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Effect of *Cyperus rotundus* essential oil against two stored pests and grain quality of some wheat cultivars during storage period

George, M. Nasr[1]; Nevein, L. Eryan[2] and Tamer, Ismail[3]

[1] ***Plant Protection Research Institute, Agricultural Research Center, Dokki, Giza, Egypt.***[2]**Crop** [2]***Physiological Research Department, Field Crops Research Institute, Agricultural Research Centre, Egypt.***

[3]***Pesticide Chemistry and Toxicology Department, Agriculture Faculty, Kafrelsheikh University, Kafrelsheikh, Egypt.***

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Abstract

Stored product pests such as *Sitophilus oryzae* L. (Coleoptera: Curculionidae) and *Tribolium castaneum* (Herbst) (Coleoptera: Tenebrionidae) are considered major insect pests in stored grain. Chemical control had a negative influence on humans and the environment. Therefore, alternative and safe control methods for such pests are needed. Essential oil of *Cyperus rotundus* was tested against insect *S. oryzae and T. castaneum* on four wheat cultivars (Misr1, Geza171, Gemmeiza12 and Sids14) under laboratory conditions after 6 months of storage. The results indicated that the values of LC_{50} for *S. oryzae* and *T. castaneum* were (221, 341, 246, 313 ppm) and (972, 1824, 1779, 2180 ppm) after 72 hours for tested cultivars (Misr1, Giza171, Gemmeiza12 and Sids14), respectively. The effect of *Cyperus rotundus* oil on the seed viability, seedling vigor, chemical composition and physical properties of wheat grains was also evaluated. The results cleared that seeds were treated with oil *C. rotundus* and stored for 6 months did not significantly affect wheat grains germination percentage, root length, seedling dry weight and electrical conductivity and grain after harvest and was the highest compared to the control. Oil%, fiber content, wet gluten, 1000-grain weight and relative density were highly significant at harvest and decreased with storage. While, ash content and moisture content increased by storage. Giza171 cultivar produced the tallest root and shoot length. While, Gemmeiza12 gave the highest germination % and protein content and Giza171 cultivar gave the highest fiber content, moisture percentage, wet and dry gluten content. Otherwise, Misr1 cultivar gave the highest ash and total carbohydrate contents.

Introduction

Storage is the most important and critical post-harvest operation. Deterioration of the grain quality during storage can be due to improper storing conditions, which lead to contamination with fungi or insect infestation. Attia *et al.* (2014) and Yaseen *et al.* (2019) reported that cereals are stored easily for a long time because of low moisture content, providing a variety of acceptable products and also stored depending on market demand, size of production and the farmer's needs.

Many storage pests originate in the field. Seeds may appear to be free of insects at the point of harvest, but eggs and larvae from the field may still be present. Insects can also be introduced when seeds are put into previously infested seed containers or grain bins. Insect damage reduces seed germination and quality and is a major cause of post-harvest seed loss (Berkelaar and Motis, 2020).

Insects and other pests have an adverse effect on seed quality after it has been harvested and while it is being stored or conditioned. The insects that we have to be concerned with within seeds are the same as those in market grain storage. Some of these insects are internal-infesting insects that spend their developmental period inside individual seeds and others are external-infesting insects that develop totally on the outside of seeds. Each of these kinds of insects can result in a different type of damage as far as seed quality is concerned.

Sitophilus oryzae L. (Coleoptera: Curculionidae) and *Tribolium castaneum* (Herbst) (Coleoptera: Tenebrionidae) consider the major insect pests of stored grain. Controlling these pests by using synthetic insecticides during storage conduces pollution to the environment, residual toxicity for humans and consumers. Moreover, Benhalima *et al.* (2004) reported that *S. oryzae* has developed resistance to synthetic insecticides.

Essential oils have affected behavioral reactions to insect pests through contact toxicity (Gupta *et al*., 2011; Lal and Raj, 2012 and Sajedeh *et al*., 2018), fumigation (Zandi-Sohani and Ramezani, 2015), repelling effect (Demirci *et al*., 2017). Appling essential oils for controlling stored insects has been a matter recently (Isman, 2000), also, essential oils and plant derivatives are rapidly demolitions by moisture, sunlight and air. Their demolition means reducing the risk for non-target organisms (Guleria and Tiku, 2009 and Singh *et al.*, 2016).

Cyprus rotundus L. (Cyperaceae) has widespread in all tropical and subtropical regions (Parrotta, 2001). Meena *et al*. (2010) reported that *C. rotundus* has plentiful in steroids, triterpenes, tannins, anthraquinone and alkaloids, and it maybe has insecticidal activity. Another study showed that *C. rotundus* oil can be used as natural insecticide (Kempraj and Bhat, 2008). Bañez and Castor (2011) showed that *C. rotundus* oil has more effective than other insecticide groups (Carbamate and organophosphate) against aphids, ants and flies.

Effect of *C. rotundus* oil on viability and vigor of seeds, chemical composition and physical properties of seeds is important to determine if this oil is safe for consumers. Little information is known about the relationship between chemical and physical composition of tested wheat grain and resistance to stored grain insects in wheat with C. *rotundus* oil.

