Egypt. Acad. J. Biolog. Sci., 5(1):127-136 (2012) **A. Entomology**
Email: egyptianacademic@yahoo.com **ISSN: 1687–8809**
Received: 19/5/2012 **www.eajbs.eg.net**

Life table parameters as indicator of potato Varieties susceptibility to infestation with *Phthorimaea operculella* (Zeller)

Abdallah, Y.E.Y; M. S. Abdel-Wahed and GH. A. Youssef
Department of Plant Protection, Fac. of Agric., Ain Shams Univ., Cairo, Egypt

ABSTRACT

Life table studies for *Phthorimaea operculella* (Zeller) were carried out on four potato varieties, namely Atlas, Spunta, Simone and Nicola to evaluate the preferred variety for feeding *Ph. operculella* larvae. The calculated biological parameters viz. Net reproductive Rate (R_0), Generation time (G_t), Intrinsic Rate of Increase (r_m), Finite Rate of Increase (λ) and Population Doubling Time (D_t) indicate that Atlas proved to be the quite favorable for achieving the highest developmental and multiplication rates of *Ph. operculella*, followed by Simone and Spunta, meanwhile Nicola was the least favorable data figure in this respect were obtained.

The natural mortality figures; Apparent Mortality (AM), Real Mortality (RM), Indispensible Mortality (IM), Mortality-Survivor Ratio (MSR) and log population and *k* factor for larvae reared on Atlas variety were 41.86, 36, 22.32, 4.42, 2.54 and 0.24 respectively, the values 32.89, 25, 13.72, 1.55, 2.48 and 0.17 were obtained for Simone, the values 43.75, 35, 21.77, 3.11, 2.50 and 0.25 for Spunta and 51.19, 43, 22.02 and 5.51for Nicola.

For pupae similar natural mortality trends were observed when *Ph. operculella* larvae were fed on Atlas, 38, 19, 19, 3.77, 2.30 and 0.21, while these values were 45.10, 23, 23, 2.6, 2.31 and 0.26 for Simone. The corresponding values on Spunta were 37.78, 17, 17, 2.43, 5 and 2.21 and 48.78, 20, 20 and 5 for Nicola.

It could be concluded that Nicola is the least susceptible variety for infestation; while Atlas is the most favorable variety for feeding *Ph. operculella* for research purposes.

Keywords: Susceptibility, Varieties, Life tables, Potato tuber moth, *Phthorimaea operculella*.

INTRODUCTION

Potato tuber moth, *Phthorimaea operculella* (Zeller) is one of the most significant insect pests attacking potato tubers which are considered the most important food crop all- over the world. This pest causes reliable damage to potato plants in the field and great losses in quality and quantity of the yielded tubers during storage. The analysis of age-specific life tables is an important and is conducted through easy procedures based on biological parameters when the key factors governing the changes in the population dynamics. In the mean time, forecasting growth parameters; i.e. natality and mortality rates, provide a rational and predictive basis for pest control.

In this respect, many investigators studied the susceptibility of potato varieties to infestation with many insect pests including *Ph. operculella* either in the field or in the stores such as Fenemore (1980); Trivedi *et al.* (1994); Khattab *et al.* (1995); El-Saadany *et al.* (1998); Gurr & Symington (1998); Ibrahim (2000); Chandel *et al.* (2001); Sileshi & Terissa (2001); Ghazala (2005); Al-Taweel *et al.* (2006); Tiwari *et al.* (2006); Douches *et al.* (2010); Golizadeh & Razmjou (2010); Horgan *et al.* (2010); Randon (2010) and Al-Omairy (2012).

In general, the present study aimed to evaluate the susceptibility of certain potato varieties to infestation with *Ph. operculella*; meanwhile determining the preferred potato variety for larval feeding.

MATERIALS AND METHODS

Rearing techniques

At harvest of potato yield of 2009 season, naturally infested tubers of four varieties namely Spunta, Nicola, Atlas and Simone were collected from the field for the establishment of a laboratory insect stock culture to provide target insect in all developmental stages required for laboratory studies. The infested potato tubers were medium sized and supplied with sound tubers and a 5 cm layer of wood sawdust to help successful pupation. These tubers were placed in nine wire gauze wooden rearing cages measuring 40 x 40 x 40 cm. The culture was maintained at laboratory conditions of 27±2ºC and 60±5% R.H. and a light regime of approximately 12h daily light periodicity. The front of the rearing cage which served as a door for inserting selected tubers was provided with white cloth sleeves to facilitate daily examination; i.e. counting emerged moths and preventing their escape.

