EFFICACY OF SOME PLANT POWDERS AND ESSENTIAL OILS AGAINST POTATO TUBER MOTH, *PHTHORIMAEA OPERCULELLA* (ZELLER) (LEPIDOPTERA: GELECHIIDAE) IN POTATO STORE

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Abstrac

Laboratory experiment carried out to protect potato tubers from the potato tuber moth (PTM) infestation during storage. At the length of evaluation the effectiveness of four plant oils: orange oil, Colocynth oil, Marjoram oil and chilli oil & four plant powder: Ginger, Cinnamon, Thyme and Rosemary and an insecticide Match 5% SC (Lufenuron) against *P. operculella*. The inspection focused on certain biological aspects such as larval penetration, pupation and adult emergence. The results indicated that, the selected oils were arranged descending based on larval penetrations as following: Marjoram oil < chilli oil < orange oil < Colocynth oil, while the selected powdered as Ginger < Cinnamon <Thyme < Rosemary. On the other hand, plant powder of Ginger and Cinnamon did not caused emerged moth at conc. 3 %. While Marjoram oil at conc.10 ml/ L recorded the highest efficiency against larval penetration %, pupation % and moth emergence %, being 7.7, 2.3 and 1.6%. Also the insecticide of Lufenuron caused the reduction in larval penetration, pupation and adult emergence; as the percentage 10.8%, 7.8% and 6.3%, respectively. Generally, the present study indicated that, could be protect the potato tuber during marketing or storage period by using safe natural material, such as Marjoram oil and Ginger & Cinnamon powder against larval penetration, pupation and emergence moth.

INTRODUCTION

Potato (*Solanum tuberosum* L.) considerd an important vegetable crop in Egypt, is seriously infested by the potato tuber moth, *Phthorimaea operculella* (Zeller) (Lepidoptera: Gelechiidae) in the field and in storages (Abd El-Wahab *et al.* 2003& and Moawad and Ebadah 2007. The larvae are the harmful stage. Heavy infestations take place when potatoes are kept in storages, where the adult moth lays its eggs on the tubers (Dawood *et al*. 1999).

Harmful effects of insecticides paied us to seek and use other safe means such as medicinal plant products for pest control. Medicinal plant products were effective for insect control in stored potato (Gomaa, 2002). Promising results against stored product pests with plant extracts and oils as pest control agents were reported by several investigators (Shemais and Al-Moajel 2000, Eid 2001and Fatoh 2003). Essential oils (EOs) are volatile and natural compounds characterized by a strong odor are formed as plant secondary metabolites by plants belonging to botanical families,

as Myrtaceae, Lauraceae, Lamiaceae and Asteraceae. Their compounds have functions in chemical defense, acting as repellents, insecticides, acaricides, and by attracting natural enemies of herbivores (Karamanoli, 2002; Karamanoli *et al.,* 2005; Bakkali *et al.,* 2008).

The present study aims, to evaluate the effectiveness of the four plant oils namely colocynth; marjoram; orange and chilli oils & four plant powders ginger; cinnamon; thyme and rosemary and an insecticide Match 5% Sc (Lufenuron) against *P. operculella* under the laboratory conditions. Where the inspection focused on larval penetration healthy, pupation and adult emergency.

MATERIALS AND METHODS

Stock culture and rearing conditions:

The stock culture of *Phthorimaea operculella* (Zeller) was reared on Sponta Cultivar of potato tubers in cages, (potato tubers were cleaned from dust and parasites by washing and drying with clean tissue papers). The front and back walls of the cage were covered with fine wire gauze, and the top of each cage was a plate glass.

Infested potato tubers were placed in the breeding cages and after the emergence of moths; fresh tubers were placed for oviposition. The moths were fed on cotton soaked with 10% sugar solution for oviposition. After pupation, the pupae were carefully collected, to be used for starting the experimental cultures. The culture was maintained under laboratory conditions at 26 ± 2 ºc and 70 ± 5 % R.H. The following materials were used: four plant oils and four plant powders in addition to an insecticide Match 5% Sc (Lufenuron).

