EVALUATION OF CERTAIN CONTROLLING MEASURES FOR PHTHORIMAEA *OPERCULELLA* (ZELLER) (LEPIDOPTERA, GELECHIIDAE) ON POTATO IN STORES

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Abstract

Spinosad, a new biochemical product was evaluated beside the known biological agents: Bacillus thuringiensis and the Granulosis virus in comparison with the chemical insecticide Tilton of the Organophosphorus group against the Potato Tuber Moth, Phthorimaea operculella (Zeller) in stores. Spinosad treatments showed high efficiency against the PTM infestations in both tested concentrations (0.125 and 0.062) over other tested control measures. Spinosad also, performed very long persistence through the whole storing period. The chemical insecticide followed after Spinosad but its efficiency start to collapse after the third inspection. Both of virus treatments (Virotecto and the GV infected larvae) give similar results in controlling the PTM. The bacterial treatment came in the fourth rank after the viral treatments. The highest PTM infestation were recorded for the control treatment.

INTRODUCTION

The Potato Tuber Moth (PTM), Phthorimaea operculella (Zeller) (Lepidoptera, Gelechiidae) is the most important insect pest on potato. It causes damage primarily in storage. Potato losses due to PTM can be devastating as without adequate control measures tuber infestation can reach 100% (Raman et al., 1994). Even slightly damaged tubers lose nearly all their market value. To avoid such damage, farmers use massive applications of chemical insecticides to control PTM larvae. Cisneros (1984) stated that, the potato tuber moth has been observed to have developed resistance to pyrethroids following frequent use of Sumicidin in Peru and other parts of the world. The insect pests control program of the Egyptian Ministry of Agriculture and Land Reclamation has recommended to ban out the use of all chemical insecticides on potato tubers in stores and replace it with other bioinsecticides. Pilot units for managing PTM were established in Egypt to introduce the use of Bacillus thuringiensis (Bt) and granulosis virus (GV) as alternatives to the toxic insecticides fenitrothion, deltamethrin and malathion, which has been officially banned for use on ware potatoes. Both Bt and GV are superior to the chemical insecticides Sumithion in protecting potato tubers against PTM infestation (Anonymous, 1997 and Gomaa, 1998).

Spinosad a new biochemical insecticide classified as environmentally friendly may soon become a widely accepted alternative to the chemical insecticides used today for the control of insect pests. Spinosad is the naturally occurring metabolite derived from fermentation of the soil bacterium Saccharopolyspora spinosa. Spinosad poses less risk than most insecticides to mammals, birds, fish, and beneficial insects. Due to its low toxicity and perceived low impact on the environment, the Environmental Protection Agency (EPA) registered Spinosad as a reduced-risk material. Spinosad has low toxicity and pest specific with primary efficacy against the lepidoptera (Binning, 2000). Spinosad is already approved for use on more than 200 crops (Bret et al., 1997; EPA, 1997; Meister and Sine, 1999; Thompson et al., 2000; Dow Agroscience, 2001 and Jachetta, 2001). Technical Spinosad is especially insecticidal to small caterpillars by ingestion and contact. Spinosad shows less human poisoning and mortality than pyrethroids and OPs, (Boyd and Boethel, 1998; Salgado, 1998; Tjosvold and Chaney, 2001).

The principal aim to this research is to focus on reducing environmental hazards on potato by developing and disseminating biological control measures to reduce or eliminate the use of harmful chemical pesticides.

MATERIALS AND METHODS

An experiment was conducted to evaluate the efficiency of the bioinsecticides: Spinosad, Protecto, Virotecto, GV infected PTM larvae and the chemical insecticide Tilton, in reducing the PTM infestation on potato under storage conditions at the International Potato Center (CIP) nawala stores in Kafr El-Zayat, Gharbia Governorate, during 2004 seasons.

