J. Plant Production, Mansoura Univ., Vol. 7(12):1387 -1393, 2016

Using Essential Oils to Decrease Potato Tubers Sprouting, Rotting and Insect Infestations during Storage at Ambient Temperature

Abd El-Kader, A. E. S.[1] ; El-S. L. El-S. Fathy[1] ; M. N. A. Gahwash[1] and Eftkhar E. Abohatab[2]
[1] Veg. Dep.; Hort. Res. Institute; ARC; Giza, Egypt.
[2] Plant Protection Research Institute. ARC; Giza; Egypt.

This article was CHECKED against plagiarism using TurnitIn software

ABSTRACT

Two storage experiments were carried out at El-Mansoura Horticultural Research Station, Dakahalia Governorate, Egypt, during four months of storage in summer seasons of 2013 and 2014 for studying the effect of seven treatments, i.e,. natural essential oils and selecron on storability and quality of potato tubers and reduction percentages in the infestations potato tubers moth (PTM) under Nawwala condition. These treatments such as ; clove oil, garlic oil, lemonion oil, eucalyptus oil, peppermint oil, basil oil, mixture of these oils and selecron. The obtained results revealed that all storage treatments expect, selecron and control gave different significantly in all studied characters. Using peppermint and clove oils recorded the lowest significant values of sprouting percentage, sprout weight, sprout length and weight of loss percentage in both seasons. The highest values of dry matter %, starch% and vitamin C were recorded with peppermint oil, but the lowest sugar percentage was obtained by using the same treatment during two seasons. Results indicated that the effects of essential oils and selecron under storage in Nawwala conditions on *Phthorimaea operculla (Zell.)* (PTM), after four months of storage, the tubers infestation in control were (48-48.67%), while the mean reduction percentages of infestation ranged between (94.10- 98.86% and 93.23- 96.84) during two seasons of 2013/2014 respectively. Peppermint oil, eucalyptus oil, clove oil and mixture oils gave highest mean reduction percentages of infestation such as selecron. Generally, the obtained data indicated that all used oils offered the highest protection. Also, the results in laboratory showed that the effects of oil treatments on larvae PTM recorded significantly variation according to the type of oil and time of exposure which showed fatal action on the larvae of PTM. The efficacy of Peppermint oil, Eucalyptus oil, clover oil and Mixer oils were the best. The percent of mortality ranged between (76.14 and 100%) compared with selecron. Also, all oils were used effected inhibitor action on adults. The inhibition of egg laying and reduction percentages ranged between were (47.54 %and 95.02 %) of peppermint oil and galaric oils, respectively. This study recommends that it can be sprayed peppermint oil concentration at (2 cm 3 / L / ton) three times during the storage of potato tubers in Nawwala for (4 months) in order to reduce the proportion of sprouting and weight loss and rotting and get a higher percentage of dry matter, starch and less injuries Pferashh (PTM) in tubers. Finally, it could be recommended with peppermint oil, eucalyptus oil, clove oil and mixer oils were the best during storage to obtain the best characters storage and quality. These natural treatments are very safe and potent in improving storability and greatly decreasing PTM insect infection during storage conditions in Nawwala on potato tubers.

INTRODUCTION

Potato (*Solanum tuberosum* L.) is an important vegetable crop in Egypt and all over the world. In world tonnage the potato ranks after wheat, rice and maize as the fourth most important crop for human consumption. Potato is seriously infested by the potato tuber moth (PTM), *Phthorimaea operculella* (Zell.) (Lepidoptera: Gelechiidae) especially, in the field and in stores (Abohatab, 2005). Infested tubers become completely unmarketable. Chemical control of potato tuber moth is a costly input that contaminated the environment, increase resistance to insecticides and can also cause health hazards for the humans. El-Awady (2002) studied the effect of some extracted-essential oils, caraway, dill and thyme and applied at different times. The author found that dipping potato tuber (cv. Spunta) for 20 second in thyme oil (2 m / L) at three applications times (30, 60 and 90 days from the beginning of storage) as the best natural, safety and cost effective treatment for storing potato tubers from summer yield, five months at room temperature and its kept potato tuber from PTM.

In potato tuber moth (PTM) larvae attack the tuber forming tunnels, the tunneling results into partial or complete rottening rending it unfit for planting or for human consumption. Finally, the activity of the larvae resulted in a great destruction in the potato vegetations and tubers which in turn adversely affected qualitatively and quantitatively the net crop yield.

The major problems that occur during potato storage are sprouting and rotting due to disease, essential oils of lavender, mint, spearmint, Turkish oregano, Greek oregano, rosemary and sage were assessed. Except for oregano-oils, all other essential oils suppressed potato sprout growth (Vokou *et al*., 1993). Kleinkopf *et al*., (2003) and Cheema (2010) on potato showed that spearmint and peppermint oils have been used successfully to prevent sprouting in potatoes for extended storage periods because this oils contain components (evg., S- carvone, eugenol) and hydrogen peroxide- base materials, physically damage the developing sprout and suppers sprout.

Several investigations reported that the application of clove oil was evaluated on shorter dormancy varieties on potatoes and sugar concentrations, in addition cloves oil was less effective in suppressing sprouting, likely due to its slower vaporization compared to dill and spearmint oils (Frazier *et al*., 2006; Song 2009). The mint oil is effective in maintaining a sprout-free condition in stored potatoes as long as the material is available in sufficient quantity in the head space of potato store. In addition, mint oil gave the highest significant dry matter and the lowest significant total and reducing sugars (Albashir *et al*., 2011; Ezzat *et al*., 2011).

