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STORAGE EFFICACY OF WHEAT GRAINS AS AFFECTED TREATING WITH SOME CHEMICAL INSECTICIDES

Attia, A.N.[1]; M.A. Badawi [1]; S.E. Seadh[1] and S.N.H. Rojbaiany[2]

[1] Agronomy Department, Faculty of Agriculture, Mansoura University, Egypt.

[2] State Company for Grain trade, Ministry of Trade, Iraq.

ABSTRACT

A laboratory experiment was carried out under the laboratory conditions of the Experimental Station of Agronomy Department, Faculty of Agriculture, Mansoura University, Egypt, from 15th May to 15th November, 2013. The purpose of the experiment was to assess the effect of some chemical insecticides treatment (phosphine, malathion and deltamethrin) with various rates on storage efficacy of wheat grains under the environmental conditions of Dakahlia Governorate, Egypt, during different storage periods (0, 3 and 6 months after harvesting). The most important results obtained from this investigation can be summarized as follows:

- Storage periods of wheat grains had a significant effect on storage efficacy traits. Increasing storage periods of wheat grains from 3 to 6 months significantly decreased storage efficacy traits over all studied grain treatments.
- Treating wheat grains with some chemical insecticides treatment *i.e.* phosphine at the rates of 5, 7 and 9 ppm, malathion at the rates of 6, 8 and 10 ppm and deltamethrin at the rates of 0.75, 1.00 and 1.25 ppm had a significant effect on storage efficacy traits as compared with both control treatments.

It can be recommended treating grains of wheat (Gemmiza 10) with phosphine at the rates of 7 or 9 ppm deltamethrin at the rates of 1.00 or 1.25 ppm to increase storage efficacy under the environmental conditions of Dakahlia Governorate, Egypt.

Keywords: Wheat, Storage efficacy, chemical insecticides, phosphine, malathion, deltamethrin.

INTRODUCTION

Wheat (*Triticum aestivum vulgare* L.) is considered as a strategic cereal crop and the main food for the human. In that manner, wheat is the stable food crop in the urban and rural areas. It is also worth mentioning that wheat straw is a source of fodder for animals.

Deterioration of stored grains is influenced by physical (temperature and humidity), biological (microflora, arthropod and vertebrate) and technical processes (storage conditions, methods and duration). During storage the wheat grain may be damaged by insect pests, rodents, domestic animals, birds and storage fungi (Compton *et al.,* 1993). More than 2000 species of field and storage pests annually destroy approximately one third of the world food production (Talukder and Howse, 1994). Losses due to stored grain pests (including insects, molds and toxins produced by fungi) may exceed 43 % of potential production per year in developing countries mainly due to improper management (Ahmed *et al,* 1990). The high post-harvest losses of grains ranging between 35 and 46% are attributed to the adverse weather conditions that favour growth of a number of insect pest and mites harmful to stored products, which reducing the quantity and/or quality of the stored products (Evans, 1987).

Losses of wheat due to inadequate storage management and some other post-harvest factors at the farm, village and in public sector up to 4 percent have been observed (Abdullahi and Haile, 1991). Losses are not easily reduced in the absence of well-integrated policies and need strategic planning to develop the total system of production, marketing, storage and distribution (Tyler and Boxall, 1984).

Regarding chemical control measures as the principal part of integrated management, contact (residual) insecticides have been widely used since the 1960s, alongside fumigants. Over the past 40–50 years, the choice of insecticide compounds to be used in storage facilities has moved away from organochlorinated compounds to include organophosphate, carbamate and pyrethroid compounds. Today the use of all compounds is becoming increasingly restricted. They are generally applied during wheat loading, mostly as liquids and, somewhat less frequently, as powders. Depending on their type and application rate, insecticides can ensure long-term protection from noxious insects (Arthur, 1994 and Desmarchelier, 1994). The solving of the problem of resistance (after first acknowledging its existence) includes accurate forecasting based on the previous history of pesticide use and making available research data on resistance parameters. Pesticide application frequency can be reduced if combined with other control procedures in an integrated pest management programme, therefore reducing the risk of resistance development (Soderland and Bloomquist, 1990).

