American-Eurasian Journal of Scientific Research 1 (1): 18-22, 2006
ISSN 1818-6785

Evaluation of the Insecticidal Effect of Pumpkin *Cucurbita pepo* Against Potato Tubermoth *Phthorimaea operculella* (Zeller) Combined with Gamma Irradiation

N.H. El-Sinary

National Center For Radiation Research And Technology (NCRRT),
P.O. Box 29, Nasr City, Cairo, Egypt

Abstract: Pumpkin leaves and seeds oil were evaluated for the potency to control the damage caused by potato tuber moth *Phthoimaea operculella* to potato tubers during storage. Three different preparations; Pumpkin leaves and seeds oil were evaluated for the potency to control the damage caused by potato tubermoth *Phthorimaea operculella* to potato tubers during storage. The different preparations of pumpkin were tested against PTM larvae and adults; fresh green leaves, minced dried leaves and oil- water suspension (1: 10). Combined effect between pmpkin and gamma- irradiation (20 and 40 GY) was studied against PTM newly hatched larvae and results indicated that fresh leaves of pumpkin gained the best results as it scored no infestation, pupation, emergence percentages, when potato tubers were covered with it. Fecundity, fertility, oviposition deterrence indices ODI and sterility were calculated after treatment of strips by the three different preparations of pumpkin. Fresh leaves treatments recorded 0.00 fecundity so PTM couldn't complete its life cycle. Oil-water suspension gave better, results than minced dried leaves; 23.5, 31.6%, 57.57 and 92.11% for fecundity, fertility, ODI and sterility %, respectively. Fresh leaves of pumpkin scored the higher percentage of larval mortality and gave 100% reduction in F1 progeny followed by oil-water suspension which recorded 81.55% while minced dried leaves registered 47.98% reduction in F1 progeny of the potato tubermoth.

Key words: *Phthorimaea operculella* · *Cucurbita pepo* · gamma irradiation

INTRODUCTION

Potatoes are the fifth most economically important crop in the world. Egypt produces 2.6 million metric tons of potatoes and exports 411.000 metric tons to Europe and the Arab countries. However, the potato tnber moth, *Phthorimaea operculella* (Zeller) (Lepidoptera: Gelechiidae) is a serious pest of potatoes both in the field and storage; the potato tubermoth (PTM) causes serious damage to potato plant leaves and to tubers either in field or in storage, also it attacks in addition to potatoes many of solanaceous crops either in fields or in stores [1]. PTM has been controlled by insecticides, which were applied repeatedly in order to achieve good control results. Actually, such a control method is costly, non-selective and environmentally unsafe. Moreover, the risk of the development of insecticide resistance is increased [2].

Therefore, there is an urgent need for safe but effective, biodegradable pesticides with no toxic effects on non- target organisms. This has created a world wide interest in the development of alternative strategies including the search for new types of insecticides. In recent years, there has been an increased interest in natural plant derived materials as alternative pesticides to convention, broad spectrum toxicants. Many plant extracts have a wide range of effects against pests, including repellence, feeding, oviposition deterrence, sterility and growth regularity activity [3-7]. The ability of some plants to control the potato tubermth, *Phthorimaea operculella* (Zeller) on potato tubers at storage, in the form of repellents or insecticides has been described and discussed by many authors [8-10].

Gamma radiation also seems to be effective and safe in addition to that it is cheep besides being cheap. The application of gamma irradiation to reduce the damage of PTM was carried out by Rananavare *et al*. [11], Haiba [12], El-Sinary [13] and Hemeida [14]

The present study was designed to investigate the insecticidal effect of three preparations of pumpkin, *Cucurbita pepo*; fresh leaves, minced dried leaves and seeds oil on some biological aspects of *P. operculella*. The study also determined pumpkin influence on oviposition deterrent indices and sterility of PTM adults.

Corresponding Author: Dr. N.H. El-Sinary, National Center For Radiation Research And Technology (NCRRT), P.O. Box 29, Nasr City, Cairo, Egypt

Pumpkin toxicity was determined and the reduction in F1 progeny of PTM was computed.

