CONTROL OF THE POTATO TUBER MOTH, PHTHORIMAEA OPERCULELLA (ZELLER) IN POTATO CROP

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Abstract

The effectiveness of Bacillus thuringiensis (B.t.), Granular virus (G.V.) and mass-trapping with sex pheromone against potato tuber moth, P. operculella were studied at El-Salheia, Ismailia Governorate, 1995 season. The results obtained indicated that B.t., G.V. and mass-trapping PTM using a sex pheromone with one application of B.t., reduced the incidence of PTM on potato plants. The reduction in PTM infestation was ranged between 82.5-95% in B.T. treatment while it was ranged between 69.5-91.8 and 74.8-91.6% in G.V. and sex pheromone treatments, respectively. The pheromone has been found highly effective in monitoring and mass trapping PTM males under field conditions. There was a positive correlation between PTM male moth catch and the percentage of infestation in potato plants. Although potato tuber moth larvae burrow in the leaves and tubers, B.t., G.V. and sex pheromone masstrapping applications reduced their population levels considerably and reduced the percentage of infestation, number of PTM larvae, and yield loss in potato tubers.

Key Words: Phthorimaea operculella (Zeller), Bacillus thuringiensis, Granulosis virus, sex pheromone.

INTRODUCTION

The potato tuber moth, *Phthorimaea operculella* (Zeller) is the most important potato pest in Egypt. Populations are low during the cold and rainy winter period, but increase to significant levels during the hot and dry summer months. It causes damage to potato tubers in the field particularly if the harvest is delayed, and in traditional rustic stores. Losses to farmers consist of discards, reduced prices for damaged potatoes, increased handling costs, and expenditures on pesticides. Farmers also sustain an opportunity cost when they are forced to sell at low prices to avoid pest damage. So, The control of *P.operculella* has incorporated the use of transgenic potato which offer certain degree of protection against feeding damage by potato tuber moth (Ebora et. al., 1994; Haines, 1977 and Raman and Redolfi, 1984), repel-

lent plant extracts (Lal, 1987 and Raman et al, 1987). Also, the sex pheromone has been found highly effective in monitoring and mass trapping PTM males under field conditions (Raman, 1982, 1984 and 1988). Replacement of the commonly used parathion with less toxic pesticides such as synthetic pyrethroids or *Bacillus thuringiensis* has been reported by (El-Sayed et al., 1979; Collantes et al, 1986; Suriaatmadja, 1988 and Broza and Sneh, 1994).

The aim of the present work was to study the effectiveness of *B.thuringiensis*, granulosis virus and sex pheromone mass-trapping in controlling the potato tuber moth under field conditions.

MATERIALS AND METHODS

In this set of experiments two biocides namely; *Bacillus thuringiensis kurstaki* (Protecto 32000 IU/mg W.P.) and *Phthorimaea operculella* Granular Virus (PTM GV 4% W.P.) were used at the rate of 16 billion IU and 800 larval equivelant (L.E.) per feddan, respectively. *B.thuringiensis* was produced by Plant Protection Research Institute, Agricultural Research Centre, Ministry of Agriculture, Egypt. Granulosis virus (G.V.) was produced by Plant Protection Research Institute, Agricultural Research Centre in collaboration with the International Potato Centre (CIP), Ministry of Agriculture, Egypt.

Sex pheromone capsules were provided by the International Potato Centre, Kafr El-Zayat, ministry of Agriculture, Egypt. PTM sex pheromone consists of two unsaturated isomers PTM1 0.4 mg (trans-4, cis-7-tridecadien-1-01 acetate) and PTM2 0.6 mg (trans-4, cis-7, cis-10-tridecatrien-1-o1 acetate). It is produced by Departmento de Nematologia y Entomologia de Centro International de la Papa (CIP), Apartado 5969, Lima 100-Peru.

The experimental area for B.t., G.V., sex pheromone and control was divided into 3 plots and each plot was represented one replicate. The plot area was ranged between 100-120, 5-7, 15-17 and 0.5-1 feddan for B.t, G.V., sex pheromone and control, respectively. The first application of Protecto and G.V. was done at 5% of infestation in potato plants and three more sprayings were undertaken with 10 days intervals. The biocides were applied to potato fields using a motorized hydraulic sprayer carrying over wheel type tractor applying 200 liters of spray solution per feddan. Check area was left free from application.

Prior to the application of the two biocides, delta sticky traps baited with PTM pheromone dispensed in were sited in each of the designated areas at the rate of one trap per 3 feddan, but, in mass-trapping experiment the pheromone traps were used at the rate of 4 traps per feddan and considered as a tool of PTM control. The PTM male moth catches were recorded daily and the correlation between the mean nightly of male moth catches and the percentage of infestation in potato plants was determined.

To evaluate the effectiveness of B.t., G.V. and sex pheromone mass trapping against PTM, samples of potato plants (one hundred each) were taken weekly in 4-5 replicates at random from the different treated and untreated areas.