Altered susceptibility or resistance of various populations of harmful insects is the most restricting factor in chemical control as it may lead to excessive use of insecticides and to detrimental economic and ecological effects, plus a negative impact on human health (Subramanyam and Hagstrum, 1996).

Fumigation with phosphine (PH_3, hydrogen phosphide) has the potential to disinfest grain stored in silo bags. Phosphine fumigation offers a cost-effective method of treating grain so that insects are controlled. Ridley et al. (2011) demonstrated that silo bags can be fumigated with phosphine for complete control of infestations of strongly phosphine resistant species. Badawi et al. (2014) decided that significant differences among wheat seed treatments on insect infestation percentage, seed dry weight loss and fungi infestation percentage were detected.

Malathion [S-l,2-bis(ethoxycarbonyl) ethyl O,O-dimethyl phosphorodithioate] is a selective, broad-spectrum insecticide that has a low mammalian toxicity (oral LD_{50} of 12,500 mg kg 1 for rats (Rengasamy and Parmar, 1989)

Synthetic pyrethroids, such as deltamethrin is pesticide derived from naturally occurring pyrethrins, taken from pyrethrum of dried Chrysanthemum flowers. They are chemically designed to be more toxic with lower break down times and are formulated with synergists increasing potency and compromising the body’s ability to detoxify pesticide (Khater *et al.,* 2009).

Therefore, this investigation was established to study the effect of treating wheat grains with some chemical insecticides treatment (phosphine, malathion and deltamethrin) with various rates on storage efficacy of wheat grains under the environmental conditions of Dakahlia Governorate, Egypt.

MATERIALS AND METHODS

A laboratory experiment was carried out under the laboratory conditions of the Experimental Station of Agronomy Department, Faculty of Agriculture, Mansoura University, Egypt, from 15th May to 15th November, 2013. The purpose of the experiment was to assess the effect of some chemical insecticides treatments (phosphine, malathion and deltamethrin) with various rates on storage efficacy and chemical constituents of wheat grains under the environmental conditions of Dakahlia Governorate, Egypt, during different storage periods (0, 3 and 6 months after harvesting).

The experiment was arranged in randomized complete block design (RCBD) with four replications. The studied treatments were as follows:

1. Control treatments 1 (storing wheat grains in jute sacks without any treatment)
2. Control treatments 2 (storing wheat grains in metal containers without any treatment with sealing).
3. Treating wheat grains with phosphine tablets at the rate of 5 ppm.
4. Treating wheat grains with phosphine tablets at the rate of 7 ppm.
5. Treating wheat grains with phosphine tablets at the rate of 9 ppm.
6. Treating wheat grains with malathion powder at the rate of 6 ppm
7. Treating wheat grains with malathion powder at the rate of 8 ppm
8. Treating wheat grains with malathion powder at the rate of 10 ppm
9. Treating wheat grains with deltamithrin powder at the rate of 0.75 ppm
10. Treating wheat grains with deltamithrin powder at the rate of 1.00 ppm
11. Treating wheat grains with deltamithrin powder at the rate of 1.25 ppm

In all studied treatments, 10 kg of wheat grains were stored. In case of treating with insecticides "phosphine, malathion and deltamithrin" (treatments from 3 to 11), wheat grains were stored in metal containers with sealing. The dimensions of metal containers were 35 × 15 ×15 cm and its shape was shown in Fig.1. Storage wheat in metal containers with sealing model was performed as simulation the storage in metal silos as a modern model of storage.

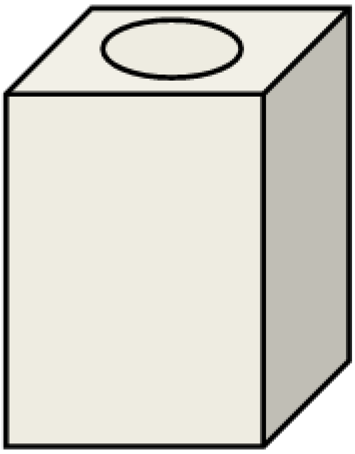

Fig. 1: The shape of used metal container.