In respect to plant oils were: Colocynth oil (*Citrullus colocynthis*) Fam.: cucurbitaceae; Marjoram (*Majorana hortensis*) Fam.: Labiatae ; Orange oil (*Citrus sinenis*) Fam.: Rutaceae and Chilli oil (*Capsicum annuum l.*) Fam.: Solanaceae , were purchased from El Captain Company (Cap pharm) for extracting oils, natural plants and cosmetics. Preparing serial concentrations of above mention plant oils were prepared by diluting 10 ml, 5 ml and 2.5 ml in one liter of water.

While the plant powders were: Ginger (*Zingiber officinale*) Fam.: Zingiberaceae; Cinnamon (*Cinnamomum Zeylanicum*) Fam.: Lauraceae; Thyme (*Thymus vulgaris*) Fam.: Lamiaceae and Rosemary (*Rosmarinus officinailis*) Fam.: Lamiaceae, were purchased from the market.

The needed parts were washed distal water, dried in shade and then ground well in an electric mill into powders.

A concentration containing 3% of the plant powder was prepared by mixing 3 g of the tested plant powder with 97 g of (Sawdust soft), as carrier material. The sieved

powder was used in the test. Potato tubers were covered with three concentrations (3%, 2% and 1%) of the plant powder to study its effect on *P. operculella* moths.

-**Insecticide**: Match 5% Sc (Lufenuron) applicated at rate 0.8 ml in one liter water.

Bioassay test:

The efficacy of the previously mentioned materials were evaluated against *P. operculella* as follows:

Potato tubers were treated with serial concentrations of the different plant oils, plant powders and Match in cages. Three replicates were used for each concentration (Each replicate was 5 kg of potato tubers). Each replicate of the treated potato tubers and untreated potato tubers (control treatment) were infested in with two virgin pairs of one-day age adults (2 males & 2 females). Experiments were carried out at 28±2◦C and 65±5% R.H. Then the numbers of larval penetration healthy, pupae and emerged moths were recorded.

The mortality was corrected using Abbott's formula (1925). Duncan's (1955) range test were adopted to variation between treatments.

RESULTS AND DISCUSSION

Results demonstrate the effectiveness of the tested concentrations, of the tested materials against *P. operculella* (Zeller) in Tables 1 and 2. Repellent properties against attacking by the potato tuber moth under traditional store conditions indicated that the highest concentration of the tested oils and plant powders was recorded the lowest the percentage of larval penetration, pupation and emerged moths.

1-Efficiency of some plant powders against *Phthorimaea operculella* (Zeller) under storage conditions.

All the tested concentrations of plant powders against *p. operculella* on potato tuber had significant effects compared with the control. Results obtained indicated that all the tested powders had activity against *p. operculella* and percent of larval penetration, pupation and emerged moths were concentration dependent. Duncan analysis indicated that, ginger and cinnamon powder came in the first category based on the % of larval penetration on potato tuber. In respect to, ginger powder recorded % of larval penetration 7.0, 9.5 and 11.4% at conc. 3%, 2% and 1%, respectively. While cinnamon powder had 5.1, 10.8 and 15.8 % at conc. 3%, 2% and 1%, respectively.

Also the data tabulated in table 1 showed that, thyme and rosemary came in the second category at conc. 3%, recorded % of larval penetration 41.1 and 43.0, respectively. The conc. 2% and 1% of thyme and rosemary had the last category.