The newly emerged moths were collected by means of vacuum suction equipment, then sexed and grouped in 10 couples (5♂+5♀) each in an oviposition cage consisting of a glass chimney measuring 17cm in depth and 7-8.5 cm in diameter. The lower rim rested on the bottom of a Petri-dish lined with a disc of filter paper. The upper rim was covered with black muslin-upon which most of eggs were laid -fixed with a rubber band. Pieces of cotton stalks 6 cm in length soaked in 10% honey solution were supplied for moth feeding and were changed when needed. Deposited eggs were collected daily from the oviposition cages and kept in large test tubes covered with pieces of cotton. Newly hatched larvae were picked up by the aid of a moistened fine brush and transferred to potato tubers for feeding till pupation. Newly formed pupae were collected soon after pupation and placed in clean chimney glass cages. Daily examinations were carried out until adult emergence. Cages were cleaned and sterilized, saw dust was changed monthly.

Life table studies

A number of 400 newly deposited eggs were transferred from rearing cages using fine moist brush to ten plastic cups (400 eggs/variety of potato; i.e. 40 eggs/ replicate). Tested potato tubers of the four varieties with the same weight and size were offered to the larvae for feeding during the whole larval stage duration.

Newly formed pupae were transferred to a glass test tube covered with cotton till moth emerged. The newly emerged adults were sexed and transferred on the same day of emergence to an ovipositor glass chimney cage (♂+♀) in each cage which was covered with muslin and provided with piece of cotton soaked in 10% honey solution for feeding of moths.

The following biological aspects were measured; egg and larval duration and mortality, percentage of pupation, duration of pupal stage, percentage of adult emergence, adult longevity, female relative fecundity and specific fertility rates.

Construction of life table data figures and estimating life table parameters

Data obtained for evaluating the preferred potato variety for rearing *Ph. operculella* survivors were used for constructing life tables according to Anderwartha and Birch (1984), Table (1).

The mortality data figures were estimated through the following:

* Apparent mortality (AM %) = (dx_1/lx_1) x 100, (dx_2/lx_2) x 100 … etc

* Real mortality (RM %) = (dx_1/lx_1) x 100, (dx_2/lx_2) x 100 … etc
* Indispensable mortality (IM %): this is that part of generation mortality that would not occur, should the mortality factor in question be removed from the life system.
* Mortality–survivor ratio (MSR%): this measure represents the increase in population that would have occurred if the factor in question had been absent. If the final population is multiplied by this ratio then the resulting value represents in individuals, the indispensable mortality due to that factor.
* Log population: the natural logarithm of the population.
* *k*- value = Log N_t – Log N_{t+1}

Table 1: Age specific life table data figures expressed as definitions and corresponded formulae

Symbol	Definitions	Formula
x	Age (in days)	----------
l_x	Probability of an individual surviving to age x.	----------
m_x	Reproductive expectation of a female at age x.	----------
R_0	Net reproductive rate, number of daughters that replace an average female in course of a generation.	$R_0 = \sum l_x m_x$
G_t	Mean generation time, mean of the period over which progeny are produced.	$G_t = (\sum x\, l_x\, M_x)/R_0$
r_m	Intrinsic rate of increase, number of progeny produced per unit time	$r_m = (\log e^{R0})/G_t$
λ	Finite rate of increase, number of times a population double itself in unit time.	$\lambda = e^{rm}$
D_t	Generation doubling time.	$D_t = (\log e^2)/r_m$

RESULTS AND DISCUTION

The following parameters were considered.

a- Survival and fecundity rates

Data presented in Tables (2-5) and Fig. (1) summarize the calculated life table parameters of potato tuber moth when larvae were fed on tubers of Atlas, Spunta, Simone and Nicola varieties, respectively. However data indicate reliable differences in the biological parameters between varieties' means.