MATERIALS AND METHODS

Rearing technique: The potato tubermoth, *P. operculella* (PTM) were reared mainly on the potato tubers in the laboratory of Entomology, in the National Center for Radiation Research and Technology. Potato tubers were cleaned from dust and parasites by washing and drying with clean towels or tissue papers [13]. A thin layer of cleaned sand (exposed to high temperature in oven to kill other insects or parasites was distributed on the bottom of the rearing cages to allow pupation [14]. The exact duration of PTM is from 21 to 25 days under laboratory conditions (27+2ºC and 60+5 R.H.) [10].

Preparation of plant: Pumpkin (*Cucurbita pepo*, Fam: Cucurbitacae) leaves were collected by agricultural workers from many farms for different preparations. Leaves were cleaned and dried with clean towels and used as fresh leaves or for dry treatment cleaned leaves were dried at the room temperature till complete dryness so were minced well by using electric machine to test the effect of sprayed powder of pumpkin leaves on PTM viability. For oil treatment seeds were squeezed by a local drug store [15].

Different experiments to evaluate the insecticidal effect of pumpkin on PTM:

Biological effects of different preparations of pumpkin on newly hatched larvae of PTM combined with gamma-irradiation: Potato tubers were treated with the different preparations of pumpkin. Fifteen newly hatched larvae of PTM (non- irradiated or irradiated with 20 and 40 Gy) were introduced to each cage which contained 500 g of potato tubers (each cage was about 3 l capacity). Cages were marked daily to investigate; percentage of infestation, pupation and emergence. Sex ratio was also determined. Each treatment was triplicated. Irradiation technique was carried out at Gamma Celll Unit 220 at the National Center for Radiation Research and Technology, Atomic Energy Authority, Nasr City, Cairo, Egypt.

Effect of different preparations of pumpkin on fecundity, fertility, ODI and sterility of PTM: Newly emerged adults were sexed and allowed to mate in glass jars of one liter capacity at the ratio of 10:10 (female: male). Each jar was supplied with two strips of tissue paper one of them was painted with pumpkin treatments and the others were painted with distilled water and used as control. Treated strips were; fresh leaves stucked on strips; aqueous solution of dried minced leaves 1: 10 (pumpkin: water) and pumpkin oil suspension 1: 10 (pumpkin seeds oil: water). Strips were lift till dryness and introduced to the jars [10, 15].

The number of eggs deposited on treated or untreated strips were counted and hatchability percentages were calculated. The results obtained were expressed in terms of : Oviposition Deterrent Indices (ODI) as defined:

$$ODI=\frac{B-A}{B+A}\times 100$$

by Lundergen [16] to provide a convenient indication of activity on a scale of zero to 100.

A and B were number of eggs laid on the treated and untreated strips, respectively. Sterility percentage was calculated;

$$\% \text{ Sterility} = 100-\frac{a-b}{A\times B}\times 100 \text{ as}$$

a = Nmber of eggs / female in treatment
b = % hatchability in treatment.
A = Nmber of egg/female in untreated control.
B = % hatchability in untreated control by Guuirgus [17].
Each treatment was triplicated.

Toxicity test and reduction in F1 progeny: The three different preparations of pumpkin (green fresh leave, minced dried leave powder and oil- water emulsion) were tested on their efficiency against neonate larvae of *P.operculella* fifteen newly hatched larvae were introduced into jar (1 liter) contained slides of treated or untreated potato tubers. All treatments were triplicated. Mortalities were recorded after 24, 48, 72 and 96 h form the beginning of treatment mortality were corrected by Abbot [18]. Larvae were transferred to other cages with untreated potato tubers to calculate the successive following generation. F1 progeny was investigated after 20 days from the treatments and percentage of reduction in F1 progeny were calculated according to the following equation which determined the toxicity of plants according to El-Lakwah *et al*. [19].

$$\text{Reduction in F1 Progeny} = \frac{\text{No. of adultsemergedin control-}}{\text{No. of adultesmergedin treatment}}{\text{No. of adultsemergedin control}}$$

Statistical analysis: The obtained data were statistically analyzed and the values of LSD were determined, wherever, the calculated "F" values were significant at 5 and 1% level [20].

