

EFFECT OF THREE CONTROL TACTICS IN INTEGRATED PEST MANAGEMENT ON THE POPULATION OF POTATO TUBER MOTH *PHTHORIMAEA OPERCULELLA* (ZELLER) (LEPIDOPTERA : GELECHIIDAE) IN POTATO FIELDS .

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Abstract

The study aimed to investigate IPM techniques which would reduce potato tuber moth (PTM), *Phthorimaea operculella* (Zeller) (Lepidoptera : Gelechiidae) , population in potato fields . Three IPM techniques , potato planting date, sex pheromone-baited water traps and the bioinsecticides were tested. Results indicated that early planting of potato summer plantation in January, significantly reduce the population of *Ph . operculella* larvae from four tested planting times . Sex pheromone – baited water traps. were effective as a means of detecting and monitoring the occurrence of adults of *Ph . operculella* in both seasons of 2004 and 2005 . Moreover potato plants in fields containing traps were statistically less infested with *Ph. operculella* than plants in field without traps by % reduction amounted 21.7 % in winter plantation and 27.1 % in summer plantation . The correlation between catches of potato tuber moth males and each of max and min temperature in winter plantation were significant .Spraying of potato plants with bioinsecticides significantly reduced number of PTM larvae . Spinosad (Tracer 24% SC) was the most effective insecticide followed by botanical insecticides Azadirachtin (Achock 15% EC) and Soybean oil (Naturals 96% EC). Thus early planting of potato summer plantation in January , Sex pheromone – baited water traps and bioinsecticides may be a promising components of IPM strategies for reducing *Ph. operculella* population in potato fields .

INTRODUCTION

Potato *Solanum tuberosum* L. considered one of the most important vegetable crop in Egypt . Potato tuber moth (PTM) , *Phthorimaea operculella* (Zeller) (Lepidoptera : Gelechiidae), is a serious pest of solanaceous crops including potato, and tomato and is widely distributed in the temperate and subtropical regions (Sporleder et al., 2004) . The suitable planting dates were determined by sever investigators (Fetoh 2003 and Abbassy, et al., 2008), in order

to gain high yield as a result of low infestation by PTM . Also, There was a highly significant positive correlation was stated by (Fetoh 2003) between the collected moths by sex pheromone and prevailed temperature, On other hand the infestation with PTM larvae in field treated with pheromone traps was drastically less than fields without pheromone trap . Biological control of this pest has had limited success , therefore chemical control remains the most widely used method. The new products with favorable environmental characteristics are required for management of this pest in Egypt (Raslan ,et al., 2009) . Therefore , the objective of this study was to investigate , IPM techniques for control of this PTM in potato plants based on avoiding , as much as possible, foliar spraying with synthetic insecticides. Three IPM techniques, planting date of potato plants, the use of sex pheromon -baited water traps , and foliar spraying with bioinsecticides, spinosad , Soybean oil and azadirachtin were tested.

MATERIALS AND METHODS

1-Effect of potato planting dates on PTM Infestation :-

The effect of potato planting dates on the level of infestation by PTM larvae was studied in two successive years on Hermis variety during season of 2004 and 2005 in Etay El-Baroud Agric. Res. Station, A.R.C. in El-Behera Governorate . The tested planting dates were 23rd of January , 10th , 23rd of February and 10th March during summer of 2004 and 2005 . The experimental area was 16 Kerate (2800 m²) , divided to four blocks as replicates and each block included four plots to represent four planting dates . After 30 days from planting , the potato plants were examined weekly until harvest time . Where,25 potato leaves were chosen randomly from each plot and identified by Biological control department, Plant Protection Research Institute and inspected carefully to record PTM larvae infestation on potato leaves . F test analysis was applied to compare among the four planting dates to declare the planting date of potato which gives low infestation.

2- Effect of sex pheromone traps :-

To evaluate the efficiency of sex pheromone traps for monitoring the changes in population density of PTM males at potato field in El-Delangate region in El-Behera Governorate , sex pheromone trap (Water pan traps) were made of plastic material in oblong shape (30 x 20x 10 cm) and placed in field at 1.20 cm height from ground level . Pheromone substance was impregnated in capsules and

