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Effect of Magnetic Field on Seed Viability and Insect Infestation of Some Wheat Varieties

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ABSTRACT

The effect of magnetic field periods (1 min, 6 and 12 h) exposure of some infected wheat seed varieties (Masr-1, Sids-12 and Sakha-93) with two stored grains insects *Sitophilus oryzae* (L.) and *Rizopertha dominica* F. to low static magnetic field (30&60 mT) on mortality (%), reduction in F_1 progeny (%), seeds germination (G%), seed and seedling vigor traits were studied under controlled laboratory conditions. Results showed that, the mortality percentage of both insects increased with increasing of MFs levels and time exposure. Magnetic field level at 60 mT for 12 hrs was the most effective against tested insects in which mortality percentage of *S. oryzae* was 56.60, 53.30 and 50.00 % with Masr-1, Sakha-93 and Sids-12 respectively after 10 days from exposure period while at the same level and time, mortality percentage of *R. dominica* was 45.00, 36.60 and 33.30% with Sids-12, Sakha-93 and Masr-1, respectively. Exposure infected seeds with (*S.oryzae* and *R.dominica*) to magnetic field treatments 60 mT for (1 min.,6 and 12 h) positively affected on all seed and seedling vigor parameters compared to control treatment (infected seed without magnetic treatment). Moreover almost equaled with uninfected seeds but it showed significant effect on all parameters comparing with untreated seeds.The results suggest that pre-sowing low-magnetic field treatment has the potential to improve seed germination and seedling vigor traits of infected wheat verities with stored grain insects*(S. oryzae* or *R. dominica*) through reduction in F_1- progeny and increasing mortality percentage.

Keywords: Magnetic Field – *Sitophilus oryzae- Rizopertha dominica-* Germination

INTRODUCTION

According to a 1990 survey of extension specialists through- out the United States, stored grain losses exceeded $500 million for the year. Most of these losses resulted from infestation by several species of insect pests and damage by numerous molds and mycotoxins. Losses resulting from insect infestations are wide spread and involve more than loss of quality (Phillip and Meronuck, 1995). Damaged kernels are of lighter weight and result in discounts when marketed. Insect infestation also causes a reduction in nutrients in the grain. Controlling insects with insecticides, including fumigants, rather than using preventative methods incurs great cost. In addition, infestation generally results in dissatisfied customers and related marketing problems that develop from a poor reputation in marketing channels. Wheat containing 32 or more IDK(insect damaged kernels)per 100 grams would result in the wheat being designated as sample grade. Restricting the sale of wheat for livestock feed is a significant loss-a loss that some sellers attempted to reduce by claiming the damage occurred in shipment and should be covered by insurance. This claim is not justified since this type of damage (primarily adult insect emergence holes) could not occur in the short shipment period (7 to 14 days). The insects producing IDK damage require 30 to 45 days for development and emergence from the kernels

Investigations on the influence of magnetic fields on seeds and plants over many years suggest that they lead to better plant growth and yield than chemical fertilizers and contributed to the improvement of the crop productivity and protection. In addition, there have been developed magnetictechnologies in several countries that are ecologically friendly and non-polluting to the soil and arepotentially attractive as being affordable to farmers (Liboff *et al*., 1992; Katsen *et al*., 2003).

Magnetic Fields (MFs) is not expensive, and at the same time not dangerous to the environment, Other than many radiation sources. (MFs) has attracted the attention of researchers due to their biological effects. Most of the studiesabout MFs' effects have focused on vertebrates and relatively fewer studies have been done on insectsand their stored-product environment (Starick *et al*., 2005).MFs have been shown to affect the orientation (Jones and Macfadden, 1982), oviposition and development (Ramirez *et al*., 1983), fecundity and behavior (Starick *et al*., 2005) of a wide variety ofinsects.

MATERIALS AND METHODS

The presentresearch was conducted at Seed Technology Research Unit, Field Crops Research Institute and Plant Protection Research Institute - Agriculture Research Centre, Mansoura, Egypt to evaluate the effect of magnetic field on seed germination characters of three wheat varieties (Masr-1,Sids-12 and Sakha-93) infected with two primary stored grain insects rice weevil, *Sitophilus oryzae* (L.) and lesser grain borer, *Rizopertha dominica* F. Seeds were obtained from Wheat Research Department, Field Crops Research Institute, Agriculture Research Centre, Giza, Egypt and were infected with the two insect pests at Plant Protection Research Institute.

Insect rearing:

Adults of *S.oryzae* and *R.dominica* were reared in glass jars (each of approximately 500 ml) containing about 250 gm of wheat seeds. Each jar was covered with muslin cloths and fixed with rubber bands for egg laying to obtain large numbers of adults needed for the tests and incubated at 30±2°c and 65±5 % R.H.

Bioassay tests:

Twenty adults of *S. oryzae* and *R. dominica* (1-2 week old) infesting 10 gm of three wheat seeds varieties ((Masr-1,Sids-12 and Sakha-93) were exposed to round permanent magnets of about 30 and 60 mT through different time (1 min., 6 and 12 hrs). Each treatment replicated 3 times. After exposure period, the mortality percentage was recorded after 2,4,6,8 and10 days then the live insects were removed and the replicates were incubated at 30±2°c and 65±5 % R.H. to investigate the reduction in F1-progeny after 60 days.