On the other hand, bioassays showed that the passive side effect on pupation and emerged moths were observed by plant powders ginger ,cinnamon at conc. 3%, 2% and 1% and rosemary at conc. 3% and 2% came in the first category, recording

percentage of pupation (1.9 , 3.9 and 4.5%) ,(3.9, 6.5 and 9.7%) and (4.5 and 7.1%) respectively and recorded percentage of emerged moths on potato tuber treated (0.0 , 0.6 and 1.9 %),(0.0, 5.2 and 9.7%) and (3.2 and 7.1%) respectively. Thyme with concentration 3% and 2% and rosemary with 1% concentration on pupation and emerged moths came in the next arrangement and recorded percentage of pupation (38.7 and 45.2%) and 42.6% respectively, compared with control and recorded percentage of emerged moths (38.1 and 45.2%) and 36.1% respectively,. So, the plant powders ginger, cinnamon were relatively the most efficient powders in protecting potato tubers against *P. operculella*.

In the same field Moawad and Ebadah (2007) showed that dusting potato tuber by 1.5%, 1% and 1% conc. of Rosemary, Cardamon and Marjoram recorded penetration of larvae (%) by 23.3, 23.3 and 26.7%, respectively. They also noted that no adults could emerge from larvae feeding on tubers treated with 1.5% conc. of Cardamon. Maha (2005) explanted that the cloves flower powder was the most effective against larvae of *P. operculella*, followed by santonica flower powder and black pepper seed powder, when treated the infested potato tuber by *P. operculella* eggs.

Also, Aziza *et al.* (2014) concluded that, when dusting potato tubers with bulb powder of *Allium cepa* (50% conc. mixed with talcum powder) displayed a highly effective role in the reduction of deposited eggs as well as adult emergence. *Allium cepa*, *Pelargonium graveolens* and *Cymbopogon citratus* caused high reduction in larval penetration into treated tubers. Mixture of Pelargonium or Allium mixed with talcum powder gave good protection for a long storage period (30-40 days).

Table 1. Efficiency of some plant powders against *Phthorimaea operculella* (Zeller).

Treatment	Con.	Larvae		Pupae		Moths	
		No. of Larval penetration	% of Larval penetration	No. of pupae	% of pupation	No. of emerged	% of emerged
Ginger *(Zingiber officinale)*	3%	11 e	7.0	3 d	1.9	0 d	0.0
	2%	15 e	9.5	6 d	3.9	1 d	0.6
	1%	18 e	11.4	7 d	4.5	3 d	1.9
Cinnamon *(Cinnamomum Zeylanicum*	3%	8 e	5.1	6 d	3.9	0 d	0.0
	2%	17 e	10.8	10 d	6.5	8 d	5.2
	1%	25 e	15.8	15 d	9.7	15 d	9.7
Thyme *(Thymus vulgaris*	3%	65 d	41.1	60 c	38.7	59 c	38.1
	2%	75 cd	47.5	70 c	45.2	70 c	45.2
	1%	112 b	70.9	111 b	71.6	108 b	69.7
Rosemary *(Rosmarinus officinailis)*	3%	68 d	43.0	7 d	4.5	5 d	3.2
	2%	93 bc	58.9	11 d	7.1	11 d	7.1
	1%	104 b	65.8	66 c	42.6	56 c	36.1
Control	--	158 a	--	155 a	--	155 a	--
L.S.D		7.447		5.625		8.901	

Within columns, means followed by the same letter are not significantly different at 5% level (P>0.05)

2- Efficiency of some plant oils and compared Lufenuron (Match 5% Sc) against *Phthorimaea operculella (*Zeller) under storage conditions.