Abd El-Moneim *et al*. (2012) showed that, essential oils (caraway, clove, carvone and eugenol) and gamma irradiation recorded the most suitable methods for inhibiting sprouting of potato tubers. Olsen *et al*., (2012) indicated that applications of clove oil should be made when sprouts are peeping and preferably no longer than 1/2 inch in length. Depending up on cultivar, not all eyes on a

potato sprout at the same time so carefully watch the sprouting. Sharma (2012) found that the most effective treatment against sprouting were carvone (68.5%) limonene (14.0%) and piperitenone oxide (79.2%) of sprouted tuber at the end of the storage.

Elbashir *et al*., (2014) indicated that, application of spearmint oil in the field exhibited early break of dormancy, fast sprout growth, high fresh weight loss and high sugar accumulation the combination treatments of sprouting spearmint oil in the field couple with evaporation in cold store controlled the sprout still the third month of storage. The spearmint oil had no adverse effects on reducing sugars, dry matter and ships yield of potatoes.

Using of essential oils as natural alternative prove significant effects in reducing potato storage problems with safe and cost effective aspects added to their antioxidantal impacts against high temperature induce oxidative stress during storage out refrigerators (Frazier *et al*., 2004; Sonli *et al*., 2010). On the other hand, essential oils, were used in potent way to control storage insect infection especially *Phythorimaea operculella* (Zeller) PTM, (Roman 1984; Lal., 1987).

Oils extracted from *E. caryophylatta* and *T. vulgaris* exhibited ovipositional deterring properties against PTM females. However, no eggs were laid by all released PTM females on treated potato tubers during all life span. Reproduction of PTM was significantly reduced when either males or females were exposed to the orange peel vapor (Sharaby, 1988). Also, Alrubeai *et al*. (2001) added that clove flower buds extract caused inhibition of egg laying by females. Moreover, females exposed to potato tubers treated with *M. piperta* laid few enviable eggs. According to Sharma *et al*. (1997), *M. arvensis* had an ovicidal properties against PTM eggs.

Several researchers reported that many essential oils of potato stored at relatively higher temperatures essential oils were most effective as sprout suppressant and reduced infestation of PTM. Cloves flower powder was effective against PTM larvae (Sing *et al*., 1997; El-Ghanam 2005; Abohatab, 2005)

The present work aimed to study the effect of sex natural essential oils and selecron on sprouting storage of potato tubers and estimated the values of dry matter, starch and vitamin C under Nawwala condition. Also, study to investigate the reduction of population potato tuber moth *P. operculella* in Nawwala and laboratory.

Materials and Methods

1. The role of some natural products as oils in protecting sprouting and PTM infestation:

Two storage experiments were carried out at Mansoura Horticultural Research Station, Dakahalia Governorate, Egypt, during two successive summer seasons (2013 and 2014). The potato variety tested was spunta of a uniform size tuber (45-55mm). It was curried after harvest and divided into groups according to the different treatments.

Table 1. The common and scientific names of oils used in storage of potato under nawwala and laboratory conditions.

Common name	Scientific name	Family	Formulation	Active ingredients
Bud flower clover	*Eugenia caryophyllus*	Myrtaceae	Oil	Eugenol
galaric	*Allium sativum*	Allecene	//	
Lemonene	*Citrus sp.*	Rutaceae	//	Limonene
Camphor	*Eucalyptus globulus*	Mytaceae	//	Eucalyptol
Spearmint	*Mentha pipperta*	//	//	Carvone 60%
Basil	*Ocimum basilicum*	Lamiaceae	//	Bascllicum
mixture of oils			//	
selecron	Colropyrophis	organophosr	72%EC	

Emulsion of different essential oil treatments were prepared at 2 ml / L (v / v) water with 0.05% (v / v) Tween 80 as an emulsifier. Control tubers were treated by water with Tween 80 solution (0.05%) only. Tubers were sprayed by emulsion and excess liquid was drained. Potato tuber were stored in pile under thick layer of rice straw of 50 cm height on 25 May -25 September in three vertical row (replications).

During the whole period of storage tubers received three sprays, the first was at the onset, the second was after 1.5 month and the third was also after 1.5 month from the second one.

Spraying oils for four months by using sprayed three times with emulsion of different treatments during the whole period of storage, Intervals between each spray were 40 days on set of storage. Weight of potato 5 kg all treatments for three replicate.

Studied characteristics:

The experiment includes three replicates, each group unit contained five kg potato tubers. At the end of storage period (4 months), potato tubers were checked and the following measurements were recorded:

1.Sprouting %.

Five randomly chosen potato used, the number of eyes, which contained sprouts, were recorded relative to number of total eyes, then calculated per tuber:

$$\text{Sprouting \%} = \frac{\text{No. of sprouted eyes}}{\text{No. of total eyes}} \times 100$$

2. Sprout length
3. Sprout weight
4. Weight loss (%)
5. Number of infested tuber (PTM): tubers were examined by using magnifier10. The number of holes *P. operculella* larvae present in each tuber of replicate was recorded.