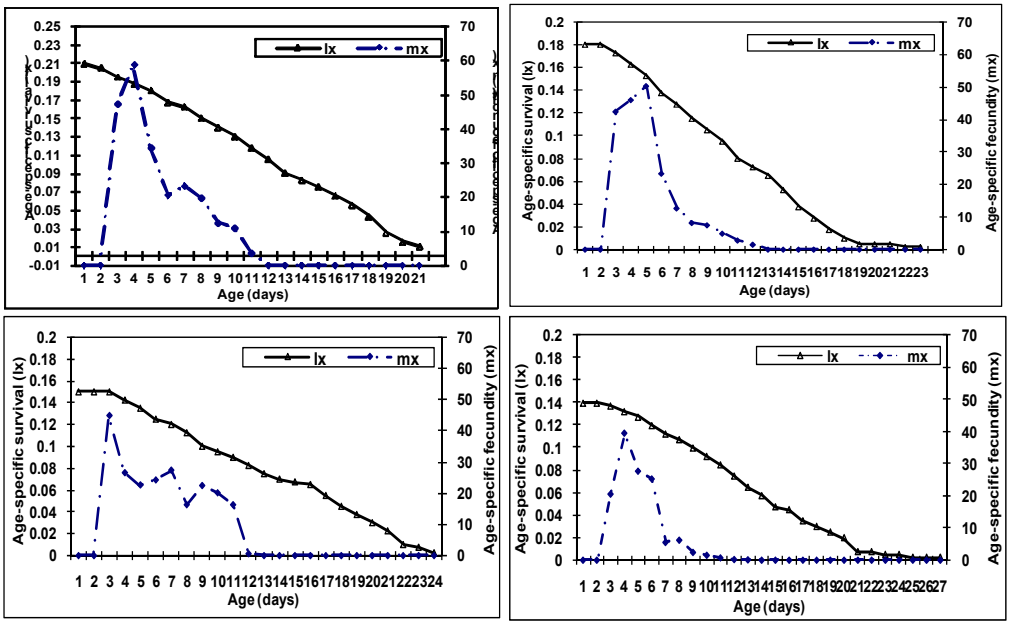

Fig.1: Age-specific survivorship (l_x) and fecundity (m_x) of *Ph. operculella* on four varieties of potatoes.

Data in Table (2) reveal that female moths emerging from larvae fed on Atlas tubers demonstrated the shortest longevity duration (21 days) and the highest age-specific fecundity rate of 229.8 eggs/female; meanwhile durations of immature stages were completed in 21 days. Females started oviposition after 2 days from emergence and lasted for 9 days while the post-oviposition period lasted for about 10 days. Net reproductive rate (R_0) was 40.01eggs/female. Meanwhile duration of generation (G_t) was 26.17 days after which death occurred. The total life span lasted for 42 days (Table 6).

Nicola variety, however, demonstrated the longest life span duration thus completing one generation in 52 days. The immature stages lasted for 25 days. Female longevity lasted 27 days. Fecundity rate was 129.3 eggs/female. Net reproductive rate was 16.33 eggs/day. Generation time was 29.85 days (Tables 5 & 6).

Potato tuber moth larvae when fed on Simone and Spunta demonstrated a moderate duration data figures thus completing one generation within 43 and 47 days, respectively. Meanwhile, the immature stages lasted for 19 & 24 days on both tested verities. Female longevity lasted 23 & 22 days, respectively. Numbers of 220.1 & 200 eggs/female; 27.23 and 29.87 eggs/female were recorded for female fecundity and net reproductive rate, respectively; while mean duration of the generation was 24.93 & 28.82 days, respectively (Tables 3, 4 & 6).

Table 2: Life table parameters expressed as number of survivors (l_x) and fecundity rates (m_x) of *Ph. operculella* when larvae were fed on potato tubers variety Atlas for one generation

Stage	Age (days) x	No. of observation	Survivorship l_x	Fecundity m_x	$l_x m_x$	$l_x m_x x$
Eggs	3	400	1.0000			
Larvae	12	344	0.8600			
Pupae	6	200	0.5000			
Female	22	84	0.2100	0.0	0.00	0.00
	23	82	0.2050	0.0	0.00	0.00
	24	78	0.1950	47.2	9.20	220.89
	25	75	0.1875	58.6	10.99	274.69
	26	72	0.1800	34.2	6.16	160.06
	27	67	0.1675	20.5	3.43	92.71
	28	65	0.1625	23.1	3.75	105.11
	29	60	0.1500	19.6	2.94	85.26
	30	56	0.1400	12.4	1.74	52.08
	31	52	0.1300	10.7	1.39	43.12
	32	47	0.1175	3.5	0.41	13.16
	33	42	0.1050	0.0	0.00	0.00
	34	36	0.0900	0.0	0.00	0.00
	35	33	0.0825	0.0	0.00	0.00
	36	30	0.0750	0.0	0.00	0.00
	37	26	0.0650	0.0	0.00	0.00
	38	22	0.0550	0.0	0.00	0.00
	39	17	0.0425	0.0	0.00	0.00
	40	10	0.0250	0.0	0.00	0.00
	41	6	0.0150	0.0	0.00	0.00
	42	4	0.0100	0.0	0.00	0.00
	Total			229.8	R_0= 40.01	1047.08
	Mean			10.94		