Germination tests:

Seeds immersed in 5% Naocl (Sodium hypochloride solution) for 5 min to avoid fungal invasion. Germination tests were performed according to ISTA, (1999),8 replicates of 50 seeds from each treatment (400 seeds) were placed in Petri dishes (12cm) containing 3 layers of moistened blotters and incubated in the growth chamber at 20± $2^o{}_C$ to study the following parameters:

- Germination percentage defined as the total number of normal seedlings at the end of the test after seven days.
- **Germination rate (GR):** It was calculated according to Bartllett,(1937):
  GR= a + (a +b) + (a + b + c) ……..(a + b + c + m)/ n (a + b + c + m)
  In which a, b, c are No. of seedlings in the first, second and third count, m is No. of seedlings in final count, n is the number of counts.
- **Mean Germination Time (MGT):** calculated based on the equation of Ellis and Roberts (1981). MGT= $\Sigma Dn/ \Sigma n$
  Where (n) is the number of seeds, which were germinated on day, D is number of days counted from the beginning of germination.
- **Speed Germination Index (SGI):** calculated according to the Association of Official Seed Analysis (AOSA., 1983) equation:

$$SGI=\frac{\text{No. of germinated seed}}{\text{Days of first count}}+\ldots\ldots+\frac{\text{No. of sgerminated seed}}{\text{Days of final count}}$$

The seeds were considered germinated when the radical was 2 mm long at least

- **Co-efficient of germination (CG):** It was calculated using the following formula (Copeland 1976).

$$\text{Co-efficient of germination} = \frac{100(A1 + A2 + \ldots\ldots An)}{A1T1 + A2T2 + \ldots\ldots AnTn}$$

Where,

A = Number of seed germinated.

T = Time (days) corresponding to A.

n = No. of days to final count.

- **Seedlings length (cm):** It was measured of ten normal seedlingsat 7 days after planting.
- **Seedlings dry weight (gm):** Ten normal seedlings at 7 days after planting, the seedlings were dried in hot-air oven at 85^o C for 12 hours to obtain the seedlings dry weight (g).
- **Seedling vigor:** It was calculated according to Abdul Baki and Anderson (1973) as;

Vigor index I = Germination (%) x Seedling length (Root +Shoot)

Vigor index II = Germination (%) x Seedling dry weight (Root +Shoot)

- **Electrical conductivity**of seed leakages was determined for 50 individually weighed seeds per sample placed into 250 mL distilled water at 20°C. After 24 h the leakage electrical conductivity was measured using the CMD 830 WPA(Matthews and Powell, 1981). The conductivity was expressed as µmhos/g seed

Seed Components Analysis:

Moisture %, crude fats%, crude protein%, ash % and carbohydrates % were determined in grains after complete application of magnetic treatments.

Total ash content: 2 gram of grains sample were added into previously weighed porcelain crucible, place in muffle furnace for 2 hours at 600^OC then placed in desiccators and weigh. The weight of the residue was calculated and expressed as percent ash (AOAC, 2000).

Crude Fat (Ether Extract): 10 gram of each powdered grains sample were extracted using (Soxhlet) with a solvent of petroleum ether (b.p.60-80^OC) for 16 hours. Each extract was dried over anhydrous Na_2SO_4 and evaporated to dryness. The residue was dried at 80^OC for 10 minutes, cooled, weighed and expressed as percent lipid (AOAC, 2000).

Crude Fiber Contents: 2 gram of each sample defatted powder were boiled with 1.25% sulphuric acid for 30 minutes and filtered. The residue was dried at 100^OC to constant weight the difference between the weight of residue after drying at 110^OC and the of powder represents the weight of crude fiber (AOAC, 2000)

Crude Protein: calculated by multiplying the total nitrogen by the factor 6.25. According to (AOAC, 2000),

Moisture Contents: Five g air-dried powder sample were accurately weighed and dried in an oven until constant weight was obtained. The loss in weight was calculated according to (AOAC, 2000)

Determination of total carbohydrate: Carbohydrate percentage was given by: 100 – (percentage of ash + percentage of moisture + percentage of fat + percentage of protein. (Shumaila and Mahpara, 2009).

Statistical analysis

Data were statically analyzed using an analysis of variance (ANOVA) of completely randomized design (MSTAT-C v. 3.1., 1988). Least Significant difference (LSD) was applied to compare mean values.

RESULTS

The adult mortality percentage of *Sitophilus oryzae* and *Rizopertha dominica* after using two MFs levels (30 & 60mT) through different time (1 min., 6 and 12 hrs) are shown in tables (1&2). The mortality percentage of both insects increased with increasing of MFs levels and time. MFs level at 60 mT for 12 hrs was the most effective against both tested insects. *R.dominica* was more resistance than *S.oryzae* in which

56.6, 53.3 and 50.0 % of *S. oryzae* died with Masr-1, Sids-12 and Sakha-93 respectively after 10 days from exposure period while at the same level and time, mortality percentage of *R. dominica* was 45.0, 36.6 and 33.3% with Sids-12, sakha-93 and Masr-1, respectively.

Although, both MFs levels didn't cause high mortality percentage with both insects but they affected on the insects feeding, mating and female fertility leading to a good reduction percentage in F_1-progeny. Reduction percentage in F_1-progeny of *S. oryzae* ranged from (36.7 – 62.0 %), (30.4 - 41.0%) and (20.5 - 36.0 %) at 30 mT level with Masr-1,Sakha-93 and Sids-12 varieties, respectively and at 60 mT level reduction was (36.0 –78.0 %), (37.0 – 74.0 %) and (24.6 -59.0 %) while reduction in F_1-progeny of *R. dominica* ranged from (4.0 – 38.0 %), (29.0 – 59.0 %) and (17.0 – 52.0 %) at 30 mT and at 60 mT reduction (%) was (24.0 - 52.0 %), (37.0 – 63.0 %) and (30.0 – 61.0 %).

Table 1.Effect of magnetic field treatments on *S. oryaza* infesting wheat cultivars and reduction percentage of F_1-progeny at laboratory conditions of 30±2°c and 65±5% R.H.