The aim of this study was to evaluate the insecticidal activity of *C. rotundus* oil against two stored grain pests *S. oryzae* and *T. castaneum* in four cultivars of wheat grains (Misr1, Giza171, Gemmeiza12 and Sids14) and to determine some chemical constituents and physical properties in stored wheat grains.

Materials and methods

1. Rearing of tested insects:

Adults of rice weevils *S. oryzae* and red flour beetle *T. castaneum* were reared at Department of Stored Product Pests, Plant Protection Research Institute, Sakha Agriculture Research Station under laboratory conditions of 28 ± 1o C and 65 ±5% RH. New emerged adults (1-2 weeks) was selected for the toxicity evaluation tests.

2. Contact toxicity bioassay:

Stock oil solution was diluted in analytical grade acetone, and five concentrations (50, 100, 250, 500, 1000 ppm) for *S. oryzae* and (500, 1000, 2000, 4000, 8000 ppm) for *T. castaneum* was prepared. Each concentration was mixed and shacked for ten min. with a wheat grain (1 ml / 20g wheat) in a sterile jar (250 ml) then left to dry. All concentrations were replicated three times for each cultivar. Twenty adults of both insects were separately transferred to each jar and covered with cotton and tied with rubber bands. The same procedure with acetone only was used as a control. Mortality was recorded after 24, 48, and 72 hrs. and corrected using the formula of **Abbott`s (1925)**. Lethal concentrations LC50 and LC90 were calculated using probit analysis, **Finney (1971)**.

3. Seed storage:

Wheat seeds under investigation were produced at Sakha Agricultural Research Station during 2018/2019 season. Biochemical analysis and laboratory germination studies were conducted at Sakha Seed Technology Laboratory, Field Crops Research Institute, Giza. Four wheat cultivars namely Misr1, Giza171, Gemmeiza12, and Sids14 were utilized in this study to determine grain quality.

A batch of 500g of each cultivar was treated with higher LC90 (8000 ppm) values estimated in the toxicity experiment for *C. rotundus* oil, the grain was placed in glass jars then jars were shaken manually until the solvent evaporate. The grain was replaced and kept in a polyethylene package under room conditions and then stored for 6 months. The untreated wheat grain was used as a control.

4. Quality characteristics:

Random grain samples both treated or controled were taken after harvest and 6 months to determine seed viability, seedling vigor, some chemical composition and some physical properties.

5. Viability traits:

A standard in vitro germination test (A.O.S.A., 2000) was conducted on four replicates of 50 seeds for each sample using folded paper towels at 20◦C and germination counts for normal seedlings were done after seven days. Ten of normal seedlings from each replicate were taken randomly to measure the shoot and radical length in (Cm). After that, the seedlings were dried in a hot air oven at 85◦C for 12 hrs. to obtain the seedling dry weight which was determined according to the procedures reported in the seed vigor testing handbook (A.O.S.A., 2000).

The electrical conductivity (EC) of leached from four replicates of 50 seeds weighed and soaked in 250 ml of distilled water for 24 hrs. was measured in µ-mhos/g seed using a conductivity meter, were carried out under optimum conditions according to the international rules (**I.S.T.A., 1993**).

6. Chemical composition of grain:

Seed samples were cleaned and materials then ground to a fine powder to pass through 2 mm were used for chemical analysis at the beginning and the end of the storage period according to the procedures outlined in (**A.O.S.A., 2000**) and to determine the moisture %, crude protein, fat %, ash content, crude fiber and total carbohydrates content.

7. Physical properties:

Wet and dry gluten were measured by handwashing 25g flour according to the standard method (AACC, 10-38, Anonymous, 1983) until starch was detected in washing water then dried and weighed. One thousand seed weight was carried out according to I.S.T.A. (1999) regulations. The relative density of the seed was calculated according to Karmer and Twigg (1962).

8. Statistical analysis:

Data were statistically analyzed according to the factorial completely randomized design with three replicates. Analysis of variance computed according to Snedecor and Cochran (1982) and treatment means (Storage period and cultivars) were compared by Duncan Multiple Range Test (Duncan, 1955).

Results and discussion

The toxicity of *C. rotundus* oil depends on LC_{50} and confidence was investigated. All concentrations showed significant mortality percentages after 72 hrs. of exposure for *S. oryzae* and *T. castaneum* on the four cultivars.

1. *Sitophilus oryzae*:

After 72 hrs. of exposure at a rate of 1000 ppm mortality recorded was Misr1 (90.00%) followed by Gemiza12 (80.00%), Seds14 (73.30%) and Giza171 (70.60%) compared with control (Figure 1). Based on LC50's, Misr1 had the most response to *C. rotundus* oil compared to Giza171 which was the least one (Table 1). Also, on LC_{90}'s the results gave the same directionality after 24, 48 and 72 hrs.

Table (1): Toxicity of *Cyperus rotundus* essential oil against adults of *Sitophilus oryzae* after 24, 48, 72 hrs.