Spinosad (WP), Dow AgroSciences product was evaluated at a rate of 3kg/ton with two concentrations:

1- Spinosad 0.125%,
2- Spinosad 0.062%,
3- Protecto (10%, WP) a commercial product of Bt containing 32x106 IU/gm of Bt. Subsp. Kurstak , was used at a rate of 150 gm/ton
4- Virotecto (4%,WP) a commercial product of Phthorimaea operculella granulosis virus (GV), containing 5x109 viral particle (PIB)/gm, was used at a rate of 150 gm/ton
5- GV infected PTM larvae was applied in a form of viral suspension at a rate of 20 infected larvae equivalent one liter of water as recommended by Raman and Alcazar, (1988) and Lagnaoui et al., (1994) and 2 ml of "Superfilm" as a spreading agent. and
6- The chemical insecticide, Tilton (57%, EC) Profenofos from the Organophosphorus group was used at a concentration of 10ppm.

The infestation was initiated by placing five infested marked tubers/ rep. Each treatment consisted of 100 kg for every tested compound. Potatoes were carefully sorted before storing, treated with the different compounds. Then potato heaps were covered with a layer of rice straw and monitored four times, at 3 weeks intervals, on a sample of 100 tubers, replicated 3 times. The infested tubers and gallery numbers for each treatment were counted and recorded after every sorting.

Minitab Program carried statistical analysis out using Duncan's Multiple Range Test (DMRT) at 5%. Percentages of reduction in PTM infestation and galleries were calculated according to Fleming and Retakaran (1985) as follows:-

Population Reduction =

$$1-\left\{ \frac{\text{Post-treatment population in treatment}}{\text{Pre-treatment population in treatment}} \times \frac{\text{Pre-treatment population in check}}{\text{Post-treatment population in check}} \right\} \times 100$$

RESULTS AND DISCUSSION

Data in Table 1 show that Spinosad treatments reveal superior control on PTM infestations and gallery numbers in both concentrations (0.125 and 0.062) over other tested control measures through the four inspections. No tuber infestation was recorded for the high concentration of Spinosad treatment through the whole storing period. Also, the second concentration of Spinosad revealed very slight infestation 1.67 and gallery numbers 3 were recorded at the second inspection and decreased at the fourth inspection to 0.67 for both tuber infestation and gallery numbers, respectively. Statistical analysis were carried out at the fourth inspection using Minitab Program which reveal no significant differences between the two concentrations of Spinosad treatment. These findings are agreed with those of (Bret et al., 1997; Meister, 1999; Binning, 2000, DOW, 2001 and Jachetta, 2001. The chemical insecticide Tilton came in the second rank after Spinosad treatments as it also, showed good results over the PTM infestations and gallery numbers. The chemical insecticide results shows slight tuber infestation 0.67 and gallery numbers of 1.00 at the first inspection which disappear in the second and third inspection but increased in the fourth inspection to 5.67 and 6.67 for tuber infestation and gallery numbers, respectively. Taking into our consideration that a very long persistence of Spinosad treatments through the whole period of storing compared to the chemical insecticide Tilton which start to collapse after the third inspection. Statistical analysis revealed significant difference between the low concentration of Spinosad treatment and the chemical insecticide Tilton treatment (P-Value= 0.023) at the fourth inspection.

Significant difference was found between the chemical insecticide Tilton and the GV larvae treatment (P-Value=0.016). Both of virus treatments (Virotecto and the GV infected larvae) give satisfactory control measures during the 1st , 2nd and 3rd inspection but increased in the 4th one to (14 and 18) and (20 and 26.33) for both PTM infestation and gallery numbers, respectively without significant differences. The bacterial treatment came in the fourth rank after the viral treatments recording high infestation at the 4th inspection of (20 and 32) for tuber infestations and gallery numbers, respectively. Although Protecto treatment recorded the highest level of infestation and gallery numbers over other treatments except the control, significant differences were found between Protecto and the control treatments (P-Value=0.002) logically indicating high significance differences between all treatments and the control one. There was no significant differences between Virotecto and Protecto treatments. The highest PTM infestation 33 and gallery numbers 49.33 were recorded for the control treatment, which agreed also, with the findings of (Raman et al., 1994).

Also, Figure 1 illustrate varied degrees of tuber infestations and gallery numbers of the tested control measures through the storing period. It is very clear that the Spinosad treatments perform zero infestation through the whole storing period. The chemical treatment start to appear clearly in the fourth inspection. The differences between the virals treatments and the bacterial treatment are not very sharp. The control revealed the highest level of infestation and gallery numbers.