Group of tuber was marked and weighted at the beginning and at the end of storage, the damaged tubers were excluded, the average weight (g/tuber).

$$\text{Average weight} = \frac{\text{Average weight of marked tubers (at the beginning or end of storage)}}{\text{No. of the same tubers}}$$

$$\text{6. Weight loss \%} = \frac{\text{Average weight of tuber at the beginning of storage} - \text{Average weight of tuber at the end of storage}}{\text{Average weight of tuber at the beginning of storage}}$$

7- Dry matter %
8- Reducing sugars were determined using methods of James (1995).
9- Starch % was determined according to the methods reported by Nelson (1974).
10- Vitamin C was determined according to the methods described by Mondy and Ponnampalam (1986).

These measurements were recorded at the end of storage period (four months).

Statistical analysis

Obtained data were subjected to statistical analysis using technique of the randomized complete block design according to Sendecor and Cochran (1982) using Costat computer. The treatment means were compared using Dancan's Multiple Rang Test (Duncan, 1955).

2-Laboratory experiments

For each treatment,9 tubers were divided into three replicates. The treated tubers were transferred to glasses jars (20 cm high and 10 cm diameter). To estimate the toxic effect of tested oils on PTM larvae, newly hatched larvae were put on each replicate (10 larvae / glass). Each glass jar was covered with fine muslin fixed to they rubber bands. Observation was carried out after 24, 48 and 72 hours of treatment for the number of dead larvae.

In addition to two pairs (males and females) of adult moths were introduced into another set of treated tubers to evaluate the Oviposition behavior of PTM females in response to oil extractions (2 pairs / glass jar). Also the number of eggs laid by PTM females were recorded after 48, 72 and 96 hours.

Statistical analysis: The reducing percentage in infestation was corrected by using (Abbott's formula (Abbott, 1925). Also lays eggs was corrected using Abbott's formula (1925) with data under the laboratory. " Costat" a product of cohort soft ware was used to differentiation between means and L.S.D. The reduction percentages of the the mortality were calculated using the following equation:

$$\text{Mortality \%} = \frac{\text{No. of life larvae in control} - \text{No. of life larvae in treatment}}{\text{No. of life larvae in control}} \times 100$$

RESULTS AND DISCUSSION

Sprouting, sprout weight, sprout length and weight loss:

All essential oils treatments greatly suppressed the incidence of sprouting, sprouts weight, sprouts length and weight loss compared with control and selecron (Table 2 and Figs. 1&2). The data showed that the application of peppermint and clove oils have significantly reduced sprouting percentage, sprout weight, sprout length and weight loss percentage in both seasons but the good treatments with peppermint oil to reduce sprouting percentage, sprout weight, sprout length the most superior ones clove oil and lemonine were peppermint oil followed by and weight of loss percentage in both season. Similar results were obtained by Vokou et al (1993); Kleinkopf et al (2003); Frazier et al (2006); Song (2009); Cheema (2010), Elbashir et al (2011); Olsene et al (2012); Sharma (2012); Castilla et al (2013) and Elbashir et al (2014).

Table 2. Effect of essential oils and selecron on sprouting%, sprout weight, sprout length and weight of loss % after four months storage during 2013 and 2014 seasons.

Treatments	Sprouting %		Sprouts weight (gm)		Sprouts length (cm)		Weight of loss %	
	S1	S2	S1	S2	S1	S2	S1	S2
Control	56.47a	55.55a	4.67a	4.95a	4.42a	5.70a	27.64a	33.25 a
Clove oil	10.46d	14.50d	1.73d	1.49f	1.00de	1.18f	10.55cd	11.06c
Garlic oil	13.68cd	17.91cd	2.33c	2.38de	2.05c	2.17c	13.22c	12.23c
Lemonine oil	10.87d	16.11cd	1.90d	2.27e	1.40cde	1.50e	12.30c	12.35c
Euculyptus oil	11.10d	16.35cd	1.90d	2.63c	1.70cd	1.80de	12.42c	12.22c
Peppermint oil	5.48e	9.10e	1.00e	1.15g	0.79e	0.84g	8.69d	10.73c
Basal oil	13.78cd	19.32c	2.33c	2.66c	2.05c	2.21c	13.25c	11.40c
Mixture oils	15.66c	19.93c	2.40c	2.51cd	1.99c	2.10cd	13.34c	13.56c
Selecron	30.31b	31.38b	3.63b	3.64b	3.07b	3.17b	18.43 b	19.40 b

Means sharing similar letter (s) don't differ significantly at p= 0.05 level according to Duncan's multiple range test.

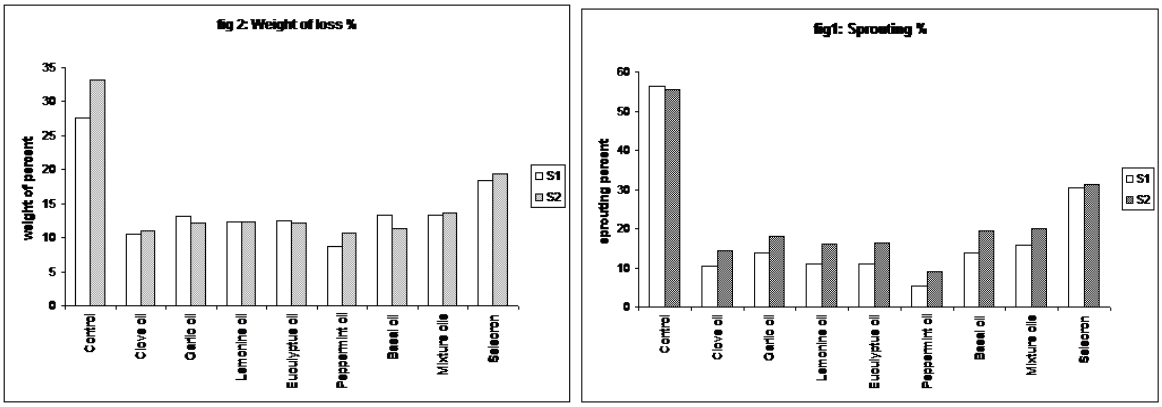


Fig. 1,2. Effect of essential oils and selecron on sprouting and weight loss after four months storage during 2013 and 2014 seasons.

