/ 200 tubers). Concerning the compound Tracer, it showed the third rank of efficacy for the same criterion.

As for the mean number of emerged moths from 200 tubers, as presented in table (1), it is clear that the lowest mean was recorded by the *Trichogramma* releases of 120,000 parasitoids/ fed., reaching 7.67 moths/ 200 tubers, followed by the *Trichogramma* releases of 80,000 wasps/ fed. On the other hand, the chemical insecticide Selecron showed the least efficacy as a relatively high mean of this trait (40 moths/ 200 tubers). The natural product Tracer occupied the third rank in minimizing the mean number of emerged moths (12.33/ 200 tubers), while the *B.t.* product recorded a moderate reduction rate of emerged moths (29 moths/ 200 tubers).

Tubers' infestation as surface infestation without or with real galleries indicated the accumulated effect of the whole season based on the different treatments. Also, the emerged moths from these tubers in the best treatment, was mostly correlated to the high protection for both foliage and tubers against PTM infestation, so it reduced the new infestation leading to the next generation of potato tuber moth.

Nearly the same results were obtained in the second season. Results revealed highly significant differences between control and the other treatments for all tested traits.

Statistical analysis indicated that the 4-releases treatment with *T. evanescens* at the rate of 120,000 parasitoids/ fed. was the best and most effective treatment comparing with the other tested treatments as shown in table (2), recording the lowest mean values of infested tubers, holes, developed pupae and emerged moths (9.33, 14.0, 12.0 and 9.67, respectively), as well as the highest values of yield (9.37 tons/ fed.) with the lowest loss of infested tuber yield (37.0kg/ ton.). However, the recommended pesticide Selecron seemed to be the least effective one for the same criteria, recording relatively high means of the previous traits (47.67, 57.33, 42.67 and 41.0, respectively), as well as a relatively low value of yield (6.4 ton/ fed.) and with a relatively high mean of infested tuber yield (89.33kg/ ton).

The 4 releases of *Trichogramma* at the rate of 80.000 wasps/ fed. scored the second rank of efficacy for reducing PTM damage as well as increasing the tuber yield and with a low mean of infested tuber yield.

To minimize the negative effects of *Ph. operculella* in potato field and to produce the highest tuber yield free from any pesticide residues, it could be concluded that the biological control program should start early by the first appearance of the PTM moth in the pheromone traps and by applying 4 releases of *Trichogramma* at the rate of 120.000 or 80.000 parasitoids/fed. at 10 day intervals. Such a treatment might achieve a highly significant protection against the pest based on the reduction of infested tubers, holes, developed pupae and emerged moths, as well as increase the produced tuber yield.

Agamy (2003) reported that the three releases of *T. evanescens* in potato field at a moderate level of PTM infestation was more successful in suppressing the infestation in produced tubers yield (4.8%) than in at heavily infested level (8.84 %).

Similar results were recorded by Gomaa and Ibrahim (2003) who stated that the microbial PTM control method was economically and ecologically sound more than the chemical control method in both field and store.

In similar studies, Temerak (2003) reported that, Spinosad was significantly better at 10 ml/ 100 L than *B. thuringiensis* subsp. *kurstaki* product at 150g/ 100 L water against *Ph. operculella* in the field. Spinosad showed rapid and high level of efficacy and should replace the old conventional insecticides for the control of *Ph. operculella*.

Table (1): Effect of different *T. evanescens* releases, two bio-insecticides and Selecron against *Ph. operculella* in potato field at Sadat district, Minufiya Governorate, Egypt in 2008

Treatments	Mean no. of infested tubers/ 200 tubers	Mean no. of holes/ 200 tubers	Mean no. of pupae/ 200 tubers	Mean no. of emerged moths / 200 tubers	Mean weight of yield tons/ fed.	Losses due to infestation kg/ ton
T1	8.33 [a]	11.33 [a]	9.67 [a]	7.67 [a]	9.65 [a]	35.33 [a]
T2	10.00 [b]	14.00 [b]	11.67 [b]	10.33 [b]	8.75 [b]	40.00 b
T3	17.00 [d]	25.00 [d]	22.00 [d]	19.67 [d]	7.63 [d]	64.67 [d]
T4	14.00 [c]	19.67 [c]	14.67 [c]	12.33 [c]	7.93 [c]	52.00 [c]
T5	35.00 [e]	41.00 [e]	32.67 [e]	29.00 [e]	6.90 [e]	74.67 [e]
T6	45.00 [f]	56.00 [f]	43.00 [f]	40.00 [f]	6.70 [f]	86.00 [f]
Control	78.00 [g]	171.00 [g]	167.33 [g]	157.33 [g]	5.20 [g]	358.00 [g]
L.S.D.$_{0.05}$	0.78	1.19	1.12	0.63	0.06	2.51

T1 = 120,000 parasitoids / fed. T2 = 80,000 parasitoids / fed. T3 = 40,000 parasitoids / fed.
T4 = Spinosad 24% SC, 30ml/100l. T5 = Protecto (WP)10%, 300 gm/fed. T6 = Selecron 72%, 750 ml / fed.