G_t = 1047.08/40.01 = 26.17

Table 3: Life table parameters expressed as number of survivors (l_x) fecundity rates (m_x) of *Ph. operculella* when larvae were fed on potato tubers variety Simone for one generation.

Stage	Age (days) x	No. of observation	Survivorship l_x	Fecundity m_x	$l_x m_x$	$l_x m_x x$
Egg	3	400	1.0000			
Larvae	11	304	0.7600			
Pupae	5	204	0.5100			
Female	20	60	0.1500	0.0	0.00	0.00
	21	60	0.1500	0.0	0.00	0.00
	22	60	0.1500	44.6	6.69	147.18
	23	57	0.1425	26.4	3.76	86.53
	24	54	0.1350	22.5	3.04	72.90
	25	50	0.1250	24.1	3.01	75.31
	26	48	0.1200	27.2	3.26	84.86
	27	45	0.1125	16.2	1.82	49.21
	28	40	0.1000	22.3	2.23	62.44
	29	38	0.0950	20	1.90	55.10
	30	36	0.0900	16.2	1.46	43.74
	31	33	0.0825	0.6	0.05	1.53
	32	30	0.0750	0.0	0.00	0.00
	33	28	0.0700	0.0	0.00	0.00
	34	27	0.0675	0.0	0.00	0.00
	35	26	0.0650	0.0	0.00	0.00
	36	22	0.0550	0.0	0.00	0.00
	37	18	0.0450	0.0	0.00	0.00
	38	15	0.0375	0.0	0.00	0.00
	39	12	0.0300	0.0	0.00	0.00
	40	9	0.0225	0.0	0.00	0.00
	41	4	0.0100	0.0	0.00	0.00
	42	3	0.0075	0.0	0.00	0.00
	43	1	0.0025	0.0	0.00	0.00
	Total			220.1	R_0 = 27.23	678.80
	Mean			9.17		

$G_t = 678.80/27.23 = 24.93$

Table 4: Life table parameters expressed as number of survivors (l_x) and fecundity rates (m_x) of *Ph. operculella* when larvae were fed on potato tubers variety Spunta for one generation

Stage	Age (days) x	No. of observation	Survivorship l_x	Fecundity m_x	$l_x m_x$	$l_x m_x x$
Egg	3	400	1.0000			
Larvae	14	320	0.8000			
Pupae	7	180	0.4500			
Female	25	72	0.1800	0.0	0.00	0.00
	26	72	0.1800	0.0	0.00	0.00
	27	69	0.1725	42.5	7.33	197.94
	28	65	0.1625	46.1	7.49	209.75
	29	61	0.1525	50.4	7.69	222.89
	30	55	0.1375	23.4	3.22	96.53
	31	51	0.1275	12.7	1.62	50.20
	32	46	0.1150	8.2	0.94	30.18
	33	42	0.1050	7.5	0.79	25.99
	34	38	0.0950	4.9	0.46	15.83
	35	32	0.0800	2.8	0.22	7.84
	36	29	0.0725	1.5	0.12	3.92
	37	26	0.0650	0.0	0.00	0.00
	38	21	0.0525	0.0	0.00	0.00
	39	15	0.0375	0.0	0.00	0.00
	40	11	0.0275	0.0	0.00	0.00
	41	7	0.0175	0.0	0.00	0.00
	42	4	0.0100	0.0	0.00	0.00
	43	2	0.0050	0.0	0.00	0.00
	44	2	0.0050	0.0	0.00	0.00
	45	2	0.0050	0.0	0.00	0.00
	46	1	0.0025	0.0	0.00	0.00
	47	1	0.0025	0.0	0.00	0.00
	Total			200	R_0= 29.87	861.06
	Mean			8.69		

$G_t = 861.06/29.87 = 28.82$

b- Intrinsic rate of increase (r_m)

The population intrinsic rates (r_m) decreased from 0.474, 0.450 to 0.237 individuals/ female/day when larvae were fed on Simone, Spunta and Nicola. Meanwhile the highest value of intrinsic rate of increase 0.664 individuals/female/day was obtained when the larvae were reared on Atlas. The fore-mentioned results

confirm that Atlas was the most suitable host variety as verified by $R_{0,}$ G_t and r_m values (Table 6).