kept frozen to preserve their effectiveness until using . It was exchanged every two weeks . The traps were filled with a mixture of water and detergent . Water was changed when it is needed . The sex pheromone capsules , used in this study were obtained from Pheromone Production Unit , Plant Protection Research Institute, Agriculture research Center . The experimental area was one feddan for each of winter and summer plantation in 2004 and 2005 seasons . The traps were distributed at four cardinal directions (South , North , West, and East) and one trap at the center of potato field. Weekly numbers of potato tuber moth males were recorded in traps in the different directions. Moreover , samples of 25×4 potato leaves were chosen randomly from fields treated with pheromone traps and compared with similar samples collected from potato fields untreated with pheromone traps. Larvae was identified as *Phthorimaea operculella* (Zeller) by Biological Control Department, Plant Protection Research Institute. This procedure was conducted from 37 days of potato plant age in summer plantation and 51 day in winter plantation until harvest time. On other hand , records of daily means temperature and relative humidity were obtained from El-Delengate Metrological Station . From these records means of maximum and minimum temperature as well as mean relative humidity were calculated 7 days earlier from corresponding sampling dates . The pheromone substance is a sex attractive consisted of a mixture of two synthetic components PTM1 (Trans-4, cis-7-Tridecadien-1-01 acetate) and PTM2 (Trans-4, cis-7, cis-10-Tridecadien 1-01 acetate) in a ratio 0.4 mg of PTM1 and 0.6 mg of PTM2 .

3-Effect of certain natural products :-

An experiment was conducted to evaluate efficiency of three natural products against *Ph . operculella* under field conditions , The experimental area of approximately one Fadden (4900 m^2) was cultivated on 10-March with potatoes plants variety (Nicola) in El-Dalangat Region, El-Behera Gavornorate , during winter plantation of 2004 , 2005 , summer plantation of 2005. Three natural products were tested in two different concentrations for each pesticide . So experimental area of (4900 m^2) was divided into four blocks then each block was divided to seven plots (six plots treated with the three natural products at two different rates and one plot was left without spraying as control) . Three sprays were conducted in 65 days of plant age by a Knepsak sprayer . Samples of 10 potato leaves were chosen randomly from each tested plot , pre and post each spraying to determine initial infestation and reducing in infestation level , respectively . The percentage

of potato tuber moth larvae reduction (Mortality) was calculated according to (Henderson and Tilton equation 1955) as follow :-

Reduction % = $[1 - (Cb \times Ta / Ca \times Tb)] \times 100$ Where T: Number of live insect individuals in treatment . C : Number of live insect individuals in control . A : Number of live insect individuals after treatment . B : Number of live insect individuals before treatment .

Tested Natural products :-

1. Spinosad : (a mixture of spinosyn A and spinosyn D . both are secondary metabolite of soil actinomycete *Saccharopolysporo spinosad as Tracer 24% SC*)
2. Azadirachtin : (extracted from the neem tree *Azadiracta indicce as Achook 0.15 % E.C.)*
3. Soybean oil (Extracted from Soybean plant as Naturals 96 % E.C.)

RESULTS AND DISCUSSION

1- Effect of planting date :-

Statistical analysis revealed that planting dates of potato plants significantly affected *Ph.operculella* larval population in both seasons of 2004 and 2005 as shown in the Table (1).The lowest infestation occurred when potato was sown in January 23rd (5.84-3.98 larvae / 25 potato leaves) , while the highest one was achieved when potato plant was sown in 10th March (10.95-6.80 larvae / 25 potato leaves) . This variation in *Ph . operculella* infestation is due to changes in prevailing weather conditions and other ecological factors . Thus culture management , such as early cultivation of potato plants can reduce its infestation with *Ph .operculella* . This agrees with the results given by (Fetoh 2003 and Abbassy,et al., 2008) .Therefore , the recommended dates for planting of potato plants is in January to reduce the population density of *Ph. operculella* .

2-Effect of sex pheromone traps :-

Sex pheromone-baited water traps were effective as a means of detecting and monitoring the occurrence of adults of *Ph.operculella* in both seasons of 2004 and 2005 as shown in Table (2) . The mean number of 25.33 and 209.04 adult males was caught during winter and summer plantation in 2004 and 2005 , respectively . Moreover , potato plants in fields containing traps were statistically less infested with *Ph.operculella* than plants in field without traps, the mean total number of PTM larvae / 100 potato leaves being 13.8 in 2005 summer plantation , and 3.33 in 2004 - 2005 winter plantation in field with traps , as compared with 50.9 and 15.83 larvae / 100 potato leaves in fields without traps in El-Behera Governorate by % reduction 21.3 % ($3.33 \setminus 15.83 \times 100$) in winter plantation and 27.3% ($13.0 \setminus 50.9 \times 100$) in summer plantation . Traps were also useful in detecting and monitoring the first occurrence of the gelechiid and its population fluctuations as reported by (Doss, 1984) . A positive correlation between max . min . temperature were detected in winter plantation and survival of *Ph.operculella*. The correlation between catches of potato tuber moth males and each of max . and min . temperature in winter plantation were significant represented by 0.792 *** and 0.857 ***respectively, but not significant in summer plantation (0.54 , 0.533 and 0.329). This results agree with (Fetoh 2003). Thus , the use of sex pheromone traps will provide the grower with an additional tool of IPM for control of *Ph. operculella* on potato plants with less environmental impact and increased applicator and consumer safety compared to standard technology (using of synthetic insecticides as foliar spray) as reported by (Mullins 1993) .