Treatment Variety	Magnetic	(%) Adult mortality after indicated days: 2	4	6	8	10	% reduction in F_1 progeny
	C_1	0.00	0.00	0.00	0.00	0.00	
	T_2	0.0 ± 0.·	1.6 ±1.6	5.0 ± 2.9	5.0 ± 2.9	5.0 ± 2.9	36.7
	T_3	6.6 ±3.3	13.3 ± 3.3	16.6 ± 4.4	21.6 ± 3.3	28.3 ± 4.4	41.0
Masr1	T_4	11.6 ± 4.4	20.0 ± 2.9	28.3 ± 6.0	30.0 ± 5.7	36.6 ± 5.8	62.0
	T_5	0.0 ± 0.0	3.3 ± 3.3	8.3 ± 4.4	10.0 ± 2.9	10.0 ± 2.9	36.0
	T_6	8.3 ± 3.3	13.3 ± 1.7	21.6 ± 1.7	33.3 ± 5.8	35.0 ± 4.9	75.0
	T_7	15.0 ± 5.7	25.0 ± 5.7	36.6 ± 6.0	43.3 ± 4.4	56.6 ± 8.6	78.0
	C_1	0.00	0.00	0.00	0.00	0.00	
	T_2	1.6 ±1.6	3.3 ±1.6	5.0 ± 2.8	5.0 ± 2.8	5.0 ±2.8	30.4
	T_3	1.6 ± 1.6	5.0 ± 2.7	11.6 ± 1.6	15.0 ± 2.8	16.6 ± 3.3	33.0
Sids12	T_4	3.3 ± 1.6	10.0 ± 2.8	18.3 ± 1.6	21.6 ± 4.4	23.3 ± 3.3	41.0
	T_5	1.6 ± 1.6	6.6 ± 3.3	8.3 ± 1.6	10 ± 2.8	11.6 ± 1.6	37.0
	T_6	3.3 ± 1.6	10 ± 5	15.0 ± 2.8	23.3 ± 3.3	30.0 ± 2.8	61.0
	T_7	16.6 ± 1.6	28.3 ± 1.6	38.3 ± 6.0	46.6 ±10.0	50.0 ± 8.6	74.0
	C_1	0.00	0.00	0.00	0.00	0.00	
	T_2	0.0 ± 0.·	0.0 ± 0.·	1.6 ±1.6	5.0 ± 2.8	5.0 ± 2.8	20.5
	T_3	1.6 ±1.6	1.6 ±1.6	5.0 ± 4.9	8.3 ± 3.3	10.0 ± 2.8	340
Sakha93	T_4	23.3 ± 7.2	33.3 ± 4.4	35 ± 4.9	43.3 ± 9.2	46.6 ± 8.7	36.0
	T_5	0.0 ± 0.·	0.0 ± 0.·	3.3 ± 3.3	5.0 ± 2.8	6.6 ± 1.6	24.6
	T_6	3.3 ± 1.6	6.6 ± 1.6	10.0 ± 4.9	13.3 ± 3.3	20.0 ± 2.8	46.5
	T_7	31.6 ± 4.4	35 ± 10.4	40.0 ± 8.6	48.3 ± 8.6	53.3 ±10.9	59.0
F.sig.		**	**	ns	ns	ns	
LSD at 5%		1.61	2.00	ns	ns	ns	
	Misar-1	5.9±1.6	10.9±2.2	16.6±3.3	20.5±3.5	24.5±4.5	
Variety	Sides-12	4±1.3	9±2.1	13.8±2.7	17.4±3.5	19.5±3.7	
	Sakha-93	8.6±2.9	10.9±3.6	13.6±3.8	17.6±4.4	20.2±4.5	
F.sig.		*	ns	ns	Ns	ns	
LSD at 5%		0.61	ns	ns	Ns	ns	
	C_1	0.00	0.00	0.00	0.00	0.00	
	T_2	0.6±0.6	1.6±0.8	3.9±1.4	5±1.4	5±1.4	
	T_3	3.3±1.4	6.7±2.2	11.1±2.6	15±2.5	18.3±3.2	
Magnetic treatment	T_4	12.7±3.8	21.1±3.8	27.2±3.3	31.7±4.6	35.6±4.7	
	T_5	0.6±0.6	3.3±1.6	6.7±1.9	8.3±1.7	9.4±1.3	
	T_6	5±1.4	10±1.8	15.6±2.4	23.3±3.6	28.3±2.9	
	T_7	21.1±3.4	29.4±3.8	38.3±3.5	46.1±4.1	53.3±4.8	
F.sig.		***	***	***	***	***	
LSD at 5%		00.93	1.16	1.33	1.57	1.63	
CV (%)		79.48	58.20	47.97	44.68	40.09	

C_1 : Control without infection without magnetic T_2 : Expose infected seeds with 30 mT for 1 minuet.
T_3: Expose infected seeds with 30 mT for 6 hours. T_4 : Expose infected seeds with 30 mT for 12 hours.
T_5 : Expose infected seeds with 60 mT for 1 minuet. T_6 : Expose infected seeds with 60 mT for 6 hours.
T_7 : Expose infected seeds with 60 mT for 12 hours.   CV: Coefficient of variation

Table 2. Effect of magnetic field treatments on *R. dominica* infesting wheat cultivars and reduction percentage of F_1-progeny at laboratory conditions 30±2°c and 65±5% R.H.