Table 5: Life table parameters expressed as number of survivors (l_x) fecundity rates (m_x) of *Ph. operculella* when larvae were fed on potato tubers variety Nicola for the fall generation

Stage	Age (days) x	No. of observation	Survivorship l_x	Fecundity m_x	$l_x m_x$	$l_x m_x x$
Egg	3	400	1.0000			
Larvae	15	336	0.8400			
Pupae	7	164	0.4100			
Female	26	56	0.1400	0.0	0.00	0.00
	27	56	0.1400	0.0	0.00	0.00
	28	55	0.1375	20.5	2.82	78.93
	29	53	0.1325	39.4	5.22	151.39
	30	51	0.1275	27.6	3.52	105.57
	31	48	0.1200	25.2	3.02	93.74
	32	45	0.1125	5.5	0.62	19.80
	33	43	0.1075	6.2	0.67	21.99
	34	40	0.1000	2.4	0.24	8.16
	35	37	0.0925	1.5	0.14	4.86
	36	34	0.0850	0.7	0.06	2.14
	37	30	0.0750	0.2	0.01	0.56
	38	26	0.0650	0.1	0.01	0.25
	39	23	0.0575	0.0	0.00	0.00
	40	19	0.0475	0.0	0.00	0.00
	41	18	0.0450	0.0	0.00	0.00
	42	14	0.0350	0.0	0.00	0.00
	43	12	0.0300	0.0	0.00	0.00
	44	10	0.0250	0.0	0.00	0.00
	45	8	0.0200	0.0	0.00	0.00
	46	3	0.0075	0.0	0.00	0.00
	47	3	0.0075	0.0	0.00	0.00
	48	2	0.0050	0.0	0.00	0.00
	49	2	0.0050	0.0	0.00	0.00
	50	1	0.0025	0.0	0.00	0.00
	51	1	0.0025	0.0	0.00	0.00
	52	1	0.0025	0.0	0.00	0.00
	Total			129.3	R_0 = 16.33	487.39
	Mean			4.79		

G_t = 487.39/16.33 = 29.85

c- Finite rate of increase (λ)

When the finite rate of increase (λ) values were worked out, it yielded 1.942, 1.606, 1.568 and 1.267 individuals/female/day when larvae were fed on Atlas, Simone, Spunta and Nicola, respectively. It is obvious from the obtained data that the highest finite rate of increase (λ) of potato tuber moth was obtained for Atlas being 1.942 individuals/female/day and accordingly considered as the most preferred variety. The lowest preferred variety in this respect was Nicola (Table 6).

Table 6: Life table parameters of *Ph. operculella* larvae reared on four potato varieties

Variety	x days	m_x egg/day	R_0 egg/female	G_t days	r_m individual/female	λ individuals/female	D_t days
Atlas	42	10.94	40.01	26.17	0.664	1.942	1.308
Spunta	47	8.69	29.87	28.82	0.450	1.568	1.930
Simone	43	9.17	27.23	24.93	0.474	1.606	1.832
Nicola	52	4.79	16.33	29.85	0.237	1.267	3.665

d- Population doubling time (D_t)

The population of potato tuber moth doubled once every 1.31, 1.83, 1.93 & 3.66 days when larvae were feed on Atlas, Simone, Spunta and Nicola tubers, respectively.

It appears from the data in Table (6) that Atlas is the most preferred variety for potato tuber moth rearing because its population was doubled in the shortest time.