Table (2): Effect of different *T. evanescens* releases, two bio-insecticides and Selecron against *Ph. operculella* in potato field at Sadat district, Minufiya Governorate, Egypt in 2009

Treatments	Mean no. of infested tubers/ 200 tubers	Mean no. of holes/ 200 tubers	Mean no. of pupae/ 200 tubers	Mean no. of emerged moths / 200 tubers	Mean weight of yield tons/ fed.	Losses due to infestation kg/ ton
T1	9.33 [a]	14.00 [a]	12.00 [a]	9.67 [a]	9.37 [a]	37.00 [a]
T2	11.33 [b]	16.33 [b]	14.67 [b]	12.00 [b]	8.47 [b]	44.00 [b]
T3	20.00 [d]	27.00 [d]	24.67 [d]	21.00 [d]	7.43 [d]	67.00 [d]
T4	17.00 [c]	20.33 [c]	17.00 [c]	14.00 [c]	7.65 [c]	54.00 [c]
T5	37.67 [e]	42.67 [e]	34.67 [e]	32.00 [e]	6.77 [e]	78.00 [e]
T6	47.67 [f]	57.33 [f]	42.67 [f]	41.00 [f]	6.4 [f]	89.33 [f]
Control	87.67 [g]	180.00 [g]	173.33 [g]	169.00 [g]	5.04 [g]	368.00 [g]
L.S.D. at 0.05	1.59	1.74	1.36	1.32	0.08	0.78

Rizk (2005) found that the biocides, Spinosad (30 ml/100L. 20 ml/ 100L), Dipel (200g/ fed.) and Protecto (300g/ fed.) were superior to the chemical insecticide Selecron 72 % EC (750 ml/ fed.) in protecting the potato foliage and harvested tubers against *Ph. operculella*. The same author reported also that Spinosad 30 ml/100L. was the most effective material comparing with other treatments, recording highest percentage of reduction (97%) and highest average of tuber yield (8.3 ton/fed.).

Temerak and Rizk (2009) mentioned that the new generation (Radiant) at 80 ml/ fed. 12 % SC was significantly equal or better than 120 ml of Tracer 24 % SC, based on foliage or tuber infestation or emerged moths (from harvested tubers), while Protecto was the weakest product for the same criteria.

Rizk (2010) stated that, only 4 early releases of *T. evanescens* wasps were the best treatment for protection against PTM, showing the lowest mean of infested tubers, galleries, developed pupae and emerged moth, as well as the highest mean weight of yield with a lowest yield due to *Ph. operculella* infestation, followed by 3 releases of *Trichogramma* integrated with *B.t.*, while the 3 late releases of only *Trichogramma* seemed to be less effective for the same criteria.

REFERENCES

Agamy, E.A. 2003. The inundative release of *Trichogramma evanescens* West. as biocontrol agent against the potato tuber moth, *Phthorimaea operculella* (Zeller) in Egypt. Egyptian J. of Biol. Pest Control, 13(1&2): 101-103.

Gomaa, A. E. and H. N. Ibrahim 2003. Economics of biological control of potato tuber moth in Egypt. Egyptian J. of Agric. Econ., vol. (13), no. (3): 802:813.

Hassan, S. A. 1995. Improved methods for the production of the angoumois grain moth, *Sitotroga cerealella* (Oliv.). Conference on *Trichogramma* and other egg parasitoids, Cairo, Egypt, October 4-7, 1994, ed. INRA, Paris, 1995 (Les collooques, no.73), pp.157-160.

Kirkham, R. 1995. Potatoes. In Horticulture Austraia, Coombs, B. (ed.) Khai Wah –Ferco Pty. Ltd., Singapore.Pp.250-256.

Loo, P. E. and P. A. Aguilera 1983. Experimental multiplication of *Trichogramma brasiliensis* (Ashm.) (Hymenoptera: Trichogrammatidae) in the region of Chile. Idsia, 7:45-52.

Pokharkar, D. S. and R. R. Jogi 2000. Biological suppression of potato tuber moth, *Phthorimaea operculella* (Zeller) with exotic parasitoids and microbial agents under field and storage conditions. J. Biol. Control, 14(2): 23-28.

Rizk, Amany, M. 2005. Further studies on the biological control of certain insects. Ph.D. Thesis Fac. Agric. Shebin El-kom, Minufiya Univ., 189pp.

Rizk, Amany, M. 2010. Evaluation of different *Trichogramma evanescens* West. releases and its combined with bacterial insecticide as control management tools for *Phthorimaea operculella* (Zeller) in potato fields in the newly reclaimed land. Minufiya J. Agric. Res. 35(2): 721-735.

Senedecor, G. W. and W. G. Cochran 1973. "Statistical methods" 6th ed., Iowa State Univ., Press Iowa, USA, p.566.

Shady, A. M.; A. E. Khalil and Samaa M. Shawky 2007. Impact of certain mineral fertilizers (NPK) on *Meloidogyne incognita* on potato in Egypt. African Potato Association Conference Proceeding, vol. 7. pp. 298-304, Alex. Egypt.

Smith, S. M. 1996. Biological control with *Trichogramma* advances, successes, and potential of their use. Ann. Rev. Entomal. 41: 375-406.

Temerak, S. A. 2003. Spinosad, a new naturally derived potato tuber worm control agent in comparisons to certain conventional insecticides. Assiut J. of Agric. Sci., 34 (4): 153 – 161.

Temerak, S. A. and Amany M. Rizk 2009. Susceptibility of *Phthorimaea operculella* (Zeller) to old and new generation of spinosyn products on two potato varieties in Egypt – resistant pest management news letter, Maharana Pratap Univ. of Agric and Technology, Udaipur. 313001, 19 (1): 52-56.