As regards, the inducible oxidative stress known to cause excessive O_2 diffusion, respiration rise, carbohydrate degradation and sugar depletion. In turn, providing more energy and structural components for the rapidly developing sprout tissues, since the sprouts servas as a powerful sinks for the materials (van and Hartmans, 1987)

Once again, the best storability case of tuber treated with antioxidant rich essential oils, includes the lowest sprouting, sprout weight, sprout length and weight loss percentage added to their preserved constituents(Table 1).

There by suppressed the oxidative stress destructive effects and in turn allowing less available energy and mobilized reserves, reducing sprouting and weight losing incidence.

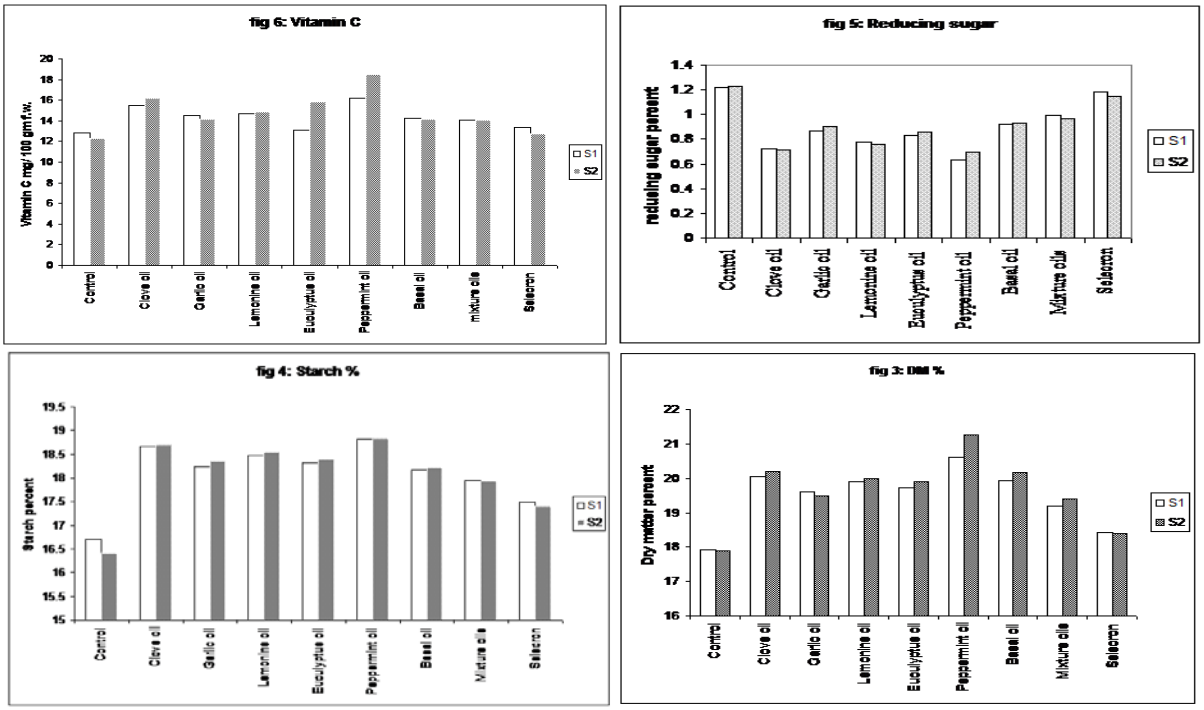
Mean while these essential oils suppressed sprouting via their monoterpenes basic constituents which known to inhibit mitochondrial respiration (Lorber and Muller, 1980), reduce carbohydrate degradation and sugars changes (Table 3)

Table 3. Effect of essential oils and selecron on DM% , starch, reducing sugar and vitamin C after four months storage during 2013 and 2014 seasons.

Treatments	DM %		Starch %		Reducing sugar		Vitamin C	
	S1	S2	S1	S2	S1	S2	S1	S2
Control	17.92 d	17.90 d	16.71 e	16.41 h	1.22 a	1.23 a	12.87 i	12.33 h
Clove oil	20.06b	20.21ab	18.67ab	18.70b	0.72fg	0.71g	15.46b	16.20b
Garlic oil	19.60 bc	19.49 bc	18.24 bc	18.36 d	0.87cd	0.90de	14.47d	14.17 e
Lemonine oil	19.91b	20.00b	18.47ab	18.55c	0.78ef	0.76f	14.67c	14.83d
Euculyptus oil	19.73b	19.89b	18.32abc	18.39d	0.83de	0.86e	13.13h	15.87c
Peppermint oil	20.62a	21.26a	18.81a	18.83a	0.63g	0.70g	16.23a	18.53a
Basal oil	19.93b	20.18c	18.17bc	18.22e	0.92e	0.93d	14.22e	14.17e
Mixture oils	19.18c	19.40bc	17.95 c	17.93f	0.99 b	0.97 c	14.07f	14.10 f
Selecron	18.42 d	18.39 cd	17.49 d	17.41 g	1.18 a	1.15 b	13.40h	12.77 g

Means sharing similar letter (s) don't differ significantly at p= 0.05 level according to Duncan's multiple range test.