Cultivars	LC_{50} (ppm) (Confidence limits)	Slope ± SE	LC_{90} (ppm) (Confidence limits)
24 hrs. post exposure			
Misr 1	736 (578 – 1014.13)	1.40 ± 0.15	6053 (3484 – 13965)
Giza 171	763 (590 – 1079.03)	1.34 ± 0.15	6836 (3793 – 16873)
Gemmiza12	796 (613 – 1137.89)	1.35 ± 0.15	7183 (3942 – 18113)
Sids 14	986 (745 – 1465.68)	1.39 ± 0.16	8212 (4406 – 11762)
48 hrs. post exposure			
Misr 1	453 (376 – 554.82)	1.38 ±0.14	3706 (2320 – 7343)
Giza 171	506 (398 – 687.95)	1.12 ± 0.13	5789 (3202 – 14385)
Gemmiza12	447 (361 – 578.41)	1.34 ± 0.14	4043 (2467 – 8381)
Sids 14	613 (475 – 860.06)	1.22 ± 0.13	6966 (3651 – 19203)
72 hrs. post exposure			
Misr1	221 (184 – 264)	1.56± 0.14	1461 (1058 – 2271)
Giza 171	341 (267 – 453)	1.08 ± 0.13	5145 (2769 – 13651)
Gemmiza12	246 (200 – 303)	1.34 ±0.13	2217 (1467 – 4016)
Sids14	313 (246 – 408)	1.11 ±0.13	4379 (2451 – 10783)

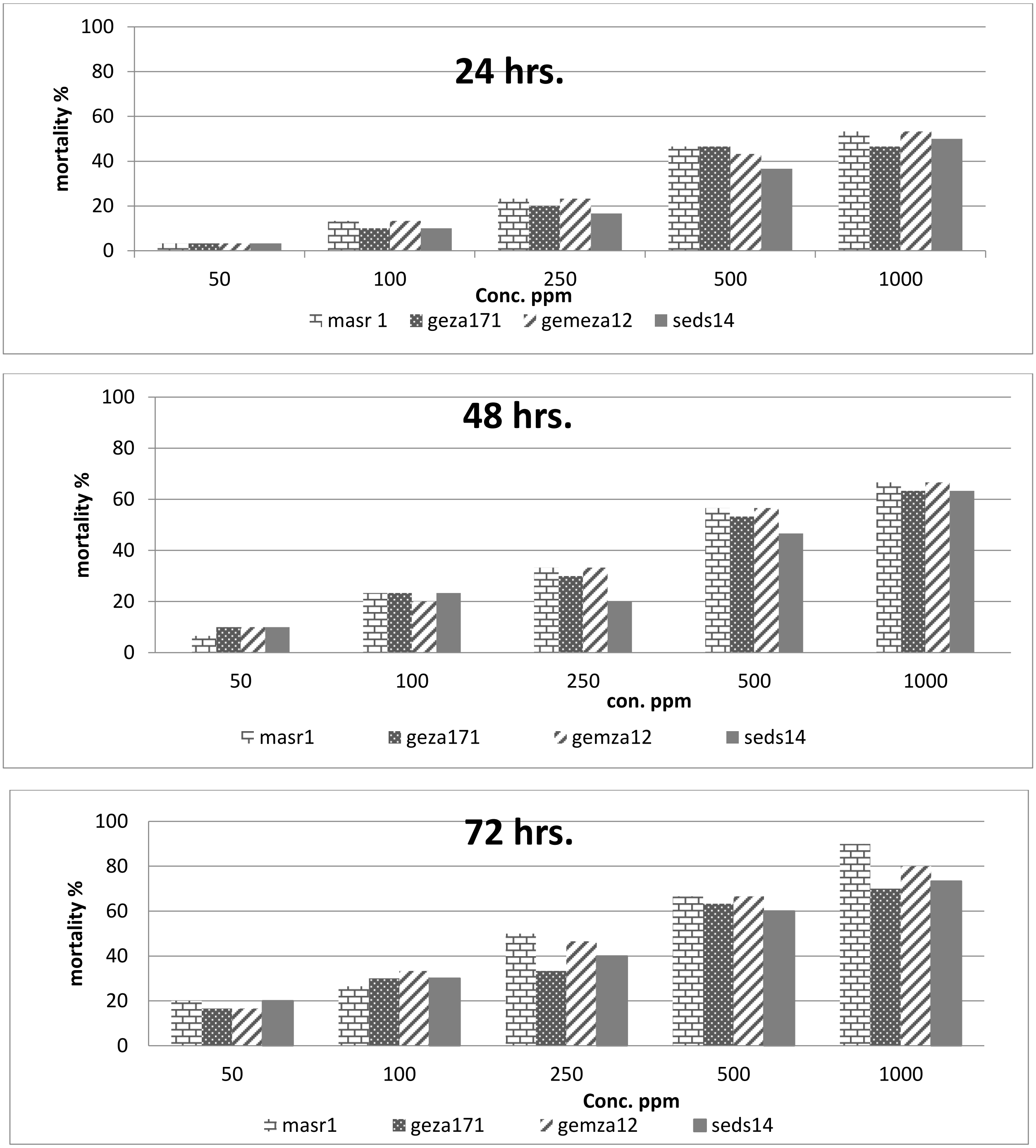


Figure (1) : Mortality percentage of *Sitophilus oryzae* adults at various concentrations of *Cyperus rotundus.*