Treatment Variety	Magnetic	(%) Adult mortality after indicated days 2	4	6	8	10	% reduction in F_1 progeny
	C_1	0.00	0.00	0.00	0.00	0.00	
	T_2	0 ±0	0 ±0	0 ±0	3.3 ± 1.6	3.3 ± 1.6	17.0
	T_3	0 ±0	0 ±0	3.3 ± 1.6	6.6 ± 4.4	6.6 ± 4.4	48.0
Masr-1	T_4	3.3 ± 3.3	6.6 ± 3.3	8.3 ± 1.6	10 ± 0	13.3 ± 1.6	52.0
	T_5	5 ± 2.8	6.6 ± 1.6	11.6 ± 1.6	11.6 ± 1.6	11.6 ± 1.6	30.0
	T_6	6.6 ± 4.4	13.3 ± 4.4	15 ± 2.8	16.6 ± 3.3	18.3 ± 1.6	43.0
	T_7	6.6 ± 3.3	15 ±2.8	21.6 ± 3.3	26.6 ±4.4	33.3 ± 4.4	61.0
	C_1	0.00	0.00	0.00	0.00	0.00	
	T_2	0 ± 0	3.3 ± 1.6	5 ± 0	8.3 ± 1.6	8.3 ±1.6	29.0
	T_3	0 ± 0	5 ± 2.8	8.3 ± 1.6	11.6 ± 4.4	11.6 ± 4.4	44.0
Sids-12	T_4	5 ± 2.8	8.3 ± 1.6	15 ± 2.8	20 ± 2.8	20 ± 2.8	59.0
	T_5	1.6 ± 1.6	11.6 ± 4.4	11.6 ± 4.4	11.6 ± 4.4	11.6 ± 4.4	37.0
	T_6	15 ± 2.8	23.3 ± 4.4	23.3 ± 4.4	26.6 ± 7.2	26.6 ± 7.2	45.0
	T_7	21.6 ± 1.6	31.6 ± 6	36.6 ± 3.3	41.6 ± 1.6	45 ± 2.8	63.0
	C_1	0.00	0.00	0.00	0.00	0.00	
	T_2	0 ±0	0 ±0	3.3 ± 1.6	3.3 ± 1.6	3.3 ± 1.6	4.0
	T_3	0 ±0	0 ±0	5 ± 2.8	10 ± 4.4	10 ± 2.8	19.0
Sakha-93	T_4	1.6±1.6	8.3 ± 1.6	11.6 ± 1.6	15 ± 4.9	18.3 ± 7.2	38.0
	T_5	1.6 ±1.6	6.6 ± 3.3	10 ± 5.7	13.3 ± 4.4	13.3 ± 4.4	24.0
	T_6	5 ± 2.8	13.3 ± 3.3	16.6 ± 3.3	16.6 ± 3.3	16.6 ±3.3	43.0
	T_7	11.6 ± 4.4	20 ± 5.7	26.6 ± 3.3	36.6 ± 3.3	36.6 ±3.3	52.0
F.sig.		*	ns	ns	ns	ns	
LSD at 5%		1.21	ns	ns	ns	ns	
	Misar-1	3.1±1.1	6±1.5	8.6±1.8	10.7±2	12.4±2.5	
Variety	Sides-12	6.2±1.9	12±2.6	14.3±2.7	17.1±3.1	17.6±3.3	
	Sakha-93	2.8±1.1	7±1.8	10.5±2.1	13.6±2.7	14±2.7	
F.sig.		*	**	**	**	*	
LSD at 5%		0.46	0.64	0.59	0.72	0.77	
	C_1	0.00	0.00	0.00	0.00	0.00	
	T_2	0.0±0	1.1±0.7	2.7±0.9	5±1.2	5±1.2	
	T_3	0.0±0	1.7±1.2	5.6±1.3	9.4±2.1	9.4±2.1	
Magnetic treatment	T_4	3.3±1.4	7.8±1.2	11.7±1.4	15±2.2	15±2.2	
	T_5	2.8±1.2	8.3±1.8	11.1±2.2	12.2±1.9	12.2±1.9	
	T_6	8.9±2.3	16.6±2.6	18.3±2.2	20±3	20.6±2.8	
	T_7	13.3±2.8	22.2±3.5	28.3±2.8	35±2.8	38.3±2.5	
F.sig.		***	***	***	***	***	
LSD at 5%		0.70	0.98	0.90	1.11	1.17	
CV (%)		95.9	62.93	42.8	42.30	42.04	

[#]**Explanations are as in Table 1**

Seed vigor traits i.e. germination rate (GR), mean germination time (MGT),speed germination index (SGI) and co-efficient of germination (CG) as affected by varieties and magnetic treatments are shown in table 3. The tested three wheat varieties (Masr-1, Sids-12 and Sakha-93) showed equal response in all seed vigor traits under infection with *R. dominica*. While slightly differences were recorded in seed vigor traits except SGI under infection with *S. oryzae*.

Regarding magnetic treatments, data in the same table showed that exposure infected seeds with (*S. oryzae* or *R.dominica*) to magnetic field treatments positively affected on all seed vigor tested parameters compared control treatment (infected seeds without magnetic treatment; C_2). Moreover, almost equaled with uninfected seeds (C_1).Expose infected seeds with both insects at 60 mT increased gradually with increasing exposes time from 1 min to 6and 12 hrs in all tested parameters except MGT where reverse trend was recorded. Generally, T_7 recorded the highest value without significant with T_6 in the most tested parameters under both insects. The percentage of improvements regarding application of different magnetic treatments compared to control (C_2) ranged between10.68-17.95%, 15.02–24.82%, 16.22–20.89% and 17.57 – 33.08% in GR, MGT, SGI and CG, respectively under seeds infected with *R. dominca*. Similar trends with higher value were recorded under *S. Oryzae* where the increasing percent ranged between 14.68-20.63%, 19.94-27.68%, 28.59-33.18% and 22.73-35.18% in the above mentioned parameters, respectively.

