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RELATIVE SUSCEPTIBILITY OF CERTAIN POTATO VARIETIES TO POTATO TUBER MOTH, *PHTHORIMAEA OPERCULELLA* (ZELLER) INFESTATIONS

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ABSTRACT

Field trials and laboratory experiments were undertaken for monitoring the relative susceptibility of four potato varieties namely; Atlas, Spunta, Simone and Nicola to potato tuber moth (PTM) *Phthorimaea operculella* (Zeller) infestations. Experiments were carried out for two summer plantations during 2006 and 2007. Results obtained indicate that Nicola potato variety was the least susceptible one among the four tested varieties. The least infestation (5.5 & 7.17) as average number of larvae/100 leaves, percentages of tuber infestation (5% & 18%) and number of larve/100 tubers (5 & 20) was recorded for Nicola variety in the two seasons, respectively. The analysis of variance yielded significant differences among the four tested varieties. Positive and highly significant relationships were recorded between plant age and the corresponding infestation (r = +0.91 for 2006 and +0.93 for 2007). Chemical analysis for tubers showed a positive relationship between lowest sap content of free phenol and the least level of PTM infestations. That will explain why Nicola variety is considered as least susceptible to PTM infestation where it had the least concentration of free phenols (19.507 ppm.). The other verities which demonstrated high concentrations of free phenols harboured the highest levels of infestation with PTM. Positive and highly significant correlation were detected between free phenols content and both tuber infestation & larval content (r=+0.80 and +0.96) respectively.

INTRODUCTION

It is well known fact that potato fields are inhabited by different insect species including; potato tuber moth (PTM) *Phthorimaea operculella* (Zeller); the black cut worm, *Agrotis* spp., the green peach aphid, *Myzus persicae* (Sulz.); the cotton aphid, *Aphis gossypii* (Glover); the cotton white fly, *Bemisia tabaci* (Gennadius) and potato leaf hopper, *Empoasca descipiens* (Paoli). These are the most economically important cause considerable damage and loss in potato species yield **(Mustafa 1992 and Ibrahim 1997).**

The characteristics infestation symptoms by PTM are commonly the bloch mines on the foliage and tunnels in tubers. This pest is considered the “key insect pest” in stores. The damage losses due to PTM infestation can reach 100%.

In high input potato production systems, i.e. IPM tactics for control of this pest usually depend on the use of recommended insecticides. Once the insecticides have been introduced into the program system in which population relative pest status may be greatly altered.

Hence, from the economical point of view we should apply other alternative control methods for suppressing the population density of PTM to be around the "General Equilibrium Position" (GEP.). It may be more effective to select the susceptible potato varieties to infestation by PTM **(Iskander 1992 and Sayed 2007).**

In general, the present study aimed to evaluate the susceptibility of four potato varieties to *Ph. operculella* infestations under conditions of Qalyubyia Governorate.

MATERIALS AND METHODS

Field trials were conducted at the Agricultural Experimental Station attached to the Faculty of Agriculture, Ain Shams University (at Shalakan, Qalyubyia Governorate) during 2006 and 2007 potato summer growing seasons.

Experimental area of about 1/4 feddan was divided into 16 equal plots (4 potato varieties x 4 replicates) distributed in a complete randomized block design each of about 65 m^2 ; 10m x 6.5m or 10m x 8 rows.

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Four commercial imported potato varieties; namely Atlas, Spunta, Simone and Nicola were cultivated on 20th of February for both 2006 and 2007 summer seasons respectively. Cultivation of potato tubers was at a depth of 10-15cm under soil and 20-25 cm apart. All the recommended agricultural practices were adopted for all the experimental field plots. No chemical insecticidal treatments were used during both growing seasons. Yield was harvested on 15th and 20th of June 2006 and 2007.

1- Foliage infestation

After germination of potato seeds, weekly samples of 100 potato leaflets of each variety were picked at random; i.e. 25 leaflets/plot. Samples were then collected in paper bags then transferred to the laboratory for examination. The percentage of infestation based on the total number of larvae/100 leaflets of potato plants was estimated.

2- Tuber infestation

At harvest, 100 tubers from each variety were picked at random; i.e. 25 tubers/plot. The tubers were then divided, randomly, into 10 replicates. The percentage of infested tubers and number of mines were recorded.

3- Determination of free phenols as a factors effecting relative susceptibility of infestation with potato tuber moth

At harvest, five tubers from each variety were picked at random; and transferred to laboratory for chemical analysis.