All storage treatments gave highest significant values in dry matter percentage, starch percentage and vitamin C but, this treatments recorded lowest reducing sugar compared with the control in both seasons (Table 3 and Figs 3&4&5&6).



Figs. 3,4,5,6. Effect of essential oils and selecron on DM% , starch % reducing sugar and Vitamin C after four months storage during 2013 and 2014 seasons.

Similar results were obtained by Vokou et al (1993), Kleinkopf et al (2003), Farzier *et al* (2006); Sheema (2010); Elbashir et al (2011); Ezzat (2011); Castilla et al (2013) and Elbashir et al (2014). The reducing sugars content increased in treatments that had a high percentage of infected and sprouted tubers Mahmoud, (1973).

Elbashir et al (2011) found that the oil extracted from mint plants is effective in maintaining a sprout free condition in stored potatoes as long as the material is available in sufficient quantity in the head space of potato store.

Generally the used of essential oils led to slowing down the activity of carbohydrates and protein breakdown associated enzymatic systems as well as respiration and energy metabolism enzymes (Trevanion and Kruger 1991, El-Awady *et al* (2006).

B-Examines insects

I- Effect of natural oils and pesticides under storage nawwala conditions on *Phthorimae operculle* (P.T.M)

The data in (Table 4) indicated that, after four months of storage, 48-48.67% of tubers were infested in the control and the mean reduction percentages in the infestations ranged between (94.10- 98.86% and93.23-96.84) during two seasons. Peppermint oil , Clove oil ,

Mixture oils , and Eucalyptus oil give the highest mean reduction percentages for oils compared with selecron. Singh et al. (1997). Tested the activity of 13 essential oils on potatoes stored at relatively higher temperatures. Essential oils of Mentha piperata and spictata were most effective as sprout suppressant and reduced the infestation of PTM.

Generally the obtained data indicated that all used oils offered the highest protection to the stored tubers. None of the treatments had an adverse effect on germination or on the yield of a subsequent crop.

Table 4. Mean Percentage of reduction in PTM infestation on potato tubers treaded with cloves, galaric, lamonin, Eucalyptus oil, Peppermint ,Basil, mixture of oils, and selecron during four months of storage under nawwala conditions during seasons 2013/2014).

Treatments	%Reduction of infestation 1st (inspection)		%Reduction of infestation 2nd (inspection)		%Reduction of infestation 3rd (inspection)		Mean reduction% percentages	
	S1	S2	S1	S2	S1	S2	S1	S2
Control	14	16	44	52	88	76	48.67	48.00
Clove oil	92.86	93.75	97.73	96.15	98.86	98.68	96.48	96.19
Garlic oil	85.71	93.75	97.73	96.15	98.86	97.37	94.10	95.76
Lemonine oil	85.71	87.5	97.73	96.15	98.86	96.05	94.10	93.23
Euculyptus oil	92.86	93.75	97.73	98.08	98.86	97.37	96.48	96.40
Peppermint oil	92.86	93.75	97.73	98.08	100	98.68	96.86	96.84
Basial oil	85.71	87.5	97.73	96.15	98.86	96.05	94.10	93.23
Mixture oils	100	93.75	97.73	98.08	98.86	98.68	98.86	96.84
Selecron	92.86	93.75	97.73	100	100	98.68	96.86	99.56

I -Effect of plant oils on potato tuber infestation by PTM under laboratory conditions :-

1- Effected of essential oils on the 1st instar of PTM larvae:-

Results in Table (5) indicated the effect on larvae which varied significantly according to the type of oil and time of exposure comparatively. The oil treatments that are used , show fatal action on the larvae of PTM. The efficacy of Peppermint oil , Eucalyptus oil, Mixer oils , and clover oil were the best. The percent of mortality ranged between 76.14 and 100% for oils compared with selecron. The percent of mortality after 24 hours was 89.28 and the mortality percent increased to reach 100% after 48 hours, while the percent of mortality with Galaric, Basil. and Lamonin were 7.14, 53.57and 57.14 after 24 hours respectively. The highest mortality percent of larvae was recorded on the first day for most treatment after treated the potato tuber.

Table 5. Effect of essential oils cloves, galaric, lamonin, Eucalyptus , Peppermint ,Basil, - mixture of oils, and selecron on mortality of the PTM 1st instars larvae under laboratory conditions.

Treatments	24(hours)		48(hours)		72(hours)	
	Mean mortality	Reduction	Mean mortality	Reduction	Mean mortality	Reduction
Control (A.T.)	0.67±0.33d	6.66	1.33± 0.33c	20	1.00± 0.58c	23.31
Clove oil	4.66± 0.33a	42.85	4.33± 0.33c	87.5	0.67± 0.33ab	95.24
Garlic oil	1.33± 0.88a	7.14	6.33± 0.33b	70	1.67± 0.67ab	90.47
Lemonine oil	6.00±0.58ab	57.14	1.33± 0.33c	66.66	1.33± 0.33bc	80.95
Euculyptus oil	9.00± 0.58a	89.28	1.00± 0.58c	100	0.00± 0.00a	100
Peppermint oil	9.00± 0 .58a	89.28	1.00± 0 .58a	100	0.00± 0 .00a	100
Basal oil	5.67± 0.33bc	53.57	1.00± 0.58c	62.5	1.33± 0.33c	76.1
Mixture oils	9.00 ± 0.58c	89.28	1.33± 0.33c	100	0.00± 0.00c	100
Selecron	8.33± 0.33d	89.28	1.33± 0.33c	100	0.00± 0.00c	100
LSD at 0.05%	1.70		1.32		0.98	
F	29.05		16.06		4.18	

Generally, the efficacy of Peppermint, Eucalyptus, Mixer oils and Cloves were the best Few numbers of larvae penetrate the tubers but they were not capable to complete their life cycle and died inside the tubers. Similar conclusion was obtained by Singh et al. (1997) and Abohatab (2005) they found that, water extract of clove flower buds (thym and spearmint), exhibited fatal effect on PTM larvae.).