At the time of harvest the observations were recorded on the number of attacked and sound tubers retained on the hundred randomly selected tubers in each treatment in three replicates. The percentage of infested tubers, number of larvae, weight of infested tubers and loss of weight/Ton were recorded.

RESULTS AND DISCUSSION

1. Percentage of infestation on potato plants

The data on the effect of B.t., G.V. and sex pheromone-mass trapping on the incidence of PTM are presented in Fig. 1,2,3 and 4. Obtained results indicated that all treatments were significantly superior over the control in reducing the percentage infestation and the number of PTM larvae. In sex pheromone treatment, the percentages of infestation showed an increase trend more than B.t. and G.V. treatments after the 3rd and 4th spraying. This may be due to the increase in the pheromone evaporation rate contributed to the temperature increase through the mid of May and the 1st week of June. The reduction in PTM infestation ranged between 82.5-95% in B.t. treatment while it ranged between 69.5-91.8 and 74.8-91.6% in G.V. and sex pheromone treatments, respectively, Fig.2. Regarding the number of larvae and pupae, applications of B.t, G.V. and sex pheromone suppressed pest populations in comparison to the untreated area, whereas extensive damage is caused by the PTM, Fig.3 and 4. In field trials conducted to evaluate the effect of two commercial preparations of B.t. (Diple and Thuricide-HP) on the population of *P.operculella* on potato plants in Egypt, Diple and Thuricide treatments as well as Gusathion treatment were efficient in reducing potato tuber moth infestation and thus led to a high

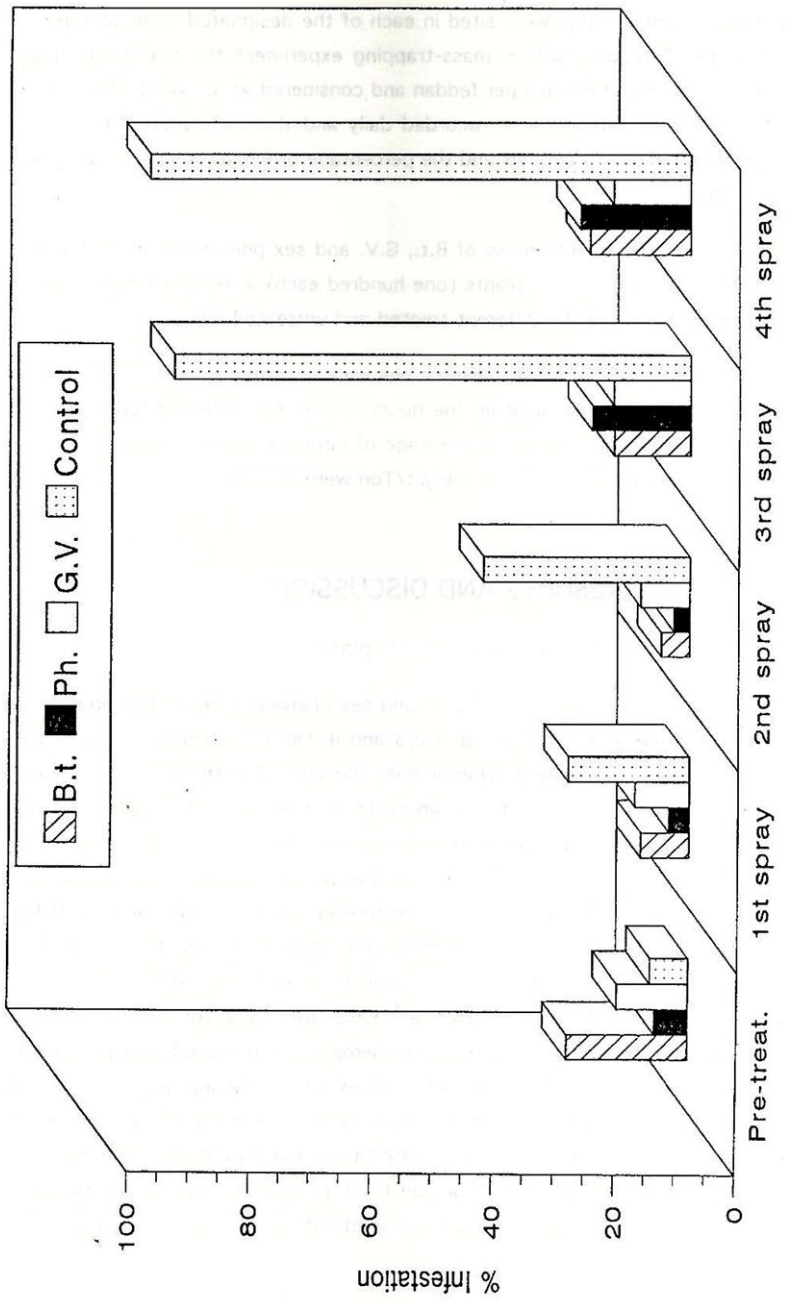

Fig. 1. Percentage of PTM infestation before and after spray in the different treatments in El-Salheia, Ismailia Governorate, Egypt, season 1995.