In general, the calculated biological parameters viz. R_0, G_t, r_m, λ & D_t indicate that Atlas proved to be the most favorable variety for achieving the highest developmental and reproduction rates for *Ph. operculella*, followed by Simone and Spunta. Meanwhile Nicola was the least favorable potato variety which is considered as the most tolerant variety for infestation with *Ph. operculella*. Abdel-Wahab *et al.* (1987) mentioned that generation time of *Ph. operculella* was 27.94 & 78.7 days during summer and winter, respectively. El-Saadany *et al.* (1998) also found that the generation time for this pest when reared at 30°C was 22.34 days.

e- Natural mortality analysis

When the values of different types of natural mortality namely, apparent mortality (AM), real mortality (RM), indispensable mortality (IM), mortality-survivor ratio (MSR), log population and *k* value were estimated. Atlas variety proved to be the most preferred variety based on number of deposited eggs in one generation revealing its strong suitability for feeding. Mortality parameters are shown in Table (7). Similar trends were observed when the natural mortality in larvae and pupae expressed by mortality index. Hence Atlas variety again proved to be highly preferred for feeding and accordingly harbored the lowest percentages of natural mortality figures (Table, 7). The respective values on Simone, Spunta and Nicola varieties are given in Tables (8-10).

For *Ph. operculella* pupae natural mortality trend AM, RM, IM, Log pop and *K* when fed as larvae on the four varieties are also are also given in Tables (7-10).

Table 7: Changes in natural mortality of the developmental stages of potato tuber moth when larvae were fed on tubers of Atlas variety

	Developmental stage							
Age class	**Egg**		**Larvae**		**Pupae**		**Adults**	
x	(0-3)		(4-15)		(16-21)		(22-42)	
l_x	400		344		200		124	
d_x		56		144		76		
A.M.%	14		41.86		38			
R.M.%	14		36.00		19			
I.M.%	5.04		22.32		19			
M.S.R.%	1		4.42		3.77			
Log population	2.60		2.54		2.30		2.09	
***k*- value**		0.06		0.24		0.21		

Numbers between parentheses represent the range of duration in days

Table 8: Changes in natural mortality of the developmental stages of potato tuber moth when larvae were fed on tubers of Simone variety

	Developmental stage							
Age class	**Egg**		**Larvae**		**Pupae**		**Adults**	
x	(0-3)		(4-14)		(15-19)		(20-43)	
l_x	400		304		204		112	
d_x		96		100		92		
A.M.%	24		32.89		45.10			
R.M.%	24		25		23			
I.M.%	8.84		13.72		23			
M.S.R.%	1		1.55		2.6			
Log population	2.60		2.48		2.31		2.05	
***k*-value**		0.12		0.17		0.26		

Numbers between parentheses represent the range of duration in days

Table 9: Changes in natural mortality of the developmental stages of potato tuber moth when larvae were fed on tubers of Spunta variety

	Developmental stage			
Age class	**Egg**	**Larvae**	**Pupae**	**Adults**
x	(0-3)	(4-17)	(18-24)	(25-47)
l_x	400	320	180	112
d_x	80	140	68	
A.M.%	20	43.75	37.78	
R.M.%	20	35	17	
I.M.%	7	21.77	17	
M.S.R.%	1	3.11	2.43	
Log population	2.60	2.50	2.25	2.05
***k*-value**	0.1	0.25	0.2	

Numbers between parentheses represent the range of duration in days

Table 10: Changes in natural mortality of the developmental stages of potato tuber moth when larvae were fed on tubers of Nicola variety

	Developmental stage			
Age class	**Egg**	**Larvae**	**Pupae**	**Adults**
x	(0-3)	(4-18)	(19-25)	(26-52)
l_x	400	336	164	84
d_x	64	172	80	
A.M.%	16	51.19	48.78	
R.M.%	16	43	20	
I.M.%	4	22.02	20	
M.S.R.%	1	5.51	5	
Log population	2.60	2.53	2.21	1.92
***k*-value**	0.07	0.32	0.29	