Regarding the interactions between varieties and magnetic treatments, results in Table 4, showed insignificant effects on all tested parameters except GR, MGT and CG under infected seeds with *S. oryzae*. Generally, application of different magnetic treatments on the tested three varieties improved all tested parameters compared with infected seed without magnetic treatment under both insects.

Table 3.Effect of magnetic field treatments on germination rate (GR), mean germination time (MGT), speed germination index (SGI) and co-efficient of germination (CG) of three wheat varietiesinfected with *R. dominica* or *S. oryzae*.

Character		*R. dominica*				*S. oryzae*			
Treatment		GR	MGT	SGI	CG	GR	MGT	SGI	CG
Variety	Misar-1	0.88	1.37	20.88	74.35	0.90	1.29	20.98	78.07
	Sides-12	0.88	1.37	20.74	74.25	0.86	1.42	20.30	72.61
	Sakha-93	0.87	1.39	20.64	73.46	0.89	1.34	20.90	76.80
F test		ns	Ns	Ns	Ns	**	**	ns	**
LSD at 5%		ns	Ns	Ns	Ns	0.02	0.06	ns	3.50
Magnetic seeds	#C_1	0.94	1.19	22.33	84.17	0.94	1.19	22.11	84.00
	C_2	0.77	1.68	17.81	59.66	0.77	1.70	16.52	60.43
	T_5	0.86	1.43	20.70	70.15	0.88	1.36	21.24	74.16
	T_6	0.90	1.31	21.54	76.73	0.91	1.28	21.76	78.85
	T_7	0.91	1.26	21.39	79.40	0.92	1.23	22.00	81.69
F test		**	**	**	**	**	**	**	**
LSD at 5%		0.03	0.07	0.75	3.43	0.03	0.08	1.19	4.52
CV (%)		2.56	4.89	3.77	4.82	3.25	6.41	5.96	6.20

C_1 : Control without infection without magnetic **C_2: Control with infection without magnetic**
T_5 : Expose infected seeds with 60 mT for 1 minute. **T_6 : Expose infected seeds with 60 mT for 6 hours.**
T_7 : Expose infected seeds with 60 mT for 12 hours. **CV: Coefficient of variation**

Table 4.Effect of magnetic field treatments on germination rate (GR), mean germination time (MGT), speed germination index (SGI) and co-efficient of germination (CG) of three wheat varieties infected with *R. dominica* or *S. oryzae*.

Character Treatment Variety	Magnetic	*R. dominica* GR	MGT	SGI	CG	*S. oryzae* GR	MGT	SGI	CG
Misar-1	#C_1	0.93	1.20	22.50	83.33	0.94	1.19	21.67	83.74
	C_2	0.78	1.66	18.17	60.31	0.87	1.39	18.17	73.06
	T_5	0.85	1.44	20.44	69.70	0.90	1.31	21.61	76.73
	T_6	0.90	1.31	21.61	76.39	0.89	1.32	21.44	76.11
	T_7	0.93	1.22	21.67	82.03	0.92	1.24	22.00	80.70
Sides-12	C_1	0.94	1.17	22.00	85.84	0.94	1.18	22.17	84.92
	C_2	0.78	1.66	17.78	60.37	0.71	1.86	15.56	53.64
	T_5	0.86	1.43	21.33	70.11	0.84	1.47	20.61	67.94
	T_6	0.91	1.27	21.56	78.98	0.90	1.30	21.33	77.11
	T_7	0.89	1.32	21.06	75.95	0.91	1.26	21.83	79.44
Sakha-93	C_1	0.93	1.20	22.50	83.33	0.93	1.20	22.50	83.33
	C_2	0.76	1.72	17.50	58.31	0.72	1.83	15.83	54.59
	T_5	0.86	1.42	20.33	70.64	0.90	1.29	21.50	77.83
	T_6	0.88	1.35	21.44	74.81	0.93	1.20	22.50	83.33
	T_7	0.92	1.25	21.44	80.22	0.94	1.18	22.17	84.92
F.sig.		ns	Ns	ns	Ns	**	**	ns	**
LSD at 5%		ns	Ns	ns	Ns	0.05	0.14	ns	7.83

#Explanations are as in Table 3

Response of three wheat varieties infected with *S. oryzae* or *R. dominica* to exposing of different magnetic treatments on changes in germination%, seedling length (cm), seedling dry weight (g), seedling vigor index (SVI) and electrical conductivity (EC) of seeds are shown in Table 5 and 6.

The tested three wheat verities differed slightly for mentioned characters under infection with both tested insects where Masr-1 gave the highest value of SL, SDW and SVI, followed by Sides-12 and Sakha-93, respectively. While under infection with *S. oryzae*, the order was Sakha-93, Sides-12 and Maser-1, respectively (Table 5).

Regarding magnetic treatments, results in the same Table showed that exposethe infected seeds to magnetic field 60 mT for 1 min, 6 and 12 hrs caused positive significant effects on all tested characters compared to infected seeds without magnetic treatment; (C_2).The percent of improvement ranged between 2.08 – 3.47%, 14.19 – 21.34%, 22.43 – 44.45% and 25.08 –

49.75% in G %, SL, SDW, and SVI, respectively under infected with *R. dominca*. Whereas, magnetic treatments after infection with *S. oryzae*, the increasing percent ranged between 2.82 – 4.23%, 10.79 – 22.35%, 55.19 – 93.34%, 58.93 100.70% in the above mentioned parameters, respectively.