Statistical analysis showed that there were significant differences (F = 29.05** and LSD = 1.70) after 24 hours

2- Effect of some essential oils and selecron on lay egg of adults PTM :-

The results obtained in Table (6) indicated the effect of plant oils and insecticide Selecron on reduction and inhibition of egg laying by adult essential of PTM. The effect increased with an increased of oil and exposure time. The treatment of Eucalyptus oil and Selecron gave the highest effect after 24 hours (81.05) and 72.83%.resp.. The efficacy of oils gave the highest mortality after 96 hours (95.02%) for Peppermint oil. The heights reduction to Cloves was (73.67) % after 48 hours, Mixer oils oil reduction the percent reached 75.58% after 72 hours. The inhibition of egg laying and reduction percentages ranged between 95.02%and 47.54% for Peppermint and Galaric oils respectively. Generally, all used oils gave on effective inhibitor action on adults. Reproduction was significantly reduced when either males or females were exposed to potato with treatments oils.

All tested oil exhibited Oviposition deterring properties against PTM females . Also, Sharaby (1988) found that, egg viability ranged from 0.0 to 30.0 when the moths were exposed to orange peel oil. Sharaby, 1988). The effect increased with the increase of oil

exposure time. Moreover, females exposed to potato tubers treated with *M. piperta* laid few enviable eggs.

Statistical analysis showed that there were high significant differences (F = 48.25** and LSD = 3.32) after 24 hours.

Table 6. Effect of essential oils cloves, galaric, lamonin, Eucalyptus, Peppermint ,Basil, - mixture of oils, and selecron on redaction lays egg percentage of the PTM adults under laboratory conditions.

Treatments	%Egg 48 (hours)		% Egg 72 (hours)		% Egg96 (hours)	
	Mean egg (No.)	Reduction %	Mean egg (No.)	Reduction (No.)	Mean egg (No.)	Reduction %
Control (A.T.)	30.66± 1.15f		28.66± 1.52e		20.33± 6.11e	
Clove oil	11.66± 1.52a	67.40	13.0± 2.46a	73.67	10.66± 1.15a	67.21
Garlic oil	10.00± 2.00b	61.96	7.66± 1.52b	54.65	6.66± 0.57b	47.54
Lemonine oil	15.66± 1.15bc	54.35	17.66± 1.15c	41.86	7.33± 0.57bc	63.93
Euculyptus oil	6.00± 0.00cd	81.05	7.33± 1.15d	74.42	3.00± 1.00c	85.25
Peppermint oil	12.33±2.51bcd	66.31	11.00± 2.64c	61.63	8.33± 1.52bc	95.02
Basal oil	11.33± 1.15cd	63.04	11.66± 0.57c	59.31	9.00± 1.00bc	55.47
Mixture oils	10.66± 3.05cd	65.22	7.00± 1.00c	75.58	6.00± 1.00bc	70.49
Selecron	8.33 ± 1.20 de	72.83	11.0±1 .73d	61.63	7.67± 0.58cd	62.60
LSD at 0.05%	3.32		2.67		3.61	
F	48.25		68.73		18.93	

Means sharing similar letter (s) don't differ significantly at p= 0.05 level according to Duncan's multiple range test.

Generally, it could be indicated that peppermint oil , Eucalyptus oil ,cloves, mixture of oils, galaric, lamonin, , ,Basil, - exhibited a reliable protection from PTM infestation .Also, extracted oils were safety and reduced sprout damage during storage (Raman & Booth, 1983a ,El-Awady, 2002, and Abohatab(2005).

Economic evaluation:

Net profit of final products was estimated as a relationship between gross return (L.E 3410/ton) was obtained from application of peppermint oil treatment in comparison with other treatments. Thus, this treatment proved to be highly economical for potato storing. It could be concluded that using peppermint oil or Euculyptus oil as the best safe, natural, good quality and high-benefit treatments.

Table 7 : Effect of essential oils and selecron on net return after 4 months storage.

Treatments	Gross return* (L.E. ton-1)	Treatment cost** (L.E. ton-1)	Total cost*** (L.E. ton-1)	Net return (L.E. ton-1)	Benefit / cost ratio ****	Order
Control (A.T.)	1500	0.00	1500	0.00	0.00	6
Clove oil	4500	67	1567	2933	1.87	3
Garlic oil	4750	90	1590	3160	1.99	2
Lemonine oil	4500	67	1567	2933	1.87	3
Euculyptus oil	4750	90	1590	3160	1.99	2
Peppermint oil	5000	90	1590	3410	2.14	1
Basal oil	4500	67	1567	2933	1.87	3
Mixture oils	4000	67	1567	2433	1.55	4
Selecron	2000	50	1550	450	0.29	5