One gram of tuber tissue was macerated in 10 ml 80% ethanol for 24 h. at 4˚C, the ethanol was clarified and the remained tissue re-extracted with 10 ml 80% ethanol two times again as above. At the end the clarified extract was completed to 50 ml 80% ethanol. One ml. of previous extract and 0.5 ml Folin-Denis reagent were well mixed in dry test tube and thoroughly shaken for 3 min. one ml. of 20% Na_2CO_3 solution was added and well mixed and 3 ml. of distilled water were added. After one hour, at room temperature, the phenolic compounds were determined by reading the developed blue color at 725 nm using Unico-2100 UV/Vis spectrophotometer. One ml. of 80% ethanol with reagent was used as a blank. If the solution was clouded or precipitate was formed, it must be filtered or centrifuged before reading the absorbance of developed blue color. The corresponding amount of phenolic compounds was calculated from as standard solution prepared from pure catichol (100 ppm**).** Determination of free phenols was carried out through **Abdel-Megeed, 1999** method.

RESULTS AND DISCUTION

1- PTM infestation on foliage of certain potato varieties

Data in **Table (1)** and **Fig. (1)** show the fluctuations in the population density of *Ph. operculella* larvae on the four potato varieties during two successive seasons. These data reveal that larvae start to infest potato leaves with comparatively few numbers during the 2nd week of April. The rates of infestation was increasing, gradually, recording three overlapping generations at the 1st and 4th week of May (67 and 85 larvae /400 leaves respectively), whereas peak of the third generation took place during the 3rd week of June (106 larvae/400 laves). According to the results, in **Table (1)** the relative susceptibility of different potato varieties to *Ph. operculella* infestations showed that variety Atlas proved to be the most susceptible where it harboured the highest mean infestation pattern (16.42 larvae/100 leaves). On the other hand, the average numbers of larvae were 15.25, 14.17 and 5.5 larvae/100 leaves for Spunta, Simone and Nicola varieties, respectively. It is clear that Nicola was the least susceptible variety to PTM infestation during 2006 season.

Statistical analysis revealed the presence of significant differences among the four tested varieties during summer plantation of 2006; where the variance ratio ("F" value) was 3.55.

For 2007 season, data in **Table (1)** and **Fig. (1)** demonstrate similar trend of infestation. It was relatively higher and began earlier than the previous summer plantation (2006). The infestation was first detected during the 1st week of April. Population increased, gradually, recording 3 distinct peaks; the first during the 1st week of May (74 larvae /400 leaves), followed by the second during the 1st week of June (84 larvae /400 leaves) and the 3rd peak appeared after 3 weeks with the highest number of larvae (104 larvae /400 leaves). The next season, 2007 followed the same trend in rate of infestation of 2006, where Atlas variety gained the highest mean infestation (17.0 larvae/100 leaves), meanwhile Spunta, Simone and Nicola came next in this respect (15.5, 15.0 and 7.17 larvae/100 leaves respectively).

Analysis of variance for 2007 results indicated that there are significant differences in the susceptibility of the tested varieties to PTM infestation (F value 3.30). The same grouping was detected for the four varieties.

However the weekly number of larvae increased, gradually, by the increasing the age of plant for all tested varieties. Positive and highly significant correlation was estimated between plant age and the total number of larvae on the four

tested varieties in both summer plantations (r = +0.91 and +0.93 for both seasons, respectively).

Table 1. Rate of larval infestation, *Ph. operculella* on four potato varieties during summer plantations of 2006 and 2007 at Qalyubyia Governorate.

Insp. date	Plant age (in days)	No. of larvae/100 leaves											
		2006						2007					
		Atlas	Spunta	Simone	Nicola	Total	Mean	Atlas	Spunta	Simone	Nicola	Total	Mean
2, April	42	0	0	0	0	0	0.0	0	3	0	0	3	0.8
9	49	0	5	0	0	5	1.3	3	3	2	0	8	2.0
16	56	3	6	5	0	14	3.5	10	6	3	0	19	4.8
23	63	8	10	9	0	27	6.8	19	11	16	2	48	12.0
30	70	15	13	10	1	39	9.8	15	9	10	5	39	9.8
7, May	77	22	23	19	3	67	16.8	21	20	24	9	74	18.5
14	84	20	19	17	9	65	16.3	24	19	20	7	70	17.5
21	91	15	12	15	7	49	12.3	19	18	19	11	67	16.8
28	98	27	22	26	10	85	21.3	20	25	15	12	72	18.0
4, June	105	25	18	23	12	78	19.5	24	24	20	16	84	21.0
11	112	26	25	19	11	81	20.3	19	15	25	9	68	17.0
18	119	36	30	27	13	106	26.5	30	33	26	15	104	26.0
Total		197	183	170	66	616	154.0	204	186	180	86	656	164.0
Mean		16.4a	15.3ab	14.2ab	5.5b	51.3	12.8	17.0a	15.5ab	15.0ab	7.2b	54.7	13.7

F among varieties = 3.55* 3.3*.
Means with the same letter do not differ significantly according to Tukey's test at 5%.