3-Effect of bioinsecticides :-

Bio-insecticides are environmentally safer and more economical (Kirschbaum 1985) . They emerged as powerful alternatives to conventional chemical insecticides (Hofte and Whiteley , 1989) . Spinosad is a broad- spectrum bacterial insecticide , represent a novel class of macrocyclic lactones produced by the soil actinomycete *Saccharopolyspora Spinosa* (Mertz and Yao , 1990) . Result in Table (3) revealed that spraying of potato plants with spinosad at 30 and 20 ml /100 L water resulted in 93.39 % and 88.4 % reduction in winter 2004 / 2005 plantation season and 92.51% and 90.26 % reduction in 2005 summer plantation , of PTM larvae respectively. This may be due that spinosad proved to reduce significantly egg-adult survivorship (Liu and Trumble 2005) . It

important to define the minimum effective rate of spinosad to PTM control , not only for economical reasons but also to minimize the potential impact on non- target organisms (Boyd and Boethel 1998) . Of the botanical insecticides tested to data , the insecticide effects of azadirachtin , are strongly antifeedant , insect growth regulator and reproductive effects (Mordue and Blackwell 2003) . Results in Table (3) revealed that foliar spray of potato plants with azadirachtin at rates of 187.5, and 140 ml/100 L. water caused significant reduction of larvae population of PTM *Ph.operculella* . The mean of corrected mortality percentage three foliar spraying was 80.64 and 80.78 at the 187.5 ml / 100 L water during winter plantation of 2004 / 2005 season and summer plantation of 2005 season , respectively .While it was at the reduced dose (140.0 ml / 100 L water) 74.92% and 70.48% during winter plantation of 2004 / 2005 and summer plantation of 2005 seasons respectively . Similary (Abbassy,et al., 2008) found that no adult emerged from neem treated leaves with 0.025 to 0.1g of azadirachtin . Very few data are available on the insecticide activity of natural oils based bioinsecticides against the PTM *Ph.operculella* on potato plants . Result in Table (3) indicated that the foliar spray of potato plants with the Soybean oil (Natural 96% E.C.) showed significant reduction on larvae numbers of this PTM. Three applications of 625 ml / 100 L resulted in 58.66 % reduction in larvae . There are significant differences between recommended and 468 ml rates of soybean oil . The effect (as % reduction) was decreased to 43.87 % , and 51.38 % respectively . In this respect , (Amany , et al., 2010) reported that plant extracts proved to be a safe alternative pest control trend rather than tradional pesticides . In conclusion , the overall results indicate that early planting of potato plant , in January , sex pheromone- baited water traps , and foliar spraying of potato plants with the bioinsecticides , spinosad and zadirachtin may be effective IPM strategies for reducing *Ph . operculella* population in the potato fields .

Table 1 . Effect of Potato planting date on the population density of *Ph. opercullela* during in 2004 and 2005 summer plantation at Etay El-Baroud Agric.Res. Station in El-Behera Governorate .