*** Gross return of final products was estimated according to the quality of potato tuber at the end of storage (healthy tuber, free in virtual and physiological defects and good quality for processing products) and ranging from L.E 1500: 5000/ton.**

**** Treatment cost was calculated according to the following price: Clove oil L.E 150/L, Garlic oil L.E 200/L, Lemonine oil L.E 150/L, Eucalyptus oil L.E 200/L, Peppermint oil L.E 200/L, Basal oil L.E 150/L, Mixture oils L.E 150/L and Selecron L.E 100/L.**

***** Total costs were price of potato tubers per ton before storage which equal nearly L.E. 1500, plus treatment cost.**

****** Benefit/cost ratio was divided by net return in total costs.**

CONCLUSION

It be concluded with storing potato at ambient temperature (nawwala conditions) for four summer month by spraying peppermint essential oil three times for strong reduction in sprouting, weight loss and damage. Also, to obtain higher storability (starch and dry matter). At the same time the least infection with storage PTM insect.

REFERENCES

Abbott, W. S. (1925). A method of computing the effectiveness of insecticide. J. Econ. Entomol., 18: 265-267.

Abdel-Moneim M.R.A; H.S. El-Beltagl; A.A.Aly and A.E. El-Ansary (2012) The impact of Y-Irradiation, Essential oils and Iodine on biochemical components and metabolism of potato tuber during storage. Note Bot. Hortic. Agrobo 40(2): 129-139.

Ali, K.S.T; C. Hetner; L. Iadislav and V. Currie (1997). The Potato association of America. Amer. Potato J.; 74: 415-425.

Cheema, M.U.A. (2010). Dormancy and sprout control in root and tuber crops. Thesis submitted in partial fulfillment for the degree of Doctor of philosophy natural Resoucres Institute Univ. of Creen . Uk.

Duncan, B.D. (1955). Multiple range and multiple F test. Biometrics, 1-42.

Eftkhar E,M, Abohatab (2005) STUDIES ON POTATO TUBER WORM ON SOME SOLANACEOUS CROPS. PhD Thesis, Economic Entomology Department, Fac. Agric., Mansoura Univ.

El-Awady, Aml, A. (2002). Studies on potato storage. M. Sci. Thesis, Fac. Agric. Mansoura Univ., 130 p.

El-Bashir, H.A.; R.A. Abdel-Halim and K.S. Yousif (2011). Effect of spearmint oil on sprouting and processing quality of Diamante and Sinara potato varieties. Current Res. J. of Biological Sciences 3(5): 530-534.

El-Bashir, H.A.; R.A. Abdel-Halim and K.S. Yousif (2014). Efficiency of different applications of spearmint on storability and processing quality of two potato varieties. Journal of Agric-Food and Applied Sciences vol. 2(5), pp 124-133, 31.

El-Ghanam, M. S. M. (2005). Studies on potato tuber moth, Phthorimaea operculella (Zeller) (Gelechiidae: Lepidoptera) and its control. M. Sc. Thesis, Fac. Agric., Moshtohor, Zagazig Univ., 111 pp.

Ezzat, A.S.; E.N. El-Banna and A.A. El-Awady (2011). Effect of foliar spray with natural sprout inhibitors on productivity and storability of some new potato varieties Egypt J. Hort., 38 (1): 23-49.

Frazier Mary J; G.E. Kleinkopf and N. Oslen (2006). Clove oil for potato sprout and silver scurf suppressionin storage. Presented at the Idaho Potato. Conference on January 19.

James C.S. (1995). Analytical chemistry of food. Seale-Hayne Faculty of Agriculture, Food and Land use, Dept. Agric. Food stud. Univ. Polymouth, UK. 1: 96-97.

Kleinkopf, G.E.; N.A. Oberg and N.L. Oslen (2003). Sprout Inhibition in storage: Current Status, new chemistries and natural compounds. Amer. J. of Potato Res. 80: 317-327.

Lal, L. (1987). Studies on natural repellents against potato tuber moth, phthorimaea operculella. (Zeller) in country stores. Potatas Res; 30: 329-334.

Lorber, p. and W. H.Muller. (1980). Volatile growth inhibitors produced by Salvia leucophlla: Effect on metabplic activity in mitochondrial suspensions. Physiol.Ecol. 5: 68-75

Mahmoud A.A.E (1973), Change in nutritive values of gamma irradiation horticultural fruits during different storage periods. M.Sc. Thesis, Hort., Dep. Fac. Agric., Ain Shams Univ., Cairo, Egypt.

Mondy, N.I. and R. Ponnampalam (1986). Potato quality as affected by source of magnesium fertilizer: Nitrogen, minerals and ascorbic acid. J. Food Sci., 51: 352-358.

Nelson, N. (1974). A photometry adaptation of the somogy methods for determination of glucose. d. Bio. Chem. 195: 19-23.

Olsen, N.; M.J. Frazier and Kleinkopf (2012). Potato sprout suppression from clove oil.http://www.kimberly . uidaho. Edu/potatoes/CIS 1120.pdf.

Raman, K.V. (1984). Evaluation of synthetic sex pheromone funnel trap for potato tuber worm moth (*Lepidoptrea*:*Gelechidiidae*). Entomol, 3(6): 61-64.

Sharma, A. (2012). Essential oil as organic and Alternative methods for potato (Solanum tuberosum L.) sprout control in storage. International J. of Engineering and Mathematical Sciences. vol.(1), Issue-1, pp 34-39.