RESULTS AND DISCUSSION

Different biological aspects; infestation, pupation, emergence and sex ratio percentages were determined (Table 1). Potato tubers were treated with the three different preparations of pumpkin plant and infested with irradiated (20 and 40 Gy) and unirradiated newly hatched larvae of *P.operculella*. The results obtained indicated that the treatment with fresh leaves of pumpkin was the highly effective preparation in which neonate larvae scored 0.0% infestation for covered potato tubers with that fresh leaves, while control. Minced dried leaves and oil suspension were scored 100.0, 25.0 and 25.0%, respectively.

Larvae irradiated with 20 and 40 Gy scored less infestation percentage than unirradiated one whether potato tubers were treated or untreated with pumpkin. Minced dried leaves and oil: water suspensions gave nearly same results with infestation percentage. Pupation percentages were highly decreased with oil suspension followed by dried leaves; 33.33 and 44.44%, respectively as compared with 88.89 in control. Irradiation significantly reduced the pupation percentages in both treated untreated investigations. Irradiation with 40 Gy gave no pupated larvae in all treatment to while it scored 15.56% pupation in control.

The drastically decrease was observed in emergence percentages; 26.67, 20.00% with dried leaves and oil suspension as compared with 86.67% in control. Dose 40 Gy scored 11.11% emergence percentage with untreated treatments while it gave 0.00 with other treatments.

It was obvious that males ratio was higher than females ratio in all treatment especially with oil suspension and irradiated treatments and that indicated that males were more tolerant than females. The important role played by larvae irradiation with 20 and 40 by was agreed with [13] findings that gamma irradiation reduced the viability of PTM larvae. Fresh leaves of pumpkin repellent and insecticidal effects authenticated the wisdom of planting pumpkin to cover prophet Jonah after his exit from the whale. This is in agreement with some explanations of Islamic scientists and scientists cared with folk medicine as explained by many of them at sites; [21] islam.com.

Table 2 screened efficacy of different pumpkin preparations on fecundity, fertility percentage, ODI and sterility percentage caused to PTM adults when treated strips were offered to ten pairs of each sex in tested cages with untreated strips as untreated control. When fresh leaves were stucked on strips females adults laid no eggs so fecundity was 0.00, so ODI and sterility % registered 100%. Oil suspension followed fresh leaves in its effect as it scored 23.5, 31.6%, 57.57 and 92.11% for fecundity, fertility percentage, ODI and sterility percentage, respectively. Dried leaves aqueous solution gave less effective results to minimize the hazards of PTM as compared with the other preparations of pumpkin.

It gained 44.67 for fecundity, 58.39% for fertility, 38.36 for ODI and70.79% sterility as compared with 118.67, 98.03%, 0.00 and 100% in untreated control, respectively. From the previous investigation we can conclude that the highest the ODI and sterility percentage the more effective and could be applied as safe and effective preparation. This is in agreement with [16, 22 and 15].

Mortalities caused to *P.operculella* neonate larvae and the reduction in F1 progeny of PTM was showed in (Table 3). The average larval mortalities was recorded in different periods (in hours) after 24, 48, 72 and 96 h from the beginning of treatment. Fresh leaves recorded the

Table 1: Combined effect of gamma- irradiation and different pumpkin preparations on some biological aspects of PTM neonate larvae

	Biological aspects														
Irradiation dose (Gy)	(%) Infestation			(%) Pupation			(%) Emergence			Sex ratio (%) ♂			Sex ratio (%) ♀		
Treatment	0	20	40	0	20	40	0	20	40	0	20	40	0	20	40
0	100.00	50.00	25.0	88.89	48.89	15.56	86.67	15.56	11.11	51.28	57.14	60.00	48.72	42.86	40.00
Fresh leaves	0.00	0.00	0.00	-	-	-	-	-	-	-	-	-	-	-	-
Minced dried leaves	25.00	25.00	0.00	44.44	31.11	-	26.67	17.78	-	58.33	62.50	-	41.67	37.50	-
Oil: water suspension (1:10)	25.00	20.00	0.00	33.33	26.67	-	20.00	13.33	-	66.67	66.67	-	33.33	33.33	-
LSD 0.05	12.40			11.30			6.80			7.20			3.40		
0.01	16.80			15.60			9.50			9.10			6.00		

Table 2: Effect of pumpkin different preparations on fecundity, fertility, ODI and sterility percentage of PTM adults