Data in Table 2 and Figure 2 represented that a reduction of different control measures against the PTM on Potato tubers at the CIP stores, season 2004. Maximum reductions of infestation and gallery numbers were obtained in tubers treated with Spinosad on both tested concentrations through the four inspections. Also, the chemical insecticide Tilton followed the biochemical compound Spinosad in the second degree but its efficiency reduced in the fourth inspection to 82.82 and 86.48 for tuber infestation and gallery numbers, respectively.

The reduction recorded 39.39, 45.45 and 57.58 for tuber infestation of Protecto, Virotecto and GV infected larvae, respectively.

The reduction recorded 35.13, 46.62 and 58.10 for the gallery numbers of Protecto, Virotecto and GV infected larvae, respectively.

It could be recommended that the Spinosad treatments should be used at the low concentration (0.062) to protect potato tubers under storage conditions effectively.

Table 1. Effect of different controlling measures for the PTM on Potato tubers at the CIP stores, 2004 season

Treatments	1st Inspection		2nd Inspection		3rd Inspection		4th Inspection	
	Infested tubers	Gallery no.	Infested tubers	Gallery no.	Infested tubers	Gallery no.	Infested tubers	Gallery no.
Spinosade .125 3 kg/ton	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Spinosad .062 3 kg/ton	0.0	0.0	1.67	3.00	3.00	2.00	0.67	0.67
Protecto 150 gm/ton	7.00	14.00	10.00	15.00	13.00	25.67	20.00	32.00
Virotecto 150 gm/ton	3.00	3.67	3.00	3.00	7.00	9.00	18	26.33
GV Larvae 20 L./ton	5.00	9.33	4.33	5.33	4.00	6.00	14.00	20.67
Tilton 10ppm	0.67	1.00	0.00	0.00	0.00	0.00	5.67	6.67
Control	13.00	16.67	18.33	37.33	23.00	48.67	33.00	49.33