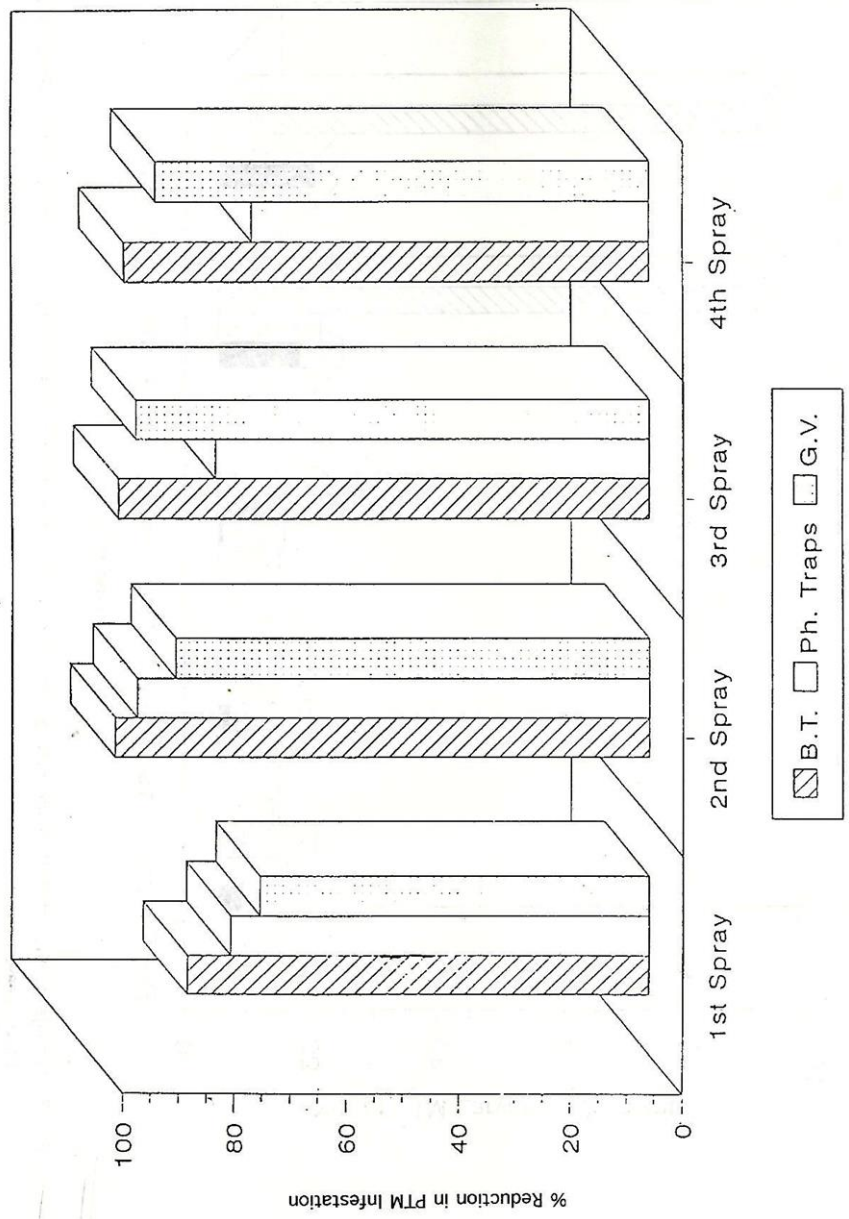

Fig. 2. Percentage reduction of PTM infestation in the different treatments in El-Salheia, Ismailia Governorate, Egypt, season 1995.