Numbers between parentheses represent the range of duration in days

The previously obtained results indicate that Nicola seems to be the least susceptible variety for infestation by *Ph. operculella* followed by Spunta and Simone. In contrast Atlas proved to be the most favorable variety. Many investigators studied the effect of variety on natural mortality and age structure data figures from which Ibrahim (2000) in Egypt revealed that larval stage exhibited the highest mortality rate at 25-30°C while this rate for egg stage was at 35°C. Gurr & Symington (1998) found that pickling the tuber surface immediately prior to inoculation with *Ph. operculella* had lead to significant increase in neonate survival. They explained that tuber periderm may constitute a significant barrier to invasion. Golizadeh & Razmjou (2010) mentioned that the lowest r_m value indicates that a certain variety of potato is insusceptible compared to other cultivars (in this research is Nicola). Again, Horgan *et al.* (2010) reported that resistance against *Ph. operculella* in wild potato varieties was generally concentrated in tuber periderm or cortex-based. Unidentified cortex-based resistance factors in the varieties they studied reduced survival and increased larval and pupal developmental times. Von-Arx *et al.* (1987); Das *et al.* (1993); Debnath *et al*. (2000); Stein & Vendramim (2000); Lopez & Vendramim (2001) and Al-Omairy (2012) reached almost the same results.

REFRENCES

Abdel-Wahab, M. A.; F. A. Abdel-Galil; K. K. Mohamed and M. M. Soliman (1987). Some biological aspects of the potato tuber worm, *Ph. operculella* in Egypt. Assuit J. Agric. Sci., 18 (3): 363-365.

Al-Omairy, Kh. O. (2012). Laboratory study of life tables of potato tuber moth, *Phthorimaea operculella* (Zeller) under constant temperature. The 11th Conf. Agric. Dev. Res., Cairo, Egypt, 27-30 March, pp 162. (Abstract)

Al-Taweel, A. A.; N. S. Zeyab and M. K. El-Jaborry (2006). Reaction of some potato varieties to infestation by potato tuber moth, *Phthorimaea operculella* (Zeller). Arab J. Pl. Prot., 24: 53-55. (Arabic Language)

Anderwartha, H. G. and L. C. Birch (1984). The distribution and abundance of animals, 298-308. Univ. of Chicago and London.

Chandel; R. S.; K. Rajnish and N. P. Kashyab (2001). Bioecology of potato tube moth, *Phthorimaea operculella* Zeller in mid hills of Himachal Pradesh (2001). J. Ent. Res., 25 (3): 195-203.

Das, G. P.; E. D. Magallona; K. V. Raman and C. B. Adalla (1993). Growth and development of the potato tuber moth, *Phthorimaea operculella* (Zeller), on resistant and susceptible potato genotypes in storage. Philippine Entomol.; 9(1): 15-27.

Douches, D.; W. Pet; D. Visser, J. Coombs; Kelly Zakra; Kimberly Flecher; G. Bothma; J. Brink; M. Koch and H. Quemada (2010). Field and storage evaluations of 'SpuntaG2' for resistance to potato tuber moth and agronomic performance. J. Amer. Soc. Hort. Sci., 135: 333-340.

Debnath, M. C.; J. N. Khaund; B. K. Borah and P. C. Sarmah (2000). The reaction of host plants on the biology of potato tuber moth, *Phthorimaea operculella* (Zeller). Res. on Crops. Gaurav Soc. Agric. Res. Information Centre, Hisar, India: 1(2): 196-200.

El-Saadany, G. B.; F. M. Mariy; F. M. Daoud and M. Y. Ibrahim (1998). Life table studies on potato tuber moth, *Ph. operculella*. Zagazig H. Agric. Res., 25 (4): 649-657.

Fenemore, P. G. (1980). Susceptibility of potato cultivars to potato tuber moth, *Phthorimaea operculella* Zell. (Lepidoptea:Gelechiidae). N. Z. J. Agric. Res., 23: 539-546.

Ghazala, E. M. A. (2005). Studies on potato tuber moth *Phthorimaea operculella* (Zeller). M. Sc. Thesis, Fac. Agric. Alex. Univ., 145 pp.

Golizadeh, A. and J. Razmjou (2010). Life table parameters of *Phthorimaea operculella* (Lepidoptera:Gelechiidae), feeding on tubers of six potato cultivars. J. Econ. Ent., 103 (3): 996-972.

Gurr, G. M. and C. A. Symington (1998). Resistance to the potato tuber moth, *Phthorimaea operculella* (Zeller) (Lepidoptea:Gelechiidae), in potato (*Solanum tuberosum* spp. *tuberosum tuberosum* L.) tubers. Australian J. Ent., 37(1): 49-51.

Horgan, F. G.; D. T. Quiring; A. Lagnaoui; A. R. Salas and Y. Pelletier (2010). Variations in resistance against *Phthorimaea operculella* in wild potato tubers. Entomol. Exp. Appli., 371 (3): 269-279.