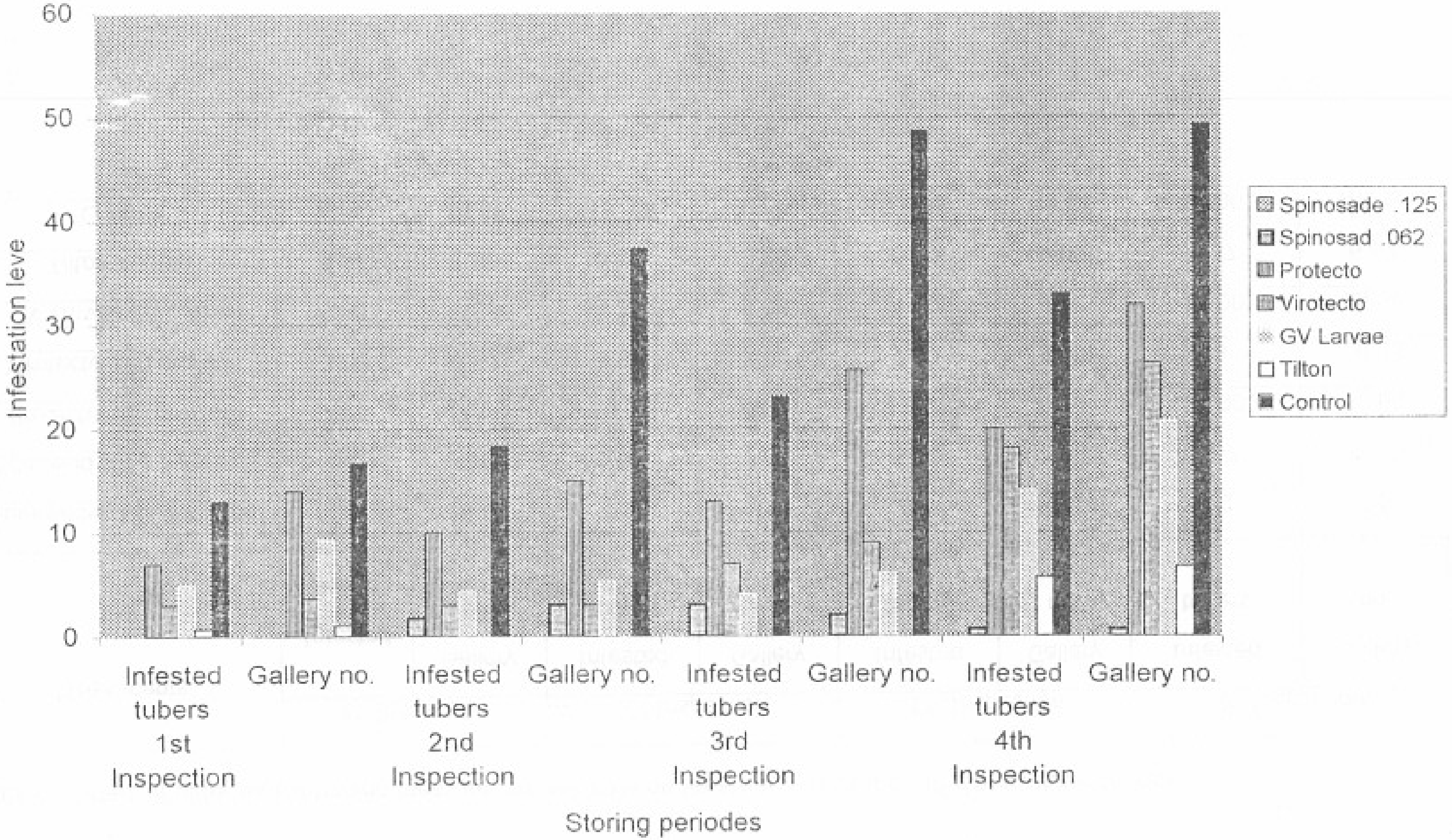

Figure 1. PTM infestation and gallery numbers after different applications under storage conditions, at CIP-Station during, 2004 season.

Table 2. Reduction in different control measures against the PTM on Potato tubers at the CIP stores, 2004 season

Treatments	1st Inspection		2nd Inspection		3rd Inspection		4th Inspection	
	Infested tubers	Gallery no.	Infested tubers	Gallery no.	Infested tubers	Gallery no.	Infested tubers	Gallery no.
Spinosade .125 3 kg/ton	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Spinosad .062 3 kg/ton	100.00	100.00	91.00	92.00	87.00	96.00	98.00	99.00
Protecto 150 gm/ton	46.15	16.02	45.44	59.82	43.48	47.26	39.39	35.13
Virotecto 150 gm/ton	76.92	77.98	83.63	91.96	69.57	81.51	45.45	46.62
GV Larvae 20 L./ton	61.54	44.03	76.38	85.72	82.61	87.67	57.58	58.10
Tilton 10ppm	94.85	94.00	100.00	100.00	100.00	100.00	82.82	86.48