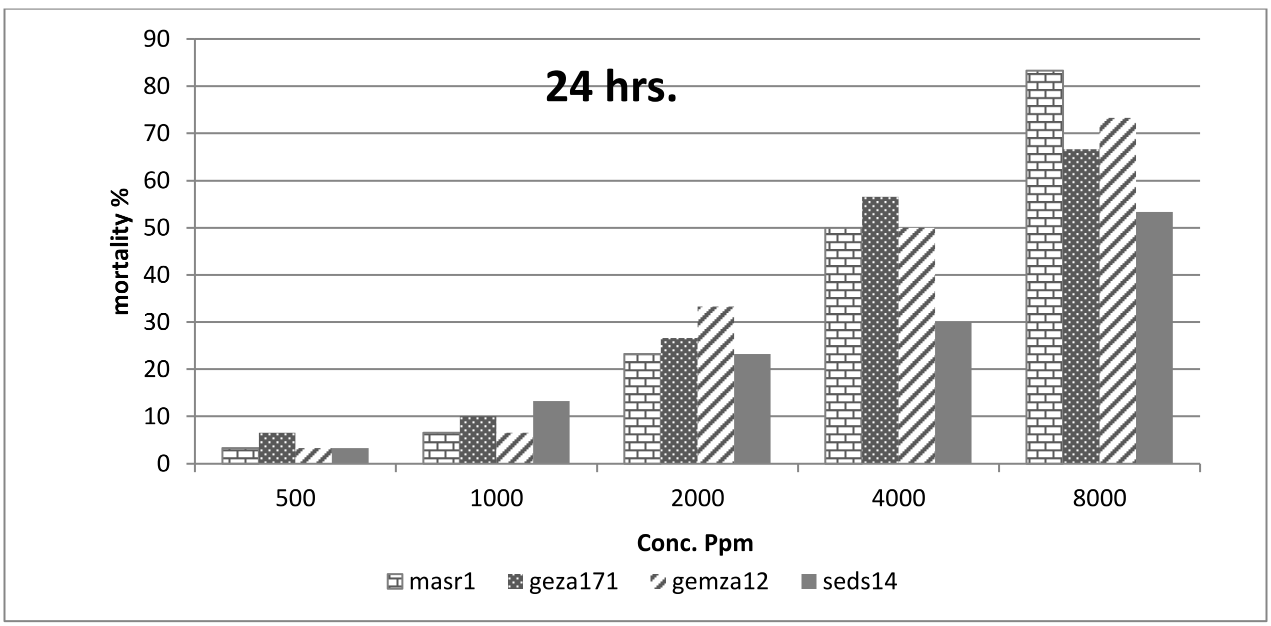
2. *Tribolium castaneum*:

At the highest experimental concentration 8000 ppm mortality percentage was, Misr1 (98.30%) followed by Giza171 (90.60%), Gemiza12 (86.60%) and Seds14 (83.30%) after 72 hr. of exposure (Figure 2).

Data obtained in Table (2) showed that the LC50 Values were 972 and 2180 ppm for verities Misr1 and Seds14, respectively. According data obtained in Tables (1 and 2) *T. castaneum* was more tolerant than *S. oryzae* with all concentrations at all periods of exposure.

Table (2): Toxicity of *Cyperus rotundus* essential oil on adults of *Tribolium castaneum* after 24, 48 and 72 hrs.

Cultivars	LC_{50} (ppm) (Confidence limits)	Slope ± SE	LC_{90} (ppm) (Confidence limits)
24 hrs. post exposure			
Misr1	3706 (3263 – 4262)	2.49 ± .20	12096 (9627 – 16371)
Giza 171	4104 (3463 – 5016)	1.80 ± 0.1	21116 (14783 – 34891)
Gemmiza12	3906 (3378 – 4608)	2.13 ±0.18	15568 (11746 – 22834)
Sids14	7525 (5731 – 8112)	1.40 ± .10	61578 (33093 –64714)
48 hrs. post exposure			
Misr1	1394 (1179 – 1626)	2.09 ±0.17	6262 (5300 – 7666)
Giza 171	2756 (2332 – 3305)	1.67 ± 0.1	16126 (11448 – 26046)
Gemmiza12	2618 (2254 – 3070)	1.89 ±0.16	1238 (9330– 18149)
Sids14	3730 (3084 – 4684)	1.52± 0.15	2594 (16843 – 48677)
72 hrs. post exposure			
Misr1	972 (849 – 1098)	2.34 ±0,21	2756 (2355 – 3370)
Giza 171	1824 (1551 – 2138)	1.77 ± 0.1	9637 (7288 – 14083)
Gemmiza12	1779 (1506 – 2093)	1.72 ±0.1	9597 (7209 – 14189)
Sids14	2180 (1819 – 2625)	1.15±0.14	15248 (10583 – 25689)