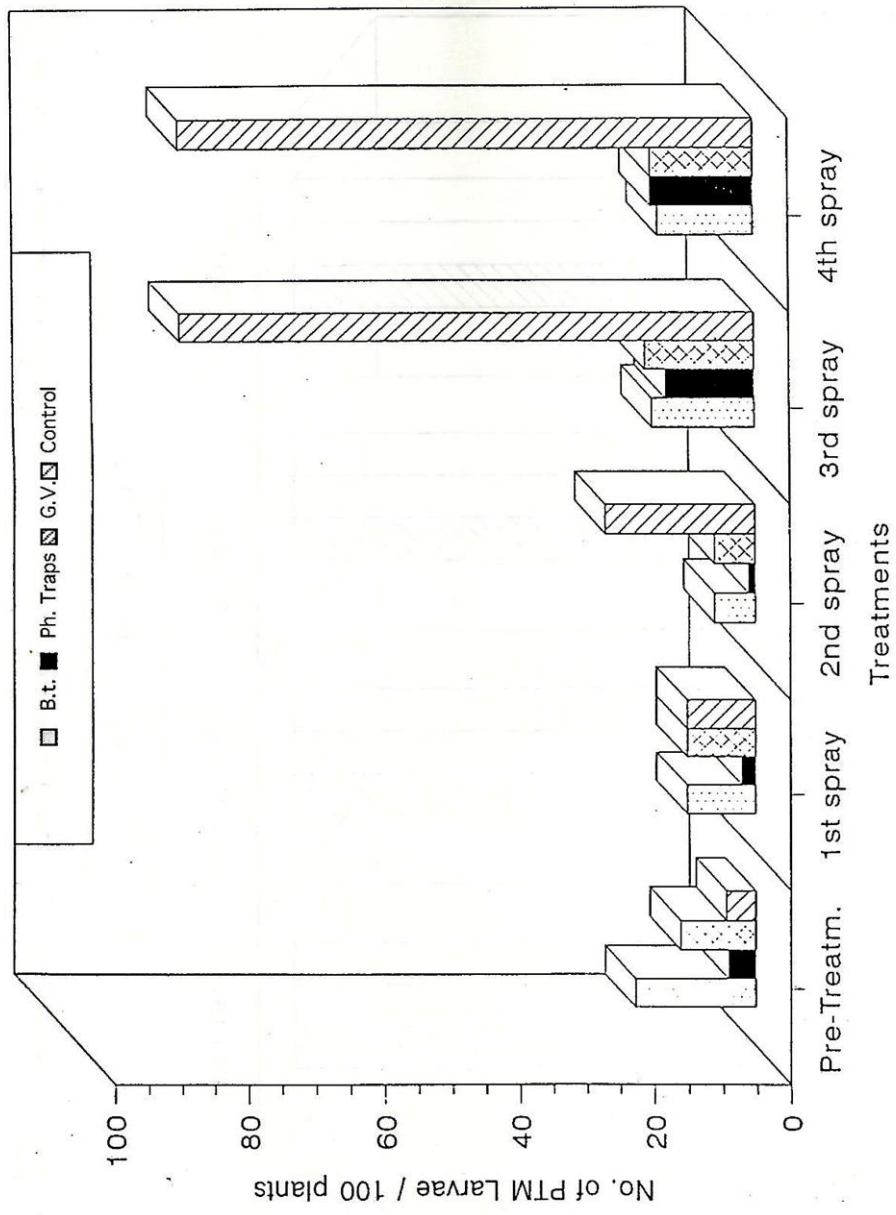

Fig. 3. Average number of PTM larvae before and after spray in the different treatments in El-Salheia, Ismailia Governorate, Egypt, Season 1995.

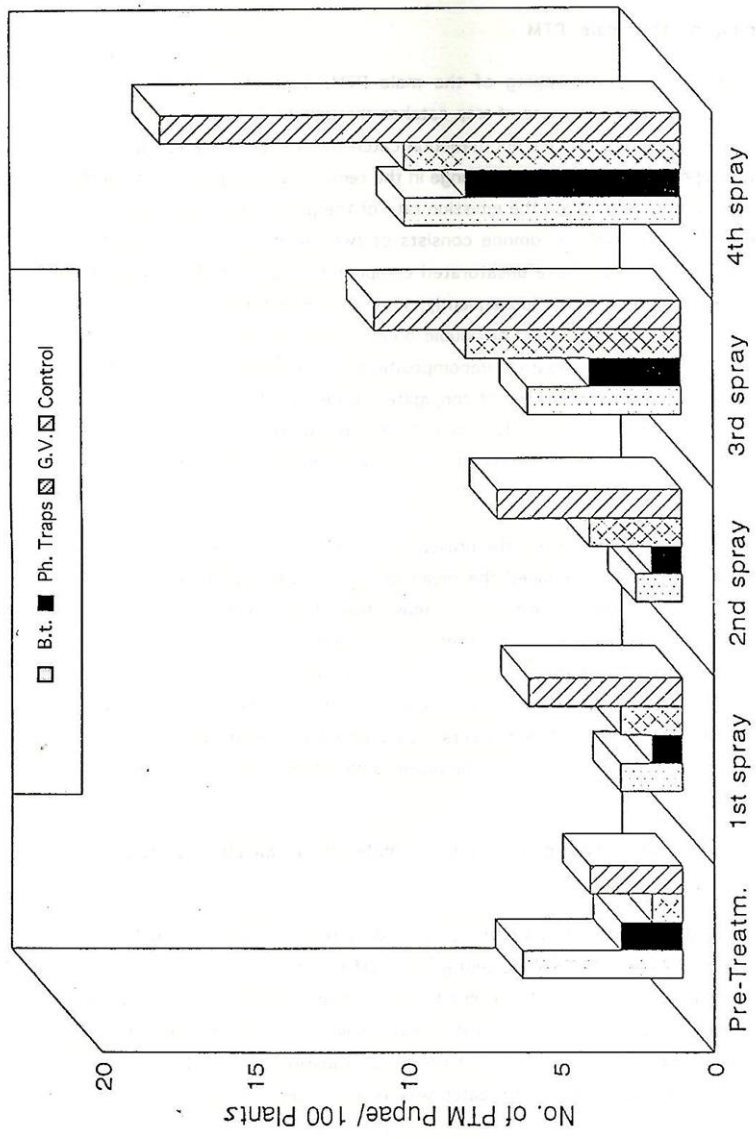

Fig. 4. Average number of PTM pupae before and after spray in the different treatments in El-Salheia, Ismailia Governorate, Egypt, season 1995.

yield (Haydar and El-Sherif, 1987).