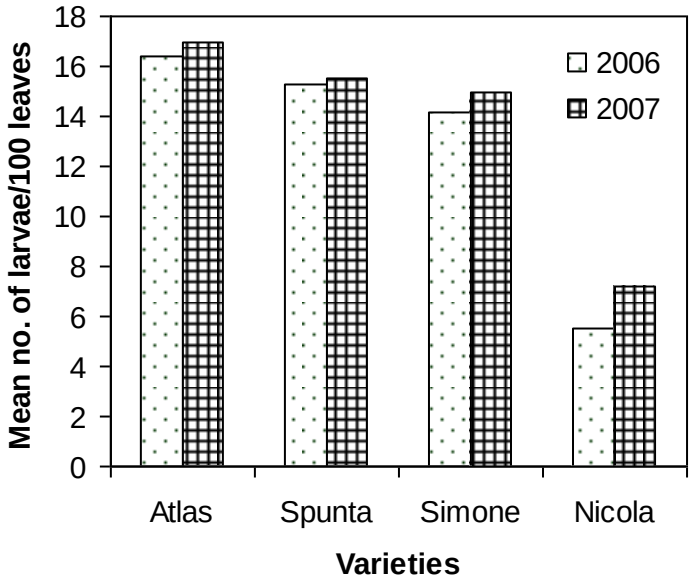

Fig. 1. Comparison between four potato varieties to infestation by *Ph. operculella* larvae during summer seasons of 2006 and 2007

These results are in agreement with those obtained by **Hayder (1983),** in Egypt. He tested the relative susceptibility of 26 potato varieties to infestation with the potato tuber moth. The author reported that the light infested varieties were Jerla, Alpha, Explera, Patrone and Desiree. The moderate infested varieties were Renova, Fundy, Kennbee and King Edward, while Culba, Sintje, Maion Cosima, Grata and Aron varieties were heavily infested. Susceptibility was related to the vegetative growth while less susceptible varieties were relatively poorer.

Imam *et al* (1984), in Egypt, found that from 28 May to 24 June, Arran Banner and Alpha showed significantly less infestation by *Ph. operculella* than the other examined varieties.

These results are also agree with those found by **Soliman (1987); Iskander (1992); Ibrahim (1997)**; **Gomma (2002)**; **Ghazala (2005)**; **Sayed (2007) and Hassan (2007).**

On the contrary, these results did not agree with **Abdel-Aziz (1983)**, in Egypt, who found insignificant difference among the tested potato varieties (Alpha, Atica, Aula, Blanka, Desiree, Dunja, Granola, King Edward, Manitar and Ostara) in PTM infestation on foliage. **Imam *et al* (1984)** found that there were insignificant differences in degree of infestation by *Ph. operculella* on the different potato varieties in the autumn-planted trial or in infestation by the pest in the first reading of the spring plantation. The results also disagree with those obtained by **Soliman (1987)** and **Sayed (2007).**

2- PTM infestation in tubers of certain potato varieties

The analysis of variance to data in **Table (2)** was carried out. A significant differences in the susceptibility among the tested varieties to PTM infestation and larval content in tubers at harvest were obtained. The same data show the expected losses induced by *Ph. operculella* larvae in potato yield for the two tested years and the four varieties of the present investigation. For 2006 results, the actual infestation in tubers, expressed as average percentages; was 15, 12, 11 and 5% for Atlas, Spunta, Simone and Nicola varieties, respectively. The corresponding larval contents were 25, 17, 16 and 5 larvae/100 tubers, respectively. Also a significant differences in PTM infestation between Atlas (a), Spunta, Simone (ab) and Nicola (b) were obtained (F = 3.25). The same result was achieved for the number of larvae/100 tubers (F = 2.72).

For 2007 season, the percentages of infestation in tubers were 41, 27, 35 and 18 % for the four varieties, while the corresponding number of larvae was 65, 54, 60 and 20 larvae/100 tubers respectively. There were significant differences in the percentage of PTM infestation (F=39.4**) where Atlas & Simone formed group (a), Spunta and Nicola came next in this respect (groups b & c): F = 39.4, P = 0.000. Also there were significant differences in larval content where: Atlas, Spunta, Simone had very close number of larvae (a) and Nicola had comparatively low larval (b) F = 9.87, P = 0.0001.