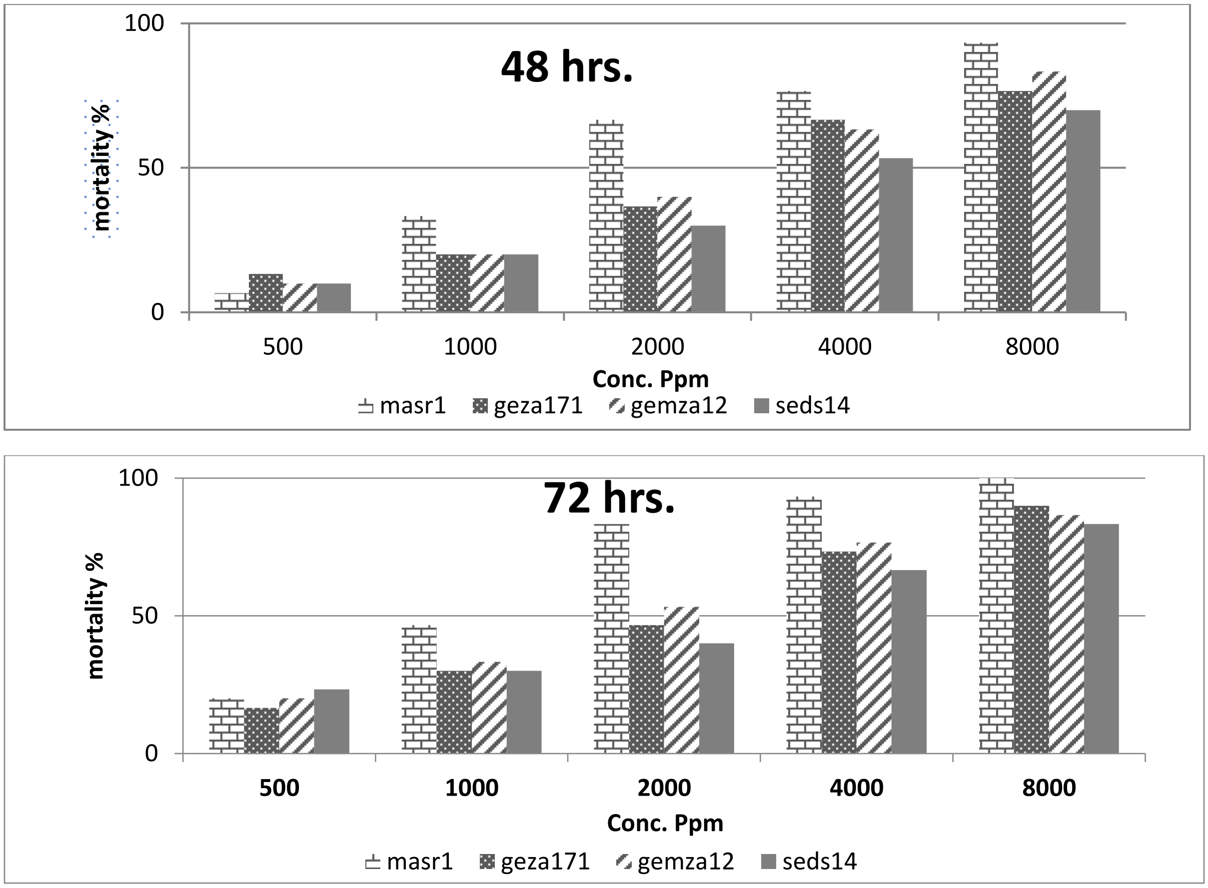


Figure (2): Mortality percentage of *Tribolium castaneum* adults at various concentrations of *Cyperus rotundus.*

Data in Tables (3, 4 and 5). Showed that there were no significant differences between after harvest and 6 months in the germination percentage, where it was 97.00 and 95.00 % compared to the control was 84.67% (Table 3). The tallest shoot and root length and heaviest seedling dry weight were obtained after harvest which was 14.28, 10.64 cm and 0.168g followed by 6 months with values of (12.63, 9.60 cm and 0.129 g and control 11.38, 8.13 cm and 0.088g), respectively.

The electrical conductivity in this study was not significant by affected with storage period between after harvest and 6 months treated (8.50 and 9.00 µS cm-1g-1,), respectively, while there was a significant difference between treatments and control which had the highest value (9.94 µS cm-1g-1). The effect of the storage period on chemical composition of the wheat grain is given in (Table 4).

Increasing the storage period after harvest to 6 months had not significantly affect the protein mean percentage (13.25 and 13.24 %). But there was significant difference between treatments and control of protein percentage (13.33 %). Increasing storage period after harvest to 6 months significantly decreased the mean oil percentage (From 3.41 to 3.14 %) compared to control (1.49%) and also fiber content reduced (from 1.35 to 1.25 %) compared to control (1.14 %).