Plant age (days)	Mean Number of larvae / 25 potatos \ leaves (± S.D)			
	23 January	10 February	23 February	10 March
Summer 2004				
30	0.00	0.00	0.00	2.50± 0.65
37	0.00	0.00	5.25 ± 1.11	5.50 ± 0.65
44	0.00	5.50 ± 0.65	6.50 ± 0.87	7.50 ± 1.19
51	5.50 ± 0.65	6.25 ± 0.63	7.75 ± 1.93	8.75 ± 1.65
58	5.00 ± 0.82	7.50 ± 0.87	7.75 ± 0.48	11.00 ± 0.92
65	6.25 ± 1.11	10.25 ± 0.63	10.25 ± 1.38	12.25 ± 0.75
72	7.75 ± 1.75	10.00 ± 0.71	10.00 ± 2.62	12.75 ± 1.65
79	8.25 ± 1.32	12.25 ± 0.86	12.50 ± 1.56	14.75 ± 1.80
86	10.00 ± 1.47	12.50 ± 1.94	13.25 ± 1.80	15.00 ± 1.42
93	10.50 ± 1.71	12.75 ± 1.25	13.75 ± 2.35	15.00 ± 2.60
100	11.00 ± 2.12	13.75 ± 1.70	14.00 ± 2.68	15.50 ± 2.73
Total	64.25	90.75	101	120.5
Mean	5.84 c	8.25 b	9.18 b	10.95 a
L.S.D 0.5 = 1.191				
Summer 2005				
30	0.00	0.00	0.00	1.00 ± 0.41
37	0.00	0.00	1.00 ± 0.41	1.00 ± 0.58
44	0.00	1.00 ± 0.58	1.00 ± 0.73	2.00 ± 0.41
51	0.00	3.25 ± 0.25	4.00 ± 1.47	4.25 ± 0.48
58	2.00 ± 0.41	3.50 ± 0.65	4.50 ± 1.23	5.00 ± 0.41
65	3.50 ± 0.29	6.00 ± 1.08	6.75 ± 1.11	6.75 ± 0.25
72	3.75 ± 0.48	7.50 ± 1.90	8.00 ± 0.82	9.00 ± 0.41
79	7.75 ± 0.48	7.75 ± 0.63	8.50 ± 1.71	10.00 ± 1.08
86	8.00 ± 0.71	9.00 ± 1.47	9.50 ± 1.26	11.75 ± 1.18
93	8.75 ± 0.48	9.50 ± 0.50	10.00 ± 1.08	12.00 ± 0.58
100	10.00 ± 0.82	10.25 ± 0.83	10.50 ± 1.19	12.00 ± 0.92
Total	43.75	57.75	63.75	74.75
Mean	3.98 c	5.25b	5.80 b	6.80 a
L.S.D 0.5 = 0.690				

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Table 2 . Weekly numbers of *Ph. oprculella* males captured in pheromone traps , numbers of larvae on potato plants and the records of main weather conditions in El-Delangate Region in El- Behera Governorate .

Inspection Dates	Plant Age (Days)	Total number of PTM larvae / 100 potato leaves under trapping	Total number of PTM larvae / 100 potato leaves without trapping	Mean Number of Capture Moth /Trap (S.E.)	Main weather conditions			
					Temperature c°			R.H %
					Maximum	Minimum	Mean	
Winter plantation 2004 - 2005								
3-Dec 2004	51	0	1	44.2 ± 4.12	22.43	13.71	18.07	52.64
10-Dec2004	58	12	13	38.6 ± 9.46	20.86	13.57	17.23	58.36
17-Dec2004	65	12	21	16.4±5.92	22.29	11.71	17.00	53.43
24- Dec 2004	72	4	30	2.6±1.69	20.71	9.57	15.14	52.86
31-Dec 2004	79	0	25	2.6±2.11	22.57	12.71	17.64	51.14
7-Jan 2005	86	4	20	3.0±1.48	18.86	9.71	14.29	53.57
14-Jan 2005	93	4	24	1.6±0.75	15.57	8.29	11.93	61.79
21-Jan 2005	100	2	14	1.2±0.58	19.71	10.14	14.93	61.07
28-Jan 2005	107	0	15	0.6±0.24	19.86	10.43	15.15	53.71
4-Feb 2005	114	2	27	0.2±0.20	18.85	8.29	13.58	60.36
Mean		3.33	15.83	25.33	21.01	11.54	16.28	55.30
Correlation Coefficient between weather factors and number of trap capture					0.792**	0.857***	0.845***	-0.327
Summer plantation 2005								
20 March	37	0	0	38.3 ± 5.31	22.57	12.14	17.36	53.79
27 March	44	0	0	48.2 ± 5.83	23.67	12.00	17.84	55.57
3 April	51	0	24	92.2 ± 25.97	22.43	11.57	17.00	60.72
10 April	58	2	50	141.4 ± 35.60	26.29	14.14	20.22	53.28
17 April	65	16	56	227.2 ±60.29	30.57	16.29	23.43	48.22
24 April	72	26	61	293.6 ± 52.8	26.29	14.43	20.36	51.00
1 May	79	34	72	451.8 ± 99.51	25.71	13.29	19.50	50.93
8 May	86	32	80	190.4 ± 76.24	30.71	15.71	32.21	48.57
15 May	93	22	80	364.5 ± 94.57	33.57	17.57	25.57	47.14
22 May	100	6	86	242.8 ± 32.01	32.43	17.57	25.00	48.93
Mean		13.8	50.9	209.04	27.42	14.48	21.85	51.82
Correlation Coefficient between weather factors and number of trap capture					0.540	0.533	0.329	-0.631