Results in Table (6) show significant effects regarding the interactions between wheat varieties and magnetic field treatments on seedling dry weight and SVIunder infected seed with *R.dominica* and *S. oryzae*. While no significant effects were reported in germination % and seedling length under both insects. Generally, Sakha-93 came in the first order followed by Masar-1 and sides-12 for producing the heaviest seedling dry weight and highest value of SVI under different treatments.

Electrical conductivity result showed that high significant effect by using mf, the lowest values resulted from exposing wheat seed to 60 mT for 12 h in all infected verities; these results refer to high seed vigor

Table 5.Effect of magnetic field treatments on germination %, seedling length (SL), seedling dry weight (SDW), seedling vigorindex (SVI) and electrical conductivity (EC) of three wheat varieties infected with *R. dominica* or *S. oryzae*.

Character / Treatment		*R. dominica* Germ. (%)	Seedling length (cm)	Seedling dry wt. (g)	SVI	EC	*S. oryzae* Germ. (%)	Seedling length (cm)	Seedling dry wt. (g)	SVI	EC
Variety	Misar-1	99.60	22.70	0.132	13.20	0.015	97.20	21.179	0.370	35.85	0.011
	Sides-12	97.20	22.53	0.117	11.40	0.012	98.00	22.756	0.390	38.37	0.011
	Sakha-93	98.80	20.86	0.145	14.38	0.010	98.40	20.766	0.480	47.81	0.013
F test		**	**	**	**	**	ns	**	**	**	**
LSD at 5%		1.39	0.868	0.01	0.86	0.003	ns	1.011	0.020	2.97	0.001
Magnetic seeds	#C_1	100.00	24.18	0.156	15.63	0.009	100.00	23.95	0.547	54.72	0.009
	C_2	96.00	18.99	0.101	9.65	0.019	94.67	18.56	0.248	23.56	0.017
	T_5	98.00	21.68	0.123	12.07	0.013	97.33	20.56	0.385	37.45	0.011
	T_6	99.33	22.25	0.133	13.17	0.011	98.67	22.07	0.410	40.37	0.010
	T_7	99.33	23.04	0.145	14.45	0.010	98.67	22.70	0.479	47.29	0.010
F test		**	**	**	**	**	**	**	**	**	**
LSD at 5%		1.79	1.121	0.01	1.11	0.004	2.98	1.306	0.03	3.83	0.002
CV (%)		1.89	5.25	9.04	8.84	23.65	3.17	6.290	9.24	9.78	15.44

#Explanations are as in Table 3

Table 6.Effect of magnetic field treatments on germination %, seedling length (SL), seedling dry weight (SDW), seedling vigor index and electrical conductivity (EC) of three wheat varieties infected with *R. dominica* or *S. oryzae*.

Character / Treatment: Variety	Magnetic	*R. dominica* Germ. (%)	Seedling length (cm)	Seedling dry wt. (g)	SVI	EC	*S. oryzae* Germ. (%)	Seedling length (cm)	Seedling dry wt. (g)	SVI	EC
Misar-1	#C_1	100.00	25.38	0.154	15.43	0.009	100.00	24.50	0.447	44.68	0.009
	C_2	98.00	19.45	0.093	9.11	0.024	90.00	17.11	0.232	20.90	0.020
	T_5	100.00	21.99	0.132	13.23	0.014	96.00	19.14	0.342	32.83	0.009
	T_6	100.00	22.79	0.133	13.30	0.014	100.00	22.43	0.375	37.53	0.009
	T_7	100.00	23.88	0.149	14.93	0.013	100.00	22.72	0.433	43.32	0.009
Sides-12	#C_1	100.00	25.11	0.136	13.57	0.009	100.00	25.75	0.518	51.77	0.009
	C_2	94.00	19.49	0.104	9.81	0.018	96.00	20.01	0.186	17.84	0.014
	T_5	96.00	22.24	0.107	10.21	0.014	98.00	22.38	0.383	37.47	0.011
	T_6	98.00	22.38	0.119	11.62	0.009	98.00	22.41	0.401	39.33	0.009
	T_7	98.00	23.42	0.120	11.77	0.009	98.00	23.23	0.463	45.42	0.009
Sakha-93	#C_1	100.00	22.06	0.179	17.88	0.009	100.00	21.59	0.677	67.71	0.010
	C_2	96.00	18.03	0.105	10.02	0.014	98.00	18.55	0.325	31.94	0.018
	T_5	98.00	20.81	0.131	12.77	0.010	98.00	20.16	0.429	42.03	0.013
	T_6	100.00	21.59	0.146	14.59	0.009	98.00	21.36	0.452	44.24	0.011
	T_7	100.00	21.82	0.167	16.65	0.009	98.00	22.16	0.541	53.12	0.011
F test		Ns	ns	*	*	ns	ns	ns	**	*	*
LSD at 5%		Ns	ns	0.02	1.91	ns	ns	ns	0.05	6.63	0.003

#Explanations are as in Table 3

Seed Components Analysis:

Means ofthree wheat varieties seeds components including moisture content %, crude fats%, crude protein%, ash % and carbohydrates % after using MF level 60mTfor 12 hrs are shown in tables 7. Control seeds were used for comparison.

Results showed that, MF level slightly increase moisture content (%) and total carbohydrate (%) while slightly decrease crude protein (%), total fats (%) and crude fiber (%) after 12 hrs exposure. Although, increasing of seed moisture content, still under limited for safe storage. Prior of storage, the moisture content of cultivars seed as good quality based on certification standard cited by (Copeland and McDonald 2004) have recommendation which moisture content for long duration storage seed does not above 14 or below 5 %. Seeds store at moisture content above 14% begin to exhibit increased respiration, heating and fungal invasion that destroy seed viability more rapidly, while below 5 % cause seed membrane structure , seed deterioration, thus improve that it had no significant effect on seeds viability

Table 7.Effect of static magnetic field at 60 mT for 12hrs on grains chemical constituents (%) of three wheat varieties infested with *S.oryzae* and *R.dominica*.