2. Trapping of the male PTM

Observation on the trapping of the male PTM, synthetic sex pheromone showed that there was an increase of trap catches throughout 19th of April, and the 3rd and 19th of June, Fig. 5. This fluctuation in catch through the experimental period is mainly depends on the sudden exchange in the temperature and the other metriological factors which affects on the emission rate of the pheromone isomers. On the other hand, since the PTM pheromone consists of two unsaturated isomers; PTM1 and PTM2 the half-lives of these unsaturated compounds is smaller than the corresponding saturated compounds. Subsequently, some of the factors affecting the formulation stability are isomerization of double bonds can be result of photochemical and thermal degradation; oxidative decomposition; photochemically or thermally catalyzed, can result in the oxidation of conjugated diene and aldehyde function. Polymerization can take place not only during field application, but also, during the manufacture, packaging, and storage of the formulation (McDonough and Butler 1983).

In mass trapping experiment, the presence of the synthetic pheromones at the rate of 4 traps per feddan reduced the mean nightly male moth catch per trap in comparison with the other treatments. In mass trapping studies, Raman (1988) demonstrated that the presence of synthetic pheromones reduced the catch in surrounding water-pan traps baited with virgin females by 97% and revealed direct control of PTM in field and stores. Microencapsulated pheromone spray significantly reduced larval infestation in stored tubers. Sex pheromone monitoring of PTM are effective tool not only for determining the proper time of insecticidal application but also revealing the good control program.

3. The correlation between the nightly male moth catch and the percentage of infestation

Statistical analysis were carried out according to Thomas and Hills (1975). Simple correlation show that the percentage of PTM infestation was positively correlated and highly significant with the number of PTM male moth catch, Fig. 6. Regression equation was $Y = -0.175 + 0.505\ X$ and simple correlation was 0.9097. The prediction of infestation we can predict it using this equation under field conditions. For example, if the nightly male moth catch was 10 moth per night the predicted infestation is 4.8%.