	Biological aspects			
Treatments	Fecundity (egg/female)	Fertility (Hatchability%)	ODI sterility (%)	Sterility (%)
Fresh leaves	0.00	-	100.00	100.00
Minced dried leaves aqueous solution (1:10)	44.67	58.39	38.36	70.79
Oil : water suspension (1:10)	23.50	31.60	57.57	92.11
Control	118.67	98.03	0.00	0.00
L.S.D 0.05	13.40	9.10		
0.01	18.50	11.60		

Table 3: Insecticidal effect of pumpkin different preparations against neonate larvae of PTM and the reduction in F1 progeny percentage

	Time (h)									
	24		48		72		96		Av. number	Reduction
	(%) Average	Corrected	(%) Average	Corrected	(%) Average	Corrected	(%) Average	Corrected	of emerged	in F1
Treatment	mortality	mortality	mortality	mortality	mortality	mortality	mortality	mortality	adults after 20 days	progeny (%)
Fresh leaves	15.56	15.56	26.67	23.26	51.1	47.62	73.33	70.73		
Minced dried leaves	6.67	6.67	11.11	6.98	15.56	9.53	28.88	21.94	0.00	100.00%
Oil: water suspension (1:10)	13.33	13.33	24.44	20.93	40.00	34.88	75.56	73.16	50.67	47.98
Control	0.00		4.44		6.67		8.89		18.33	81.55
L.S.D 0.05	4.80		6.20		8.70		16.00		99.33	0.00
0.01	7.30		10.30		11.90		19.10		14.20	8.90
									17.40	13.20

highest mortality percentage; 73.33% after 96 hrs from treatment followed by oil water suspension treatment which scored 28.88% and the lowest percentage was registered with minced dried leaves treatment compared with 8.89% in untreated control. No adults were emerged with fresh leaves treatments so the reduction in F1 progeny was 100%. Minced dried leaves and oil water suspension treatments recorded 50.67 and 18.33 average number of emerged adults and 47.98 and 81.55% reduction in F1 progeny average number of adults and 0.00% reduction in F1 progeny in untreated control. These results were in harmony with findings carried out by many authors [7, 15, 19, 23].

It could be concluded that coverage of potato tubers by fresh leaves of pumpkin actually reduce the attack of the potato tubermoth *P.operculella* because of its repellent, oviposition deterrent, insecticidal effect on larvae and adults of PTM. Dried leaves have less effective influence on PTM larvae and adults and that may related to volatile substances which decreased when leaves was dried. Oil-water suspension gave good influence to minimize the viability of PTM. It could be applied by spraying it on the potato tubers during storage because of its insecticidal influence on PTM larvae and adults and may be for that idiosyncrasy, modern folk healers avocado pumpkin seeds to rid the intestinal worms and to expel parasites, so the pumpkin oil insecticidal and repellency effect may be successfully used beside fresh leaves to give the best results.

REFERENCES

1. El-Sinary, N.H., 2002. Influence of the entomopathogenic fungus, *Beauveria bassiana* (Balsmo) on the mature larvae of the potato tubermoth, *phthorimaea operculella* (Zeller) under different degrees of temperature and relative humidity. J. Agric. Sci. Mansoura Univ., 27: 4155-4165.
2. Saour, G. and H. Makee, 1997. Radiation induced sterility in male potato tubermoth *phthorimaea operculella* zeller (Lep., Gelechiidae). J. Appl. Ent., 121: 411-415.
3. Jacobson, M., 1989. Focus on phytochemical pesticides. Vol. 1: The neem tree CRC, Boca Raton. Fl. pp: 178.