Character		Grains chemical constituents (%)					
Treatment		Moisture	Crude protein	Total fat	Ash	Total Carbohydrates	Crude fiber
	Control	10.30	11.78	2.40	2.27	73.52	2.58
Masr-1	*S. oryzae*	11.63	8.84	1.74	1.66	74.55	1.85
	R. dominica	12.95	9.63	0.98	1.05	75.39	1.14
	Control	9.16	12.47	2.87	2.66	72.84	3.05
Sids-12	*S.oryzae*	10.49	11.41	2.16	2.06	73.88	2.30
	R.dominica	11.84	10.33	1.49	1.45	74.89	1.61
	Control	9.61	12.1	2.62	2.48	73.19	2.81
Sakha-93	*S.oryzae*	10.92	11.04	1.98	1.84	74.22	2.07
	R.dominica	12.59	9.97	1.25	1.27	74.92	1.36

DISCUSSION

The development of alternative treatments for pest control is an increasing demand from the food industry. Alternatives should meet consumer demands for the reduced use or elimination of pesticides, while at the same time maintaining a high degree of control efficacy (Riudavets*et al.*, 2010). The present study established the efficacy of using magnetic fields(MFs) to control stored product pests. The advantages of magnetization as a pest control methods that it does not leave undesirable residues. Other few researchers studied the biological effect of MFs on stored grain insects like (Pandir*et al.*, 2013a) who investigate the effect of MFs from a DC power supply on the longevity of adults, fecundity and daily egg laying pattern of female *Ephestia kuehniella* (Zeller)and found that mortality increased with increasing MFs level and complete mortality was achieved at the level of 10 mT. Pest longevity was significantly reduced with increasing level of MFs. There was no significant difference in the longevity of males and females. Exposing adults to increasing level of MFs significantly influenced daily egg laying patterns and fecundity of magnetized females. Larval emergence from these eggs was completely prevented at highest level of MFs. (Pandir and Sahingoz2014) investigation showed that MFs caused oxidative stress and proved to be DNA damage as revealed by the comet assay. MFs may be used to determine potential toxic effects as a control agent against *E. kuehniella* larvae. (Pandir*etal*., 2013b).Investigated the effect of strong magnetic fields as insecticidal activity on *E.kuehniella* (Lepidoptera: Pyralidae) larvae and eggs at different stages of development and their preference by the egg parasitoid, *Trichogramma embryophagum*. Eggs ranging in age from 24-h to 48-h and 72-h-old and larvae (1 to 2 days) were exposed to 1.4 Tesla (T) magnetic fields from a DC power supply at 50 Hz for different time periods (3, 6, 12, 24, 48 and 72 h). Twelve hours of exposure at 1.4 T was toxic to 24-h-old eggs of *E. kuehniella*. The 72-h-old host eggs treated with 1.4 T for 6-72 h were not significantly preferred by *T. embryophagum*. The magnetic field was toxic to 24-h-old eggs of *E. kuehniella* exposed to 1.4 T for 12. The treatment of magnetic fields on the 72-h-old host egg with 1.4 T at 6-72 h was not significantly preferred by *T. embryophagum*. Magnetization of 24-h-old eggs of *E. kuehniella* for 3 h could be effectively used with *T. embryophagum* as sterilised host eggs. These eggs were markedly preferred by *T.embryophagum*. The LT_{50} and LT_{99} values of magnetic fields at different egg stages of *E. kuehniella*, and larvae were measured. A level of 1.4 T at 72 h completely prevented the development of the larvae. There was no significant effect on larval survival at 1.4 T at 48 and 72 h. Increasing magnetic fields exposure times for eggs that were 24-h, 48-h and 72-h-old prevented larval emergence and increased their mortality rate. Consequently, magnetic fields could be used in controlling stored-product pest eggs and larvae of *E. kuehniella*.

Results showed that exposure infected seeds with (*Sitophilus oryzae* and *Rizopertha dominica*) to magnetic field treatments positively affected on all seed and seedling vigor parameters compared control treatment (infected seed without magnetic treatment; C_2). Moreover almost equaled with uninfected seeds but it showed significant effect on all parameters comparing with untreated seeds (C_1). MF affected the various characteristics of the plants like germination of seeds, root growth, rate seedlings growth, reproduction and growth of the meristem cells and chlorophyll quantities (Namba *et al.*, 1995; Atak *et al.*, 1997; Reina *et al.*, 2001; Atak *et al.*, 2003 and Aycih and Alikamanoglu2005) concluded that magnetic field increased the shoot and root regeneration rate and their fresh weight in soybean and paulownia organ cultures. (Pouya and Nasrin 2015) found that, an application of alternating magnetic field of (B=0.5mT and f=50Hz) on seed affected seedling growth. Longer exposure time (40 s) has generally induced slightly growth.The resulting differences in fresh weight of seedling were not correlated with the differences in shoot heights, In 20 seconds period, the specific electromagnetic field intensity, increased the stimulation of wheat buds and gained germination percentage rather to the control group, but shifting the effective time to 40 seconds, the growth decreased to some extent. (Cakmak*et al.*, 2010) observed that the application of magnetic field doses of 4 mT and 7 mT promoted germination ratios of bean and wheat seeds. (De Souza *et al.*, 2010) concluded that pre-sowing magnetic treatments have the potential to enhance tomato seed germination and early seedling growth. Alvarez *et al.*, (2012) concluded that magnetic treatment improves germination rate of triticale seeds. In general, most of the parameters recorded for all the doses applied to triticale seeds were better than control values. Furthermore, seedlings from magnetically treatedseeds grew taller than control.