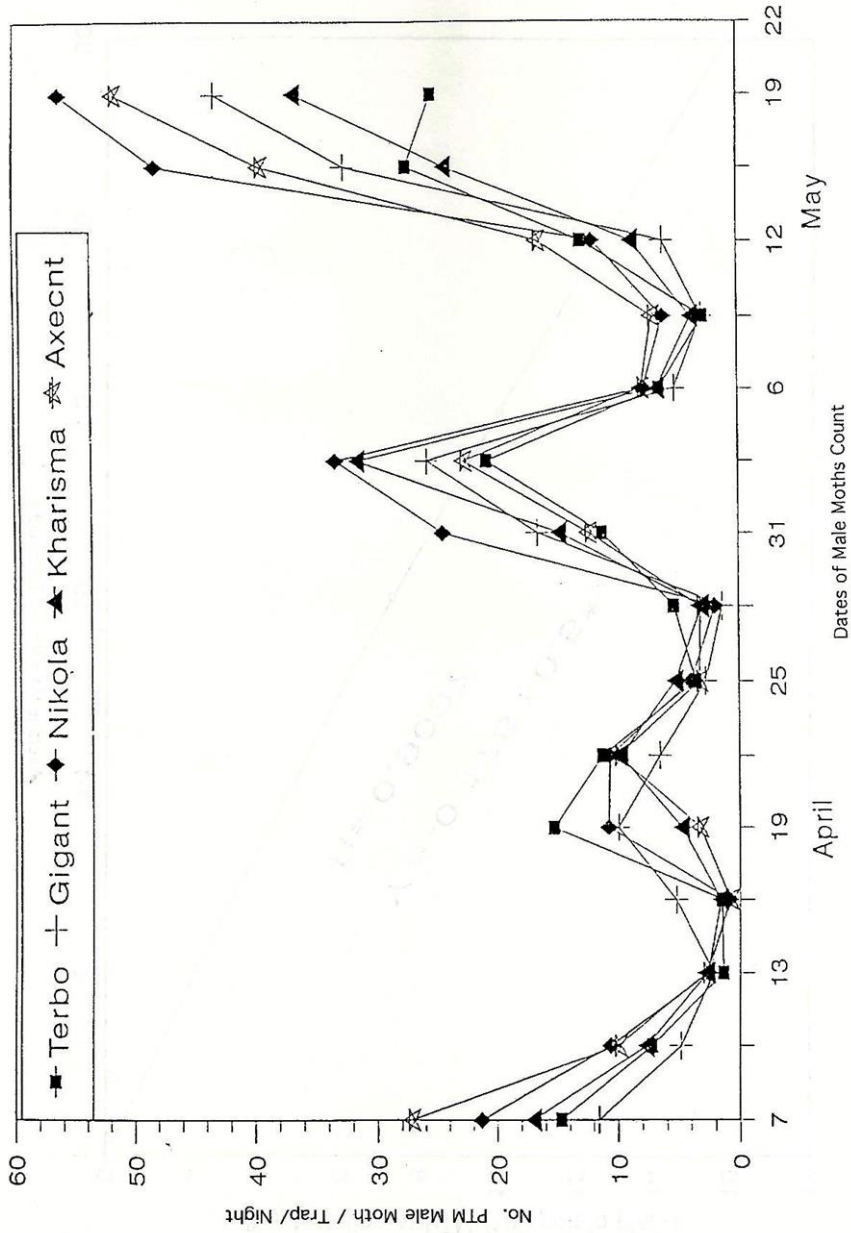

Fig. 5. Mean nightly of PTM male moths catch in pheromone traps in the different potato varities in El-Salheia, Ismailia Governorate, Egypt, season 1995.

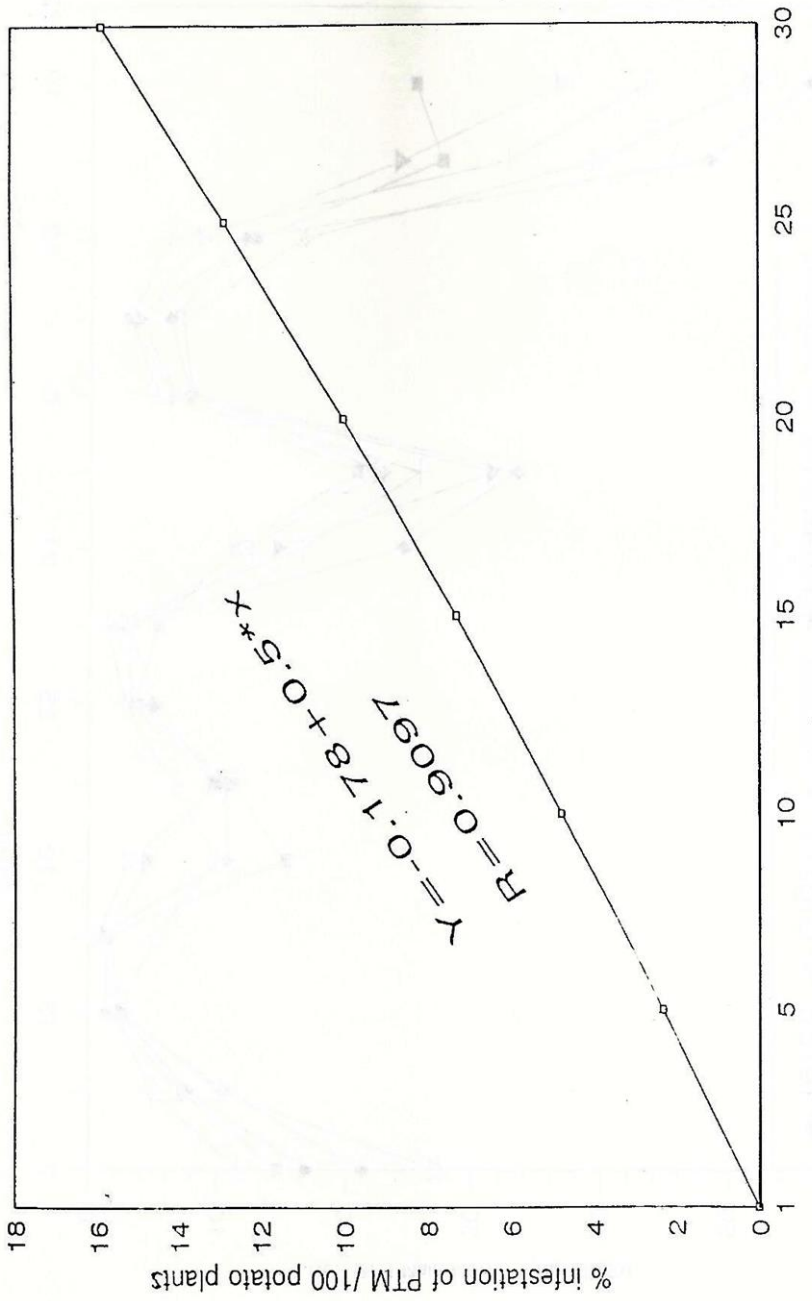

Fig. 6. The relationship between the average of nightly male moths catch of PTM and the percentage of infestation in potato crop in El-Salheia, Ismailia Governorate, Egypt, season 1995.

4. Yield loss

Results obtained in Fig. 7 indicated that *B.thuringiensis* treatment revealed the lowest level of infestation and damaged in potato tubers followed by sex pheromone mass-trapping that received one application of B.t, insecticides, G.V. and control, respectively. There was no clear correlation between the percentage of infestation in potato plants and the percentage of yield loss. This may be due to the difference in the potato variety which affect on the total yield.