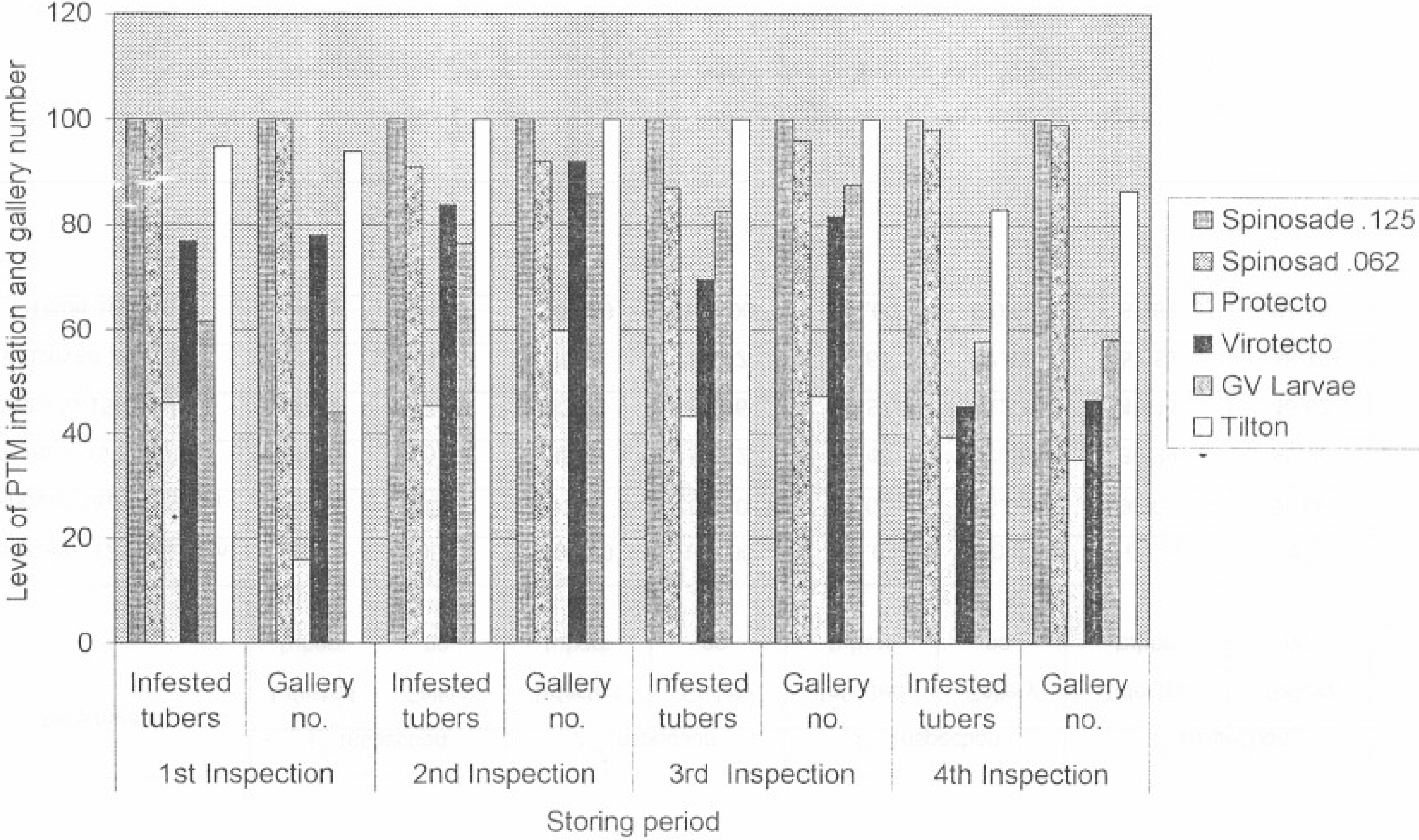

Figure 2. Reduction of PTM infestation and gallery numbers after different applications under storage conditions, at CIP-Station during, 2004 season.

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تقييم بعض وسائل مكافحة دودة درنات البطاطس فى المخزن

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تم تقييم المركب الحيوى الجديد سبينوساد والمركبان الحيويان من كل من البكتريا باسلس ثورنجنسز *Bacillus thuringiensis* والفيروس المحبب Granulosis virus ومقارنتهم بالمبيد الفوسفورى تلتون Tilton فى مكافحة دودة درنات البطاطس فى المخزن، وأظهرت النتائج أن المركب الحيوى سبينوساد بالتركيزين المختبرين وهما (٠,١٢٥ و٠,٠٦٢) قد فاق كل المركبات المختبرة بما فيها المبيد الكيماوى فى حماية الدرنات وقلة عدد الأنفاق على الدرنات، كذلك لوحظ أطول فترة بقاء لفاعلية المركب سبينوساد طوال فترة التخزين، يليه المبيد الفسفورى تلتون والذى أعطى مستوى حماية جيدة خلال الفحصة الأولى والثانية والثالثة ثم بدأت تقل الحماية للدرنات بزيادة عدد الأنفاق أعتبارا من الفحصة الرابعة، حيث لوحظ أن كلا من المركب الفيروسى فيروتكتو والفيروسات المحببة فى صورة برقات مفيرسة كانت نتائجها متقاربة وتأتى فى الدرجة الثالثة بعد المركبان السابقان، ثم أخيرا المركب البكتيرى بروتكتو فى المرحلة الأخيرة ،كانت أعلى الإصابات مسجلة فى المقارنة حيث كانت هناك فروق معنوية بين جميع المعاملات وبين المقارن