In addition, results showed that increasing of storage period from zero to 6 months significantly increased the percentages of ash, carbohydrates and moisture content. Meanwhile, there were significant differences between treatments and control. The control was the highest for ash%, carbohydrate% and moisture% compared to biomaterials. Increasing the storage period from zero time to 6 months decreased all tested parameters for example 1000-grain weight reduced (From 50.66 to 47.37g), wet gluten reduced (From 25.41 to 22.55 %) and relative density reduced (from 1.14 to 0.79 %), except dry gluten, there were significant differences between treatments and control (Table 5).

Data acquired in Table (3) showed that Gemmiza12 cultivar produced the highest germination percentage (98.33%). While, Giza171 had the highest values in shoot length (13.86 cm) and electrical conductivity (11.45 μ-mhos). Sids14 produced the lowest shoot length (12.05 cm), root length (8.28 cm) and electrical conductivity (6.93 μ-mhos), respectively. The type of cultivar had a significant effect on all tested parameters except the oil% (Table 4).

Results obtained presented that the highest crude protein content of wheat grain was recorded for Gemmiza12 (13.63 %), while the highest ash content was recorded with cultivar Misr1 (1.67%) as well Giza171 and Sids14 had the highest fiber content the first rank belonging to (1.33 %) and (1.31 %), respectively. Misr1 cultivar produced the highest total carbohydrate content (81.88%) and Giza171 cultivar gave the highest moisture (12.88%). The four wheat cultivars showed significant differences in the values of wet gluten, dry gluten, 1000-grain weight and relative density as presented in (Table 5).

The results showed that the grains of Giza171 cultivar had a high wet gluten content (28.72 %), dry gluten content (10.87 %) and 1000-grain weight (52.81 g) in comparison with other cultivars. Sids14 cultivar produced the lowest wet gluten content (18.59 %), and dry gluten content (7.13 %) while, Gemmiza12 cultivar gave the lowest 1000-grain weight (42.03 g). These results might be attributed to the differences among these cultivars in their genetic constitutions as well as their response to the prevailing environmental conditions.

Table (3): Effect of storage period and oil treated wheat cultivars on germination, shoot length, root length, seedling dry weight and electrical conductivity.

Characters	Germination%	Shoot length (cm)	Root length (cm)	Seedling dry weight (g)	Electrical conductivity (μ-mhos)
			Storage period		
After harvest	97.00 a	14.28 a	10.64 a	0.168 a	8.50 b
6 month treated	95.00 a	12.63 b	9.60 b	0.129 ab	9.00 b
Control	84.67 b	11.38 c	8.13 c	0.088 b	9.94 a
F-test	**	**	**	*	**
			Cultivars		
Misr 1	94.22 ab	12.22 c	10.42 a	0.105 a	9.66 b
Giza 171	91.33 c	13.86 a	9.98 ab	0.128 a	11.45 a
Gemmiza 12	98.33 a	12.93 b	9.13 bc	0.154 a	9.23 b
Sids 14	95.78 ab	12.05 c	8.28 c	0.126 a	6.93 c
F-test	*	**	**	N.S	**

***, ** and NS indicated P<0.05%, P<0.01% and not significant, respectively.**

Table (4): Effect of storage period and wheat cultivars were treated on crude protein, oil, ash content, fiber content, total carbohydrate content and moisture.

Characters	Protein %	Oil %	Ash %	Fiber %	Carbohydrate %	Moisture %
Storage period						
0 month	13.25 b	3.41 a	1.47 c	1.35 a	80.18 c	11.36 c
6 months treated	13.24 b	3.14 b	1.55 b	1.25 b	81.49 b	12.42 b
Control	13.33 a	1.49 c	1.62 a	1.14 c	82.25 a	13.15 a
F-test	*	**	**	**	*	**
Cultivars						
Misr1	12.90 d	2.48 a	1.67 a	1.18 b	81.88 a	12.26 b
Giza 171	13.33 b	2.83 a	1.60 b	1.33 a	80.97 c	12.88 a
Gemmiza12	13.63 a	2.72 a	1.55 c	1.17 b	81.03 c	11.76 c
Sids14	13.21 c	2.71 a	1.47 d	1.31 a	81.35 b	12.32 b
F-test	**	N.S	**	*	**	**

***, ** and NS indicated P<0.05%, P<0.01% and not significant, respectively.**

Table (5): Effect of storage period and wheat cultivars were treated on wet gluten, dry gluten, 1000-grain weight and relative density.

Characters	Wet gluten %	Dry gluten %	1000-grain weight (g)	Relative density %
Storage period				
0 month	25.41 a	9.45 a	50.66 a	1.14 a
6 months treated	23.87 b	9.38 a	47.37 b	1.02 b
Control	22.55 c	9.17 a	45.63 b	0.79 c
F-test	**	N.S	**	**
Cultivars				
Misr1	26.21 b	10.05 b	48.27 b	1.05 a
Giza 171	28.12 a	10.87 a	52.81 a	1.03 a
Gemmiza12	23.21 c	9.29 c	42.03 c	1.05 a
Sids14	18.23 d	7.13 d	48.44 b	1.04 a
F-test	**	**	**	N.S