Regarding the number of PTM larvae in potato tubers, data in Fig. 8 indicated that there were a clear differences in the number of larvae between the different treatments. B.t. treatment revealed the lowest number of larvae in potato tubers followed by mass-trapping which received one application of B.t., G.V., pesticides treated and untreated areas. From this Fig., it is appear that the cultural practices such as regular irrigation at the end of season, high hilling, the early harvest, rapidly handling and storage will reveal good protection of potato tubers.

In conclusion, it can safely be said that both B.t. and G.V. based products represent an effective solution to control PTM. Also, a more widespread use of these products is to be expected because the good results so far obtained, the possibility to improve the efficacy, the ever greater need for pesticides with lower impact on environment and high selectivity. Beside that, the increase in using of these biocides depends on reduction of their cost to the farmers. Although potato tuber moth larvae burrow in the leaves and tubers, *B.thuringiensis*, G.V. and sex pheromone mass-trapping applications reduced their population levels considerably and reduced the percentage of infestation, number of PTM larvae, and yield loss in potato tubers.

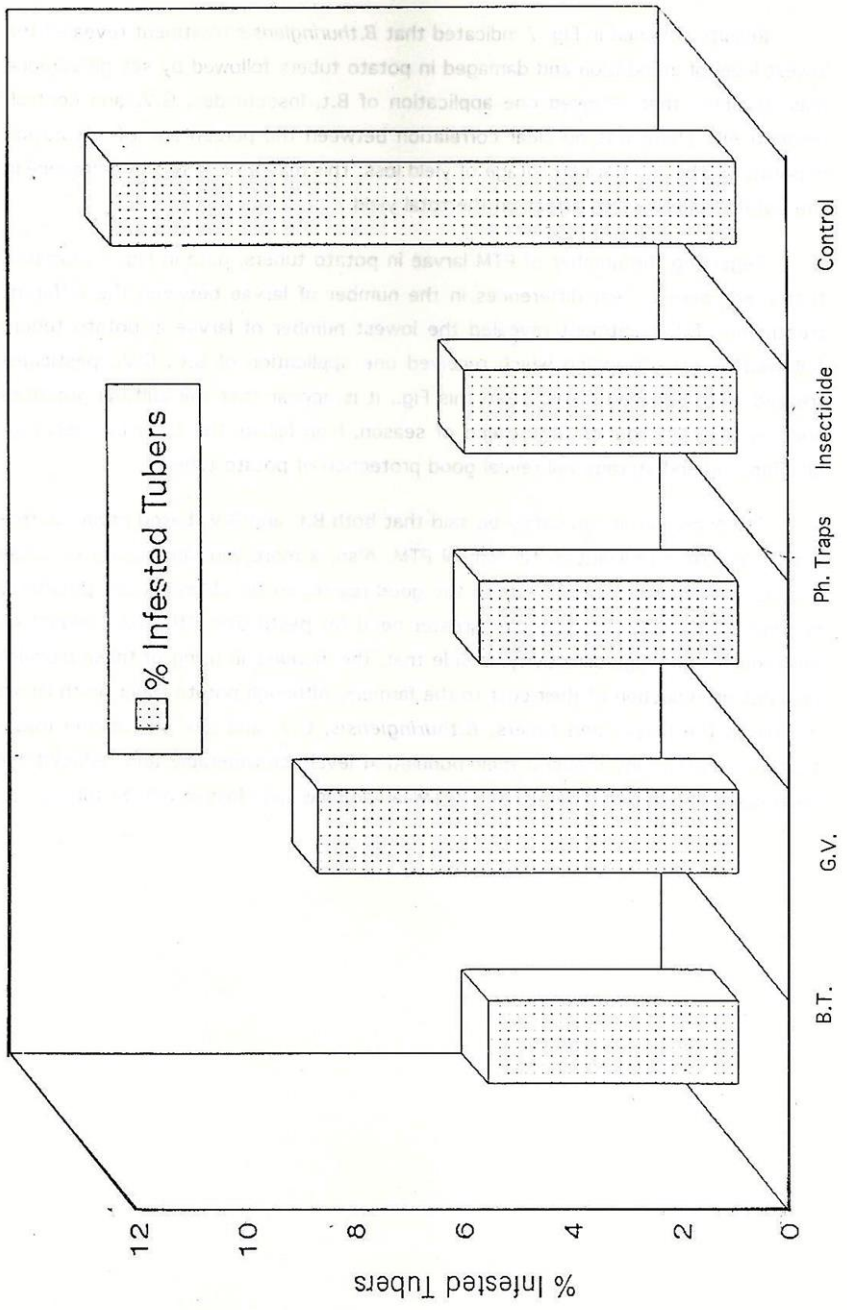

Fig. 7. Percentage of PTM infestation in potato tubers at crop harvest in the different treatment in El-Salheia, Ismailia Governorate, Egypt, season 1995.