Singh, G.; I. P. S. Kapoor; S. K. Pandey and G. Singh (1997). Studies on essential oils. Part 7. Natural sprout inhibitors for potatoes. Pesticide Res. J., 9 (1): 121-124.

Snedecor, G.W. and Cochran, W.G. (1982). Statistical methods. Lowa State Univ. Press USA. 6th Ed. pp 34-93.

Song, X. (2009). The impact of dill weed, spearmint and clove essential oils on sprout suppression in potato tubers. Master of science in the department of plant Science. Univ. of Sakatchewan Saskatoon, SK.

Trevanion, SJ. and NJ. Kruger (1991), Effect of temperature on the kinetic properties of pyrophosphate fructose -6-phosphate phosphotransferase from potato tuber. J. Plant. Physiol., 137: 753-759.

Van. Es. A; K.J. Hartmans (1987). Sttructura and chemical composition of the potato. In: Rastovski. A., Van. Es. A. (eds): Storage of potatoes. pudoc, Wageningen: 39, 47.S

Vokou, D.; S. Vareltzidov and P. Katinakis. (1993). Effects of aromatic plants on potato storage: sprout suppression and antimicrobial activity. Agriculture, Ecosystem and Environment, 43: 223-235.

استخدام الزيوت العطرية لتقليل التزريع والتعفن والإصابة الحشرية لدرنات البطاطس أثناء التخزين في درجات الحرارة العادية

أحمد السيد عبد القادر[١]، سعيد لطفي السيد[١]، محمود نبيه علي جحوش[١] و افتخار السيد أبو حطب[٢]

[١] معهد بحوث البساتين - مركز البحوث الزراعية -الجيزة- مصر

[٢] معهد وقاية النباتات- مركز البحوث الزراعية - جيزة- مصر

تم اجراء تجربة تخزين خلال عامين في محطة بحوث البساتين بالمنصوره بمحافظة الدقهلية-مصر خلال أربع أشهر صيف عامي ٢٠١٣/٢٠١٤ لدراسة تأثير سبعة زيوت نباتية عطرية ومخلوطها إضافة لمبيد السيلكرون الحشري على قابليه التخزين وجوده درنات البطاطس وتقليل نسبة الإصابة بفراشة درنات البطاطس تحت ظروف النواله . وهذه المعاملات كانت زيت القرنفل وزيت الثوم وزيت الليمونين وزيت الكافور وزيت النعناع الفلفلي وزيت الريحان وخليط من هذه الزيوت ومبيد السليكرون. أظهرت النتائج المتحصل عليها أن كل معاملات التخزين ماعدا مبيد السليكرون والكنترول أعطت اختلافات معنويه في كل الصفات التى درست. اظهر استخدام زيت النعناع والقرنفل اقل معنوية في نسبة الإنبات وزن النبوت وطول النبت واقل فقد في الوزن في كلا الموسمين. وسجل زيت النعناع اعلي نسبة مئويه فى المادة الجافة و النشا وفيتامين ج ،ولكن أعطت اقل فيمه في نسبه السكر لنفس المعاملات خلال الموسمين. أوضحت النتائج تأثير الزيوت النباتية ومبيد السليكرون علي فراشة درنات البطاطس وذلك بعد أربعة شهور من التخزين حيث وصلت نسبة الإصابة (٤٨%-٤٨.٦٧%) في الكنترول بينما انخفضت متوسطات الإصابة بنسب تراوحت بين (٩٤.١٠%-٩٨.٨٦ و ٩٣.٢٣%-٩٦.٨٤)خلال الموسمين علي التوالي. وقد اعطى زيت النعناع وزيت القرنفل وزيت الكافور وخليط الزيوت انخفاضا فى نسبه الاصابه مماثلة السليكرون.عموما اوضحت النتائج ان كل الزيوت المستخدمة أعطت اعلي حماية من الآفة. وأيضا أوضحت نتائج الدراسة المعملية أن المعاملة بهذه الزيوت لها تأثير قاتل علي يرقات فراشة درنات البطاطس وتبين وجود اختلافات معنويه تبعا لنوع الزيت وزمن التعرض وكان الأفضل فعاليه زيت النعناع وزيت الكافور وزيت القرنفل وخليط الزيوت وتراوحت نسبةالقضاء على الافه من (٧٦.١٤ -١٠٠%) مقارنه بالسليكرون. أيضا هذه الزيوت كان لها تأثير مثبط لوضع البيض في الفراشات وصل نسبة التثبيط بين(٤٧.٥٤% إلي ٩٥.٠٢ %)ا لكل من زيت الثوم و زيت النعناع علي التوالي. وتوصي الدراسة بأنه يمكن رش زيت النعناع بتركيز (٢سم٣/لتر/طن) ٣ مرات أثناء تخزين درنات البطاطس بالنوالات (٤ شهور) وذلك لتقليل نسبة التزريع وفقد الوزن والتلف والحصول على أعلى نسبة مادة جافة ونشا وأقل إصابات بفراشة درنات البطا طس وأخيرا، فإنه يمكن التوصية بالرش بزيت النعناع وزيت الكافور، وزيت القرنفل وخليطهم حيث انها كانت الأفضل . أثناء التخزين للحصول على أفضل تخزين الأحرف والجودة. لقد بينت الدراسه باستخدام المعاملات الطبيعية انها آمنة جدا وفعالة في تحسين القدرة التخزينية وخفضت الى حد كبير نسبه الاصابة بفراشة درنات البطاطس فى الدرنات تحت ظروف التخزين فى النواله.