The obtained results infer that infestation was comparatively higher in 2007 season as compared to that in 2006 season, on the other hand crop yield in 2006 was higher than 2007. Nicola potato variety is comparatively the highly resistant variety followed by Simone, Spunta and Atlas respectively. However the variations in infestation between the different potato varieties were due to some factors related to the plant morphology and specific chemical constituents as plant defenses against insect attack.

Table 2. *Ph. operculella* infestation expressed as percentage of infested potato tubers by larval content in infested potato tubers in four tested var. during summer plantations of 2006 and 2007 (Qalyubyia Governorate).

Plantation	Variety	% Infested tubers	Variance ratio (F)	No. of larvae/100 tubers	Variance ratio (F)
2006	Atlas	15a	F=3.25*	25a	F=2.27*
Season	Spunta	12ab		17ab	
	Simone	11ab		16ab	
	Nicola	5b		5b	
2007	Atlas	41a	F=39.4**	65a	F=9.87**
Season	Spunta	27b		54a	
	Simone	35a		60a	
	Nicola	18c		20b	

Values with the same letter do not differ significantly according to Tukey's test at 5%.

These results are in agreement with those obtained by **Doss (1984)**, in Egypt**,** who studied the relative susceptibility of 17 potato varieties to infestation by *Ph. operculella*, *Euzophera osseatella* and *Gryllotalpa gryllotalpa* in tubers at harvest at Kalubia and Minia Governorates. He found that variety Spunta was the only one resistant to all 3 insect species; the least susceptible variety to the pests were Diamond for *Ph. operculella*, King Edward for *G. gryllotalpa* and Grata, Draga and Clau-

dia for *E. osseatella*. **Malmberg and Theander (1984)**, found that development of PTM populations after 2 months of storage differed between genotypes. The maximum population being recorded on Huayro and the lowest on Cica. The results of **Musmeci *et al* (2000)**; **Esfahani (2003); Gomaa *et al* (2005)**; **Rondon *et al* (2007)** are in harmony with our results.

3- Free phenols content in relation with PTM infestation in certain potato varieties

Data presented in **Table (3)** show concentrations of free phenols that considered one of the factors affecting the variation in responding of different potato varieties to PTM infestation in the four tested varieties at harvest during 2007 summer season.

It appears from these data that Nicola represented minimum percentage of infestation and larval content (18% and 20 larvae/100 tubers); also it had the lowest amount of free phenols 19.507ppm. while the highest content of free phenols (25.825ppm.) was recorded for Simone followed by Spunta (25.451ppm.) and Atlas (25.178 ppm). The corresponding percentages of infestations in these three var., were 35, 27 and 41% respectively, meanwhile the corresponding larval contents were 60, 54 and 65 larvae/100 tubers, respectively. The analysis of variance for these data of free phenols yielded a significant differences between the four tested varieties (F = 9.87**).

These results revealed that, the higher content of free phenols and the higher infestations were found in the corresponding varieties. Positive and highly significant correlation (*r* = +0.80 and +0.96) were found between free phenols content and both tuber infestation & larval content, respectively.

These results are in agreement with those obtained by **Valencia and Rice (1982),** in Australia, reported that the chemical nature of the oviposition substrata influences the deposition of eggs by potato tuber worm. **Malmberg and Theander (1984)** stated that potato tubers contain a large number of phenolic compounds. Some of them appear in free and some in bound form. The largest portion of phenolic compounds is found in the skin and the periderm layer next to it. They found about ten times as much phenolic compounds in the peel as in the flesh of the potato tubers. They added that population development of PTM was positively correlated with total protein content.

Also our results agree with the findings of **Debnath *et al* (2000); Andersen *et al* (2002); Gomaa (2002); Stein & Vendramim (2000) and Gomaa *et al* (2005).**

Table 3. Free phenols content (ppm.) in relation with PTM infestation in potato tubers of four tested varieties during 2007 season.

Variety	Free phenols (ppm)	S.E.	% Infestation	Larval content
Atlas	25.178 a	0.411	41a	65a
Spunta	25.451 a	0.078	27b	54a
Simone	25.825 a	0.087	35a	60a
Nicola	19.507 b	0.299	18c	20b
r =			+0.80**	+0.96**

Values with the same letter do not differ significantly according to Tukey's test at 5%.

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