4. Schmutterer, H., 1990. Properties and potential of natural pesticides from the neem tree. *Azadirachta indica*. Ann. Rev. Entomol., 35: 371- 97.
5. Schmutterer, H., 1995. The neem tree *Azadirachta indica* A. Juss. And other malicious plants: Sources of unique natural products for integrated pest management, medicine, industry and other purposes. VCH, Weinheim, federal Republic of Germany, pp: 195-204.
6. Ascher, K.R.S., 1993. Nonconventional insecticidal effects of pesticides available from the neem tree. *Azadirachta indica*. Arch. Insect. Biochem. Physiol., 22: 433-449.
7. Wang, J., F. Zhu, X.M. Zhou, G.Y. Niu and C.L. Lei, 2006. Repellent and fumigant activity of essential oil from *Artemisia vulgaris to tribolium castaneum* (Herbst) (Coleoptera: Tenebrionidae). J. Stored Products Res., 3: 339-347.
8. Doss, S.A., R.E. Bedewy and A.N. Fayad, 1994. Control of potato tubermoth, *phthorimaea operculella* (Zeller) in potato stores in Egypt. J. Agic. Sci., Mansoura Univ., 19: 2759-2768.
9. El-Sinary, N.H. and S.A. Rizk, 2001. Insecticidal and biological effects of neem extract against different development of stages of the potato tnbermoth *phthorimaea operculella* (Zeller). J. Egypt. Ger. Soc. Zool., 34: 41-52.
10. El-Sinary, N.H. and S.A. Rizk, 2002. Oviposition deterrence and other biological influences of aqueous leaves extract of neem, colocasia and their mixtures alone or combined with gamma radiation to reduce the risk of the potato tubermoth. *Phthorimaea operculella* (Zeller). Pak. J. Biol. Sci., 5: 911-914.
11. Rananavare, H.D., M.R. Harwalkar and G.W. Rahalkar, 1990. Studies on the mating behavior of radio sterilized males of potato tnbermoth, *Phthorimaea operculella* (Zeller). J. Nuc. Agric. Biol., 19: 47-53.
12. Haiba, I.M., 1990. Gamma-irradiation effect on the potato tubermoth, *phthorimaea operculella* (Zeller). Ph.D. Thesis, Fac., Sci. Cairo. Univ., Egypt, pp: 230.
13. El-Sinary, N.H., 1995. Magnitude and applicability of gamma-irradiation and controlling atmospheres to minimize the hazards to potato tubermoth, *phthorimaea operculella* (Zeller). Ph. D. thesis Fac. Agric. Cairo Univ., Egypt, pp: 187.
14. Hemeida, E.A., 1976. Biological and physiological studies on *phthorimaea operculella* (Zeller) (Lepidoptera : Gelechiidae) M.Sc. Thesis, Ain Shams Univ., Egypt, pp: 104.
15. El-Sinary, N.H. and M.N. Orabi, 2005. Toxicity effect, oviposition deterrence and other biological effects of oil extracted from three strains of Sinai plants combined with gamma irradiation against the potato tubermoth. *Phthorimaea operculella* (Zeller). Al-Azhar Agric. Res., pp: 133-143.
16. Lundgren, L., 1975. Natural plant chemicals acting as oviposition deterrents on cabbage butter flies (*Pieris brassicae* L.), *P. rapae* L. and *P. nape* (L.) Zool. Sci., 4: 253-258.
17. Guuirguis, A.A., 1979. The use of some physical and chemical mutagens for the induction of sterility in *Spodoptera littoralis* (Boid). M. Sc. Thesis. Fac. Agric, Zagazig Uni., Egypt.
18. Abbott, W.S., 1925. A method of computing the effectiveness of an insecticides. J. Econ. Entomol., 18: 265-267.
19. El- Lakwah, F.A., Z.A. Halawa and A.M. Abdel- latif, 1997. Effect of the extracts of *withania somnifera* leaves and fruits on some stored products insects. Ann. Agric. Sci. Moshtohor, 35: 537-552.
20. Snedecor, G.W. and W.G. Cochran, 1980. Statistical methods. 7th Edn., Iowa State Univ. Press, Ames. IOWA USA., pp: 225-269.
21. Sites: www.Science4islam.com. www.Sciences lead to islam.com. www.motherearthnews.com
22. Hossain, S.M.Z., G.P. Das and M.Z. Alam, 1994. Use of various indigenous materials and insecticides in controlling potato tubermoth in storage. Bulletin of the Institute of Tropical Agriculture Kyushu University, 17: 79-84.
23. Don-Pedro, K.M., 1989. Mechanism of action of some vegetable oils against *Sitophilus zeamais* Motsch (Coleoptera: curculionidae) on wheat. J. Stored Prod. Res., 25: 217-223.