Data presented in table (2) revealed that the tested plant oils had variable reduction of the percentages of larval penetration, pupation and adults emerged. Moreover, treatment of potato tubers by marjoram oil caused the highest reduction percentage of penetrating larvae into treated tubers with 7.7, 13.1and 15.4% at concentrations 10, 5 and 2.5 ml/L, respectively. Plant oils of chilli at conc.10 and 5 ml/L and orange at conc.10 ml/L, also gave percentage of penetrating larvae, being 12.3% ,16.9 % and 13.1% , respectively; comparable untreated controls . It is noticed that, Duncan analysis showed that the selected oils at tested concentration recorded overlap categories. On the other hand, it was noticed that, the tested concentration of the selection of plant oils had latent effect, where led to reduction in the percentage of pupation and adult production from larvae that feed on sprayed tubers. Therefore, it was apparent that the percentages of pupation and adult emergence were related to the percentage of penetrated larvae which had the ability to complete development. Thus, the plant oils of marjoram caused the highest reduction in pupation and adult emergence; as the percentage of pupation reached 2.3, 7.03 and 12.5% at rate 10, 5 and 2.5 ml/L, respectively; while adult emergence reached 1.6, 7.1 and 12.7% at the aforementioned rates, respectively. In the same field , Homam and Maha 2017 recorded that Marjoram oil had promise results against *P. operculella* eggs especially it had not passive effects against one of the most common arthropod predators (green lace wing). Treatment by Plant oils of chilli and orange at conc. 10 and 5 ml/L caused reduction in % pupation (7.03 & 10.2%) and (10.9 &16.4%), respectively, while the percentage of adult emergence of previous oils at conc. 10 ml and 5 ml/ L were 4.8% ,9.5% and 7.1%,11.9%, respectively. Also found treatment by Plant oils of colocynth at 10 ml /L conc. caused reduction in % pupation (12.5%) and % adult emergence (9.5%) comparable to untreated controls. Both, orange and colocynths oils at conc. 2.5 ml / L recorded the lowest pupation and emergence moth, being % 25.8 & 24.2 and 26.2 & 23.8, respectively.

Although the insecticide of Lufenuron caused the high reduction in larval penetration, pupation and adult emergence; as the percentage 10.8%, 7.8% and 6.3%, respectively.

Similar observations with other plant powders, as recorded by spraying a thin layer of tested natural oils may also act as a defensive layer, which causes confusion or disturbance to the searching neonate larvae as suggested by Bowers and Nishid (1980). Rama (1989) showed that spraying Neemerich oil (*Azadirachta indica*) on potato tuber caused ovicidal and larvicidal action against PTM. Moawad (2000) recorded that the spraying on potato tuber by 1.0 % natural and commercial oils of *Mentha citrate*, *Cymbopogon citrates*, *Myristica fragrans* and á-ionon possessed ability

to reduce the percentage of larval penetration of PTM and failure of many of them to complete their development to adult stage. Also showed that the volatile oils of oils mentioned can successfully reduce infestation by PTM, through shortening the life span of adults and reducing their fertility. As majority of exposed females died before laying eggs; and failure of others to lay their full load of eggs. Moawad *et al.,* (2007) showed that spraying potato tuber by natural Cardamon oil (1.5%) mixed with talcum powder was the most repellent against PTM (larval penetration was 13.3%) while the penetration of larvae (%) by spraying of 1.5%, 1% and 1% concentrations of Rosemary, Cardamon and Marjoram were 23.3, 23.3 and 26.7%, respectively. They also noted that no adults could emerge from larvae feeding on tubers treated with 1.5% concentration of Cardamon. Aziza *et al*. (2009) the results clearly indicate that some of the natural essential oils such as peppermint, camphor, and pineapple proved to be repellent to the larvae.

Generally, from the present data, it was quite evident that the tested plants, particularly marjoram and chilli also orange and colocynth with high concentration had not only action against the neonate larvae of PTM but also had accumulative latent effect which led to reduction in pupation and adult emergence. On the other hand, plant powder of Ginger and Cinnamon did not caused emerged moth at conc.
3 %.

Table 2. Efficiency of some plant oils and an insecticide against *Phthorimaea operculella (*Zeller).