The studied wheat grains were obtained directly after harvesting from the Agricultural Research Station Farm in Tag AL-Ezz, Dakahlia Governorate, Agricultural Research Center, Egypt of Gemmiza 10 cultivar.

The insecticides under study (phosphine, malathion and deltamithrin) were produced by T. Stanes & Company Limited, India and obtained from Gaara Establishment for Import and Export Co.

Phosphine tablets which were used in the experiment were from an Indian origin and the rate of the active material was 57% like all other international origin. It is important to mention that the activity of phosphine tablets will take action when it is subject to air. For reason it is urgent to specify the weight of used piece of phosphine tablet versus the sample of wheat. The tablet was broken into small pieces and calculated weight of each piece which was suitable for each sample (10 kg).

As for malathion and deltamithrin also calculated sufficient quantity for treating the sample of (10kg) of wheat grain after the concentration of the active material was determined.

Studied characters:

- **Insect infestation percentage.**

After each storage period (3 and 6 months from harvesting), four replicates 100 grains from each treatment were manually picked from each metal container from different depth randomly for inspection. Grains which having holes or infestation were collected also, the grains which showed signs of insect damage were considered as infested as shown in Fig. 2. The infestation level was expressed as number and percentage damage grains according to formula of Jood *et al.* (1996).

Fig. 2: Signs of insect damage.

$$\text{Damage grains percent} = \frac{\text{Number of insect damage}}{\text{Number of total grains inspected}} \times 100$$

Grains weight loss percentage:

After 3 and 6 months, the dry mass (weight) losses caused by insect infestation were calculated as follows according to Dick (1987).

$$\text{Dry mass (weight) loss \%} = \frac{(U\,Nd) - (D\,Nu)}{U\,(Nd + Nu)} \times 100$$

Where: Nu = Number of undamaged grains.
Nd = Number of damaged grains.
U = Weight of undamaged grains.
D = Weight of damage grains.

All obtained data were statistically analyzed according to the technique of analysis of variance (ANOVA) for the randomized complete block design (RCBD) as published by Gomez and Gomez (1984) by using means of "MSTAT-C" computer software package. Means of grains treatments were compared using Duncan's multiple range tests at 5 % level of probability as described by Duncan (1955). New least significant of difference (NLSD) method was also used to test the differences between treatment means at 5% level of probability as described by Waller and Duncan (1969).

RESULTS AND DISCUSSION

The statistical analysis of obtained results showed that treating wheat grains with some chemical insecticides treatment *i.e.* phosphine at the rates of 5, 7 and 9 ppm, malathion at the rates of 6, 8 and 10 ppm and deltamethrin at the rates of 0.75, 1.00 and 1.25 ppm had a significant effect on storage efficacy traits (number of infected wheat grains, damage grains percentage and grains weight loss percentage**)** as compared with both control treatments *i.e.* control treatments 1 (storing wheat grains in jute sacks without any treatment) or control treatments 2 (sto ring wheat grains in metal containers without any treatment with sealing) after 3 and 6 months of beginning storage as well as combined over storage periods Table 1.

Table 1: Number of infected wheat grains, damage grains and grains weight loss percentages as affected by treating grains with some chemical insecticides treatment after 3 and 6 months of storage.

Treatments / Character	Number of infected grains		Damage grains (%)		Grains weight loss (%)	
	After 3 months	After 6 months	After 3 months	After 6 months	After 3 months	After 6 months
Control 1	5.25 a	8.75 a	1.30 a	2.18 a	9.55 a	23.12 a
Control 2	3.37 b	5.75 b	0.83 b	1.43 b	9.40 ab	14.72 ab
Phosphine at the rate 5 ppm	0.25 d	0.50 d	0.06d	0.12 d	0.31 d	2.34 cd
Phosphine at the rate 7 ppm	0.00 d	0.50 d	0.00 d	0.12 d	0.00 d	2.32 cd
Phosphine at the rate 9 ppm	0.00 d	0.25 d	0.00 d	0.06 b	0.00 d	0.77 d
Malathion at the rate 6 ppm	2.62 bc	5.68 d	0.65 b	1.42 bc	9.46 a	12.85 bc
Malathion at the rate 8 ppm	2.37 bc	4.25 bc	0.