***, ** and NS indicated P<0.05%, P<0.01% and not significant, respectively.**

The storage period and four wheat cultivars interaction showed that root length and seedling dry weight were not affected significantly in Table (6). Misr1, Giza171, Gemmiza12 and Sids14 with control and Misr1, Gemmiza12 and Sids14 with 6 months treated produced the highest germination percentage. While, Giza171 with after harvest gave the highest shoot length (15.53 cm), Sids14 cultivar with after harvest produced the lowest electrical conductivity of the seed soak water (5.86 µ-mhos). The results of the protein %, oil %, ash, fiber and carbohydrate contents indicated that the interaction between storage period and cultivars was a significant effect in Table (7). Gemmiza12 cultivar was the highest protein content (14.51%) with control. While, the highest oil content was produced with all cultivars and after harvest and 6 months treated. Misr1 produced the highest ash content (1.74 %) with control. The highest fiber content was highest at Sids14 at after harvest (1.47 %). On the other hand, total carbohydrate content was the highest with Gemmiza12 with control (82.81 %). The moisture% was highest with Misr1 and Giza171 with control (13.41 and 13.31 %). The results showed that the percentage of wet gluten content significantly increased from (17.18 to 30.30%) and dry gluten from (6.78 to 11.40 %), respectively with an increasing storage period with Giza171. In contrast, Giza171 gave the heaviest 1000- grain weight (54.75 g) with after harvest. While, Gemmiza12 with after harvest produced highest relative density (1.265%) in (Table 8).

Table (6): Impact of interaction between storage period and wheat cultivars were treated on germination, shoot length, root length, seedling dry weight and electrical conductivity.

Storage periods	Cultivars	Germination %	Shoot length (cm)	Root length (cm)	Seedling dry weight (g)	Electrical conductivity (μ-mhos)
After harvest	Misr1	96.00 a	13.47 cd	11.63 a	0.132 a	8.94 de
After harvest	Gizga 171	97.33 a	15.53 a	11.60 a	0.134 a	10.35 bc
After harvest	Gemmiza12	97.33 a	14.55 b	10.59 ab	0.251 a	8.84 de
After harvest	Sids14	97.33 a	13.57 c	8.73 b-d	0.155 a	5.86 f
6 months treated	Misr1	97.33 a	13.19 cd	10.27 a-c	0.116 a	9.01 cd
6 months treated	Giza 171	90.00 b	13.25 cd	10.39 a-c	0.147 a	10.80 b
6 months treated	Gemmiza12	97.33 a	12.34 ef	9.37 b-d	0.125 a	8.87 de
6 months treated	Sids14	95.33 a	11.74 f	8.36 cd	0.127 a	7.73 e
Control	Misr1	89.33 b	9.99 h	9.37 b-d	0.067 a	10.50 bc
Control	Giza 171	72.00 c	12.78 de	7.96 d	0.103 a	12.78 a
Control	Gemmiza12	86.67 b	11.90 f	7.44 d	0.085 a	9.72 cd
Control	Sids14	94.67 a	10.85 g	7.75 d	0.095 a	6.77 f
F-Test		**	**	**	N.S	**

***, ** and NS indicated P<0.05%, P<0.01% and not significant, respectively.**

Table (7): Impact of interaction between storage period and wheat cultivars were treated on crude protein, oil, ash content, fiber content, carbohydrate content and moisture.

Storage period	Cultivars	Protein %	Oil %	Ash	Fiber	Carbohydrate	Moisture %
After harvest	Misr1	12.83 gh	3.50 a	1.60 cd	1.34 b	80.70 ef	11.15 d
After harvest	Giza 171	13.25 e	3.58 a	1.51 e	1.37 b	80.31 f	12.23 bc
After harvest	Gemmiza12	13.57 c	3.34 a	1.42 f	1.22 de	79.25 g	10.99 d
After harvest	Sids14	13.34 de	3.23 a	1.34 g	1.47 a	80.47 f	11.05 d
6 months treated	Misr1	12.91 d	2.47 b	1.67 b	1.19 e	82.35 bc	12.22 bc
6months treated	Giza 171	13.85 b	3.50 a	1.60 cd	1.35 b	81.02 e	13.11 a
6months treated	Gemmiza12	12.80 e	3.37 a	1.58 d	1.19 e	81.03 e	11.82 c
6months treated	Sids14	13.39 c	3.24 a	1.48 e	1.28 c	81.54 d	12.52 b
Control	Misr1	12.98 d	1.48 c	1.74 a	1.02 g	82.58 ab	13.41 a
Control	Giza 171	12.91 d	1.40 c	1.70 ab	1.26 cd	81.59 d	13.31 a
Control	Gemmiza12	14.51 a	1.43 c	1.65 bc	1.10 f	82.81 a	12.48 b
Control	Sids14	12.90 de	1.66 c	1.58 d	1.19 e	82.03 c	13.41 a
F-Test		**	*	**	**	**	**

***, ** and NS indicated P<0.05%, P<0.01% and not significant, respectively.**

Table (8): Impact of interaction between storage period and wheat cultivars were treated on wet gluten content, dry gluten content, 1000-grain weight and relative density.