Ibrahim, M. Y. (2000). Further ecological and biological studies on some potato pests in Egypt. Ph. D. Thesis, Fac. Agric., Ain Shams Univ., pp 236.

Khattab, M. M.; A. N. Fayad and R. H. G. Mikhael (1995). Relative susceptibility of potato varieties to infestation with insect pests. Annals Agric. Sci. Moshtohor, 33 (4): 1539-1552.

Lopes, M. T. and J. D. Vendramim (2001). Resistance of potato genotypes to the potato tuber moth *Phthorimaea operculella* (Zeller). [Portuguese]. Sci. Agric. Univ. Sao Paulo, Escola Superior Agric. "Luiz de Queiroz" Piracicaba, Brazil; 58 (2): 235-239.

Randon, Silvia I. (2010). The potato tuber worm: A literature review of its biology, ecology and control. Am. J. Pot. Res., 87: 149-166.

Sileshi, G. and J. Teriessa (2001). Tuber damage by potato tuber moth, *Phthorimaea operculella* Zeller (Lepidoptera: Gelechiidae) in the field in Eastern Ethiopia. Internat. J. Pest Manag., 47 (2): 109-113.

Stein, C. P. and J. D. Vendramim (2000). Antibiosis of potato clones to *Phthorimaea operculella* (Zeller) (Lepidoptera: Gelechiidae). Anal. Soc. Entomol. Brazil; 29(4): 783-788.

Tiwari, D. B.; R. B. Thapa; S. M. Shrestha and S. L. Joshi (2006). Field survey and monitoring of potato tuber moth, *Phthorimaea operculella* (Zeller) (Lepidoptera: Gelechiidae). J. Inst. Agric. Anim. Sci., 27: 157-160.

Trivedi, T. P.; D. Rajagopal and P. L. Tandon (1994). Life table for establishment of potato tuber moth, *Ph. operculella*. J. Indian Potato Assoc., 12 (1-2): 97-105.

Von-Arx, R.; J. Goueder; M. Cheikh and T. A. Ben (1987). Integrated control of potato tuber moth *Phthorimaea operculella* (Zeller). Insect Sci. Appl. 8: 989-994.

ARABIC SUMMARY

معايير جداول الحياة كدليل لحساسية أصناف البطاطس للإصابة بفراشة درنات البطاطس *Phthorimaea operculella* (Zeller)

يوسف عزالدين يوسف عبد الله - محمد سالم عبد الواحد - غسان علي يوسف
قسم وقاية النبات – كلية الزراعة – جامعة عين شمس– شبرا الخيمة– القاهرة– مصر

أجريت تجربة معملية لدراسة جداول الحياة لفراشة درنات البطاطس *Phthorimaea operculella* (Zeller) علي أربعة أصناف من البطاطس هي أطلس، سبونتا، سيموني ونيقولا لتقييم مدي حساسية هذه الأصناف عند تغذية يرقات الحشرة عليها.

أظهرت النتائج أنه عند حساب معدلات البقاء والخصوبة ومعايير جداول الحياة (معدل الزيادة الطبيعي، معدلي الزيادة الاولي والنهائي، مدة الجيل ومعدل التضاعف) أن الصنف أطلس هو الأكثر تفضيلا لفراشة درنات البطاطس يليه الأصناف سيموني وسبونتا بينما كان الصنف نيقولا هو الأقل تفضيلا لتغذية يرقات هذه الحشرة. عند حساب معدلات الموت الطبيعي كانت أعلى قيم النسب المئوية للموت الطبيعي 51,19 ، 43,00 ، 22,62 ، 5,51 ، 0,07% لكل من النسبة المئوية للموت الظاهري، الموت الحقيقي، الموت الجوهري، معدل الموت/البقاء وقيمة ك على التوالي عند التربية على الصنف نيقولا. بينما كانت أقل قيم لنسب الموت هي 32,89 ، 25,00، 13,77، 1,55، 0,12على التوالي عند التغذية على الصنف سيموني مما يؤكد أن الصنف نيكولا أقل الأصناف قابلية للإصابة بفراشة درنات البطاطس خاصة تحت ظروف التخزين الطبيعية، بينما كان الصنف أطلس هو الأفضل لتربية الحشرات عليه للأغراض البحثية.