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تاثير المجال المغناطيسى على حيوية وجودة البذور والاصابة الحشرية لبعض اصناف القمح

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تم اجراء التجارب المعملية لاختبار فعالية قوتين منخفضتين من المجال المغناطيسى (٣٠& ٦٠ مللى تسلا) لثلاث فترات مختلفة من التعرض (١دقيقة ، ٦ ساعات ، ١٢ ساعة) على ثلاث اصناف مختلفة من القمح (مصر١ ، سدس ١٢ ، سخا ٩٣) ضد حشرتى سوسة الارز وثاقبة الحبوب الصغرى كما تم حساب نسبة الخفض فى تعداد الجيل الاول وايضا اختبار تاثير القوتين محل الدراسة على انبات وحيوية البذور وقد اظهرت النتائج:ازياد نسبة الموت بزياده القوة المستخدمه ومده التعرض . اظهرت حشرة ثاقبة الحبوب الصغرى مقاومة اعلى من سوسة الارز مع جميع القوى المستخدمة . سجلت حشرة سوسة الارز نسب موت ٥٦.٦ ، ٥٣.٣ و ٥٠ % بعد ١٠ ايام من التعرض مع اصناف مصر١ ، سدس ١٢ وسخا ٩٣ على التوالى بينما سجلت حشرة ثاقبة الحبوب الصغرى نسب موت ٤٥ ، ٣٦.٦ و ٣٣.٣ مع اصناف سدس ١٢ ، سخا ٩٣ و مصر ١ على التوالى مع اعلى قوة مستخدمة ٦٠ مللى تسلا لمده ١٢ ساعة تعرض . على الرغم من نسب الموت المنخفضة اظهرت النتائج قدرة المجال المغناطيسى (٦٠ مللى تسلا) على خفض تعداد الجيل الاول بنسب عالية وصلت ل٧٨ % مع سوسة الارز و٦٣% مع ثاقبة الحبوب الصغرى .واستكمالا أجريت تجربة انبات بمعمل قسم بحوث تكنولوجيا البذوربالمنصورة لدراسة تأثير المعاملة بالمجال المغناطيسى ٦٠ مليتسلا لمدة ١ دقيقة، ٦ و ١٢ ساعة على انبات وقوة بادارات اصناف القمح تحت الدراسة (مصرا ، سدس ١٢ و سخا٩٣) المصابة بنوعين من حشرات المخازن (سوسة الارز و ثاقبة الحبوب الصغرى) : ويمكن تلخيص أهم النتائج فيما يلى اظهرت الاصناف الثلاثة استجابة متساوية فى جميع الصفات (معدل الانبات ، متوسط زمن الانبات، دليل سرعة الانبات و طاقة الانبات) فى حالة الاصابة بحشرة تاقبة الحبوب الصغرى ، وباستثناء دليل سرعة الانبات ظهرت اختلافات واضحة لجميع الصفات مع الاصابة بسوسة الارز. تاثرت جميع الصفات بالتعرض للمجال المغناطيسى مقارنة بالكنترول (بذور مصابة بدون معاملة ماجنتيك) وتساوت فى معظمها مع الكنترول (الغير معامل او مصاب) و كانت الزياده باطالة فتره التعرض للمجال المغناطيسى حيث اعطي التعرض ل ٦٠ ملتسلا لمده ١٢ ساعه اعلى قيم للصفات في كلا الحشرتين ادي التفاعل بين المجال المغناطيسي و الاصناف المختبره الى تحسين جميع الصفات مقارنه بالكنترول في كلا الحشرتين ظهرت اختلافات واضحه في صفات طول البادرات و الوزن الجاف للبادرات و دليل قوة البادرات و التوصيل الكهربي في الاصناف الثلاثه المصابه بكلا الحشرتين، و قد اعطي مصر١ اعلي القيم في طول البادره و دليل قوه البادرات و الوزن الجاف للبادرات يليه سدس ١٢ و سخا ٩٣ مع الحشره ثاقبة الحبوب الصغرى، بينما مع حشره سوسه الارز كان الترتيب سخا٩٣ ثم سدس ١٢ و مصر١ علي الترتيب .ادي تعريض البذور المصابه للمجال المغناطيسي لتاثير معنوي واضح في جميع الصفات مقارنه بالكنترول ظهر تاثير معنوي واضح نتيجة التفاعل بين المجال المغناطيسي و الاصناف على الوزن الجاف للبادرات و دليل قوه البادرات مع حشره سوسه الارز و ثاقبه الحبوب الصغري بينما لا يوجد تاثير معنوي في نسبه الانبات و طول البادرات مع كلا الحشرتين و عموما جاء سخا ٩٣في المركز الاول ثم مصر١ و سدس ١٢ في انتاج اثقل البادرات وزنا و اعلي قيم في دليل قوه البادرات تحت المعملات المختلفه .اظهر التوصيل الكهربى تاثير معنوي عالي باستخدام المجال المغنطيسي و كانت اقل القيم مع ٦٠ مليتسلا لمده ١٢ ساعه.صفات جوده البذور: - جوده البذور تشمل الرطوبه % ، البروتين % ، الدهون%، الرماد % و الكربوهيدرات%- اعطى استخدام المجال المغناطيسي ٦٠ مليتسلا لمده١٢ساعه زياده طفيفة في الرطوبه% و الكربوهيدرات الكليه و نقص طفيف في البروتين% و الدهون% و الالياف %.