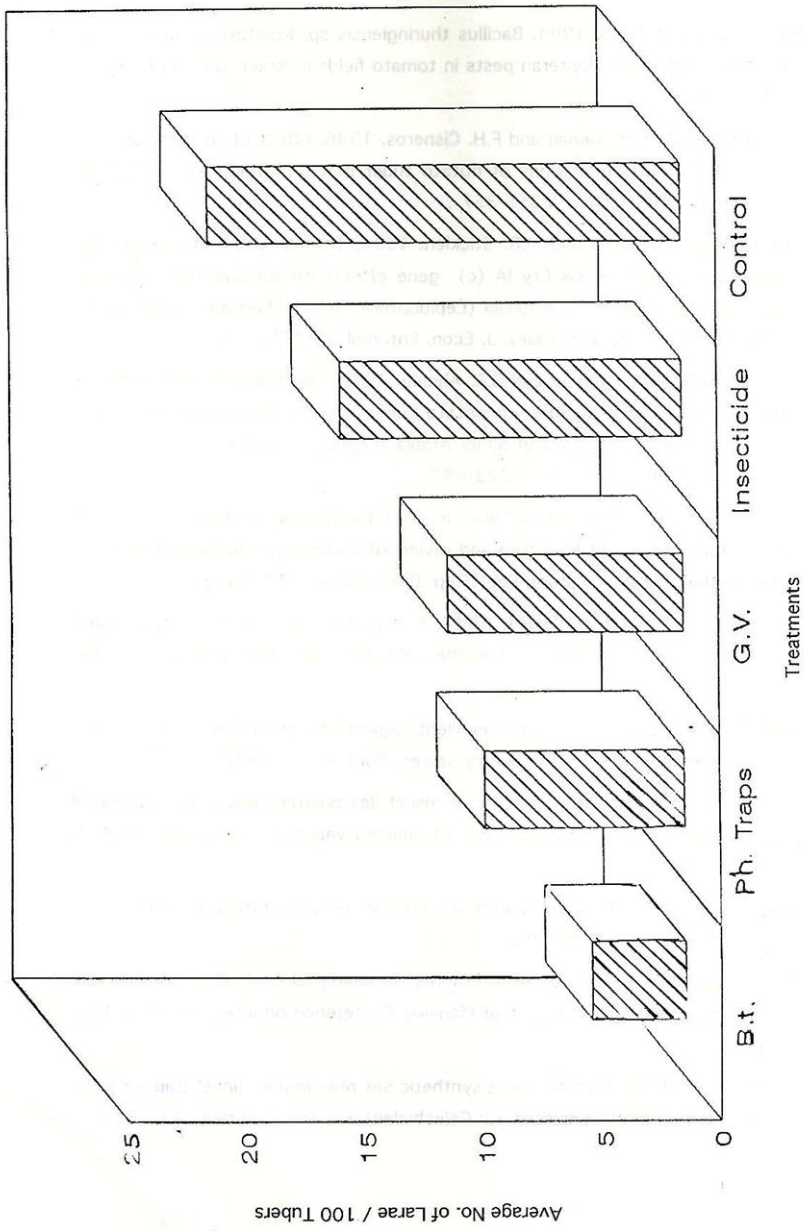

Fig. 8. Average number of PTM larvae in potato tubers at harvest in the different treatments in El-Salheia, Ismailia Governorate, Egypt, season 1995.

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مكافحة فراشة درنات البطاطس فى محصول البطاطس

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تمت هذه الدراسة بمنطقة الصالحية الجديدة – محافظة الاسماعيلية بغرض دراسة فعالية بكتريا الباسيلس ثيورنجنسيس، والفيروس المحبب، والمصائد الجاذبة الجنسية لفراشة درنات البطاطس فى مكافحة فراشة درنات البطاطس فى الحقل وذلك خلال موسم ١٩٩٥ فى مساحة ٣٧٥ فدان. أوضحت النتائج المتحصل عليها أن كلا من معاملة بكتريا الباسيلس ثيورنجنسيس والفيروس المحبب اربع رشات أو أستخدام مصائد الفرمونات بمعدل ٥ مصايد للفدان مع رشة واحدة من بكتريا الباسيلس أدت الى تقليل نسبة الاصابة فى البطاطس بالمقارنة بالحقول غير المعاملة. وقد تراوح معدل الخفض فى نسبة الاصابة فى معاملة البكتريا بين ٨٢,٥ – ٩٥٪ بينما فى معاملة الفيروس والفرمونات تراوح بين ٦٩,٥ – ٩١,٨، ٧٤,٨ – ٩١,٦٪ على التوالى. كذلك يمكن استخدام الفرمونات الجاذبة فى التنبؤ وكذلك خفض التعداد عند استخدامه بمعدل ٥ مصائد للفدان. كما لوحظ ايضا من النتائج المتحصل عليها أن هناك علاقة قوية موجبة بين متوسط تعداد الفراشات فى المصائد ونسبة الاصابة فى النباتات. وبالرغم من ان يرقات فراشة درنات البطاطس تحفر فى الدرنات والاوراق نجد ان معاملات البكتريا والفيروس والمصائد الجاذبة قللت تعداد الآفة وبالتالى نسبة الاصابة وعدد اليرقات ونسبة الفقد في المحصول.