" F value between treated and untreated plots with pheromone traps " = 22.718 ** in summer 2005 and = 17.7 ** in winter 2004

Table 3. Efficacy of certain natural products against PTM larvae on potato leaves var. " Nicola " at El-Delangate Region in El- Behera Governorate

Treatments	Rates / 100L water	Numbers of larvae per 40 leaves (A) and (%) reduction rates (B)								
		Pre- spray	Spraying times						Mean	
			1 st		2 nd		3 rd			
			A	B	A	B	A	B	A	B %
Winter 2004-2005 plantation season										
Spinosad	30 ml	16	1	94.53	1	94.85	2	90.79	1.33	93.39 a
	20 ml	14	2	87.50	2	88.24	2	89.47	2.00	88.40 a
Azadirachtin	187.5 ml	14	3	81.25	4	76.47	3	84.21	3.33	80.64 b
	140.6 ml	16	4	78.13	5	74.26	6	72.37	5.00	74.92 b
(Soybean oil)	625 ml	13	5	66.35	8	49.32	7	60.32	6.67	58.66 c
	468.5 ml	11	7	44.32	7	47.59	9	39.71	7.67	43.87d
Check		14	16	-	17	-	19	-	17.33	-
Summer 2005 plantation season										
Spinosad	30 ml	32	2	94.49	3	92.19	4	90.85	3.00	92.51 a
	20 ml	33	3	91.98	4	89.90	5	88.91	4.00	90.26 bc
Azaderachten	187.5 ml	28	6	81.09	6	82.14	8	79.09	6.67	80.78 d
	140.6 ml	31	9	74.38	12	67.74	13	69.32	11.33	70.48 e
(Soybean oil)	625 ml	32	11	69.67	16	58.33	18	58.84	15.00	62.28 e
	468.5 ml	32	16	55.88	18	53.13	24	45.12	19.33	51.38 h
Check		30	34	-	36	-	41	-	37.00	-

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استخدام ثلاث طرق من أسلوب مكافحة المتكاملة لمكافحة فراشة درنات البطاطس
***Phthorimaea operculella* (Zeller) (Lepidoptera : Gelechiidae)**
على نباتات البطاطس

حافظ إسماعيل حافظ عمر¹ ، محمد عبد القادر منصور العو² ، خليل عبد الله احمد دراز² ،
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أجريت هذه الدراسة بمحطة البحوث الزراعية ايتاي البارود ، مركز البحوث الزراعية ،
وكذلك مركز الدلنجات محافظة البحيرة خلال الفترة 2005 ، 2004 حيث تم دراسة تكامل
استخدام ثلاثة طرق متتالية للسيطرة على فراشة درنات البطاطس (رتبة : حرشفية الأجنحة ،
عائلة : جيليكيدي) (Order : Lepidoptera , Family : Gelechiidae) وهي تأثير المواعيد
الزراعية ، استخدام مصائد الجاذبات الجنسية المائية ثم الرش بالمبيدات الحشرية الحيوية الطبيعية .
اوضحت النتائج ان زراعة نباتات البطاطس (صنف الهيرموز) في الوقت المناسب وهو شهر
يناير حيث قد سجلت إحصائيا اقل تعداد من الاصابه ، يلي ذلك استخدام مصائد الجاذبات الجنسية
الذكريه المائية حيث أدى استخدامها إلى خفض نسبه الاصابه بواقع 27.30% في العروة الصيفية
و 21.30% في العروة الشتويه ، و أخيرا رش النباتات باستخدام المركب الحيوي الطبيعي
اسبينوساد (تريسر 24% SC) بالمعدل 30ملى/100لتر ماء حيث أدى إلى خفض نسبه الاصابه بواقع
93.39% ، أو المركب الحيوي النباتي اذاتراختين (اشوك EC%0.15 بالمعدل
187.50ملى/100لتر ماء حيث أدى إلى خفض نسبه الاصابه بواقع 80.64% يحقق السيطرة
على الاصابه بفراشه درنات البطاطس .