Treatment	Conc./ L.	Larvae		Pupae		Moths	
		No. of Larval penetration	% of Larval penetration	No. of pupae	% of pupation	No. of emerged	% of emerged
Orange oil (*Citrus sinenis*)	10 ml	17 def	13.1	14 cde	10.9	9 de	7.1
	5 ml	28 cde	21.5	21 bcd	16.4	15 cde	11.9
	2.5ml	42 b	32.3	33 bcd	25.8	33 b	26.2
Colocynth oil *(Citrullus colocynthis)*	10 ml	24 cde	18.5	16 cde	12.5	12 de	9.5
	5 ml	29 cde	22.3	24 bc	18.8	21 bc	16.7
	2.5ml	38 bc	29.2	31 b	24.2	30 bcd	23.8
Chilli oil (*Capsicum annuum*)	10 ml	16 cdef	12.3	9 de	7.03	6 de	4.8
	5 ml	22 cdef	16.9	13 cde	10.2	12 cde	9.5
	2.5ml	27 cde	20.8	22 bcd	17.2	22 bcd	17.5
Marjoram oil *(Majorana hortensis*)	10 ml	10 f	7.7	3 e	2.3	2 e	1.6
	5 ml	17 def	13.1	9 de	7.03	9 de	7.1
	2.5ml	20 cdef	15.4	16 cde	12.5	16 cde	12.7
Match 5% Sc (Lufenuron)	0.8 ml	14 ef	10.8	10 cde	7.8	8 de	6.3
Control	--	130 a	--	128 a	--	126 a	--
L.S.D		4.137		4.772		5.736	

Within columns, means followed by the same letter are not significantly different at 5% level (P>0.05)

CONCLUSION

In general the potato tubers could be protected during marketing or storage periods by using safe natural materials, such as the dried powders of Ginger, Cinnamon, and also Marjoram oil at 10 ml\ L. The foregoing results serve as alternatives to chemical pesticides for controlling this pest in the integrated pest management program.

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فعالية بعض المساحيق النباتية والزيوت النباتية ضد فراشة درنات البطاطس فى مخزن البطاطس

مها صبرى الغنام

معهد بحوث وقاية النباتات مركز البحوث الزراعية الدقى- الجيزة – مصر

تم إجراء تجارب معملية لحماية درنات البطاطس من الاصابة بفراشة درنات البطاطس أثناء التخزين. تم تقييم فعالية أربعة من الزيوت النباتية : (البرتقال والحنظل والشطة والبردقوش) وأربعة من المساحيق النباتية (الزنجبيل والقرفة والزعتر والروزمارى) والمبيد الحشري ماتش (Lufenuron) ضد فراشات درنات البطاطس.

ركز البحث علي بعض الجوانب البيولوجية مثل أختراق اليرقات و التشرنق وخروج الفراشات

وأشارت النتائج الي ترتيب الزيوت المختارة تنازليا بناءا علي أختراق اليرقات علي النحو التالي : زيت البردقوش < زيت الشطة < زيت البرتقال < زيت الحنظل

في حين رتبت المساحيق النباتية المختارة علي النحو التالي : الزنجبيل < القرفة < الزعتر < الروزمارى ومن ناحية أخرى وجد أنه لم يحدث خروج لفراشات درنات البطاطس عند معاملة الدرنات بمسحوق الزنجبيل والقرفة عند تركيز ٣% وفي حين كفاءة زيت البردقوش عند تركيز ١٠ مل لكل لتر ضد اختراق اليرقات والتشرنق وخروج الفراشات سجلت ٧,٧% و ٢,٣ % و ١,٦% علي التوالي .

كما سجل المبيد الحشري ماتش أرتفاع في خفض أختراق اليرقات والتشرنق وخروج الفراشات وكانت ١٠,٨% و 7,٨% و 3, 6 % علي التوالي .

وعموما أشارت الدراسة الى أنه يمكن حماية درنات البطاطس خلال التسويق أوفترة التخزين عن طريق أستخدام مواد طبيعية أمنة مثل زيت البردقوش والمسحوق النباتي للزنجبيل والقرفة ضد أختراق اليرقات والتشرنق وخروج الفراشات