Storage period	Cultivars	Wet gluten %	Dry gluten %	1000-grain weight (g)	Relative density %
After harvest	Misr1	28.53 b	11.04 ab	51.73 b	1.11 ab
After harvest	Giza 171	30.30 a	11.40 a	54.75 a	1.04 bc
After harvest	Gemmiza12	23.62 e	8.78 f	45.98 ef	1.26 a
After harvest	Sids14	19.20 g	7.47 g	50.20 c	1.13 ab
6 months treated	Misr1	23.30 ef	9.00 f	47.70 d	1.03 bc
6 months treated	Giza 171	28.17 bc	10.51 cd	52.15 b	1.03 bc
6 months treated	Gemmiza12	25.70 d	9.99 e	41.71 g	0.96 c
6 months treated	Sids14	18.30 h	7.14 gh	47.91 d	1.04 bc
Control	Misr1	26.80 c	10.12 de	45.38 f	1.00 bc
Control	Giza 171	25.90 c	10.69 bc	51.52 bc	1.00 bc
Control	Gemmiza12	20.31 f	9.11 f	38.41 h	0.92 c
Control	Sids14	17.18 h	6.78 h	47.20 de	0.96 c
F-Test		**	**	**	*

***, ** and NS indicated P<0.05%, P<0.01% and not significant, respectively.**

Results obtained discern that contact toxicity of *C. rotundus* oil had strong activity against the two tested insects. Effectiveness on mortality percentages was determined by increasing concentration and exposure time needed to obtain morbidity results of mortality percentage. These results agree with Sajedeh *et al.* (2018) reported that *C. rotundus* oil had good action on mortality percentages against *Trogoderma granarium, Callosobruchus maculatus* and *Oryzaephilus surinamensis.* Abdel-Sattar *et al.* (2010) concluded that *C. rotundus* had a greater lethal impact than *Schinusmolle* L. on *T.granarium.* Also, El Monairy and Kamel (2011) confirmed that *C. rotundus* oil was effective against *S. oryzae*.

4. Quality characteristics:

The general effect of storage time on germination percentage, seedling quality attributes chemical composition and physical properties of wheat cultivars. The highest germination percentage and lowest electrical conductivity after harvest and after 6 months treated had no significant effect perhaps due to the high seed viability and maintaining its vitality when using C. *rotundus* oil this result was in agreement with Derbalah and Ahmed (2011) who reported that at the end of the 168 days test period the seed germination of *Cymbopogon nardus and Cymbopogon zeylanicum* treatments and the untreated control were not significantly differed (p>0.05).

Seedling vigor parameters (shoot length, root length and seedling dry weight) were significantly affected by storage periods (Seadh *et al.* , 2019), found that increasing storage periods of a rice grain from 3, 6, 9 and 12 months after harvesting significantly affected seedling parameters (Shoot lengths). The proportional increase in mineral content in all treatments is due to the consumption of organic compounds due to the grain metabolism during storage and the values observed are proportional to the increase in the acidity, also minerals content in grain and consequently in the flour is influenced by genetic factors, edaphic and climatic conditions, agronomic, physiologic (Stage of maturation of the grain in the crop) and technological (Conditioning of the grain before milling grinding and degree of extraction of the flour during the milling).

For moisture content Adly *et al.* (2011) and Ahmed (2015) found that extending the storage period from 1 to 10 days decreased the moisture content of the flour, and this decline increased the storage period up to thirty days (Alakali *et al.*, 2016) reported that there was no significant difference ($p \leq 0.05$) in the moisture %, carbohydrate content and fiber content among biomaterials of garlic, ginger, black pepper and lemongrass and the control. Also, Ahmed (2015) and Keskina and Ozkayab (2015) reported that the 1000-grain weight, oil and ash contents and gluten decreased with the increase of storage period. Sabrina *et al.* (2016) confirmed that the lowest quality performance was observed from the earthen pot.

BARIGom 26 performed best quality in retaining highest the germination percentage, shoot and root length, and seedling dry weight with the lowest electrical conductivity and days to germination. The findings of the present study are in line of Adly *et al.* (2011) who found that Gemmeiza7, Gemmeiza10 and Giza168 had more favorable abilities for better storability and had the highest germination percentage and the lowest electrical conductivity than other varieties. Also, Gemmeiza7 and Gemmeiza10 had the highest significant crude protein and 1000- seed weight and the lowest total carbohydrate content compared with other varieties. These results are in agreement with El-Sisy *et al.* (2015) reported that there were highly significant differences among wheat genotypes in 1000-grain weight, moisture content, wet and dry gluten.

From this study, it could be concluded that use of essential oil of *Cyperus rotundus* by LC_{90} which leads to more controlling insect infestation and keep their viability 6+ without deterioration as compared with the control. Misr1 gave the higher mortality after 72 hrs. followed by Gemiza12, Seds14 and Giza171 comparing control. On the other hand, Gemmiza12 gave the highest germination% and protein content %. While, Giza171 produced the highest both fiber content, wet and dry gluten content % and heaviest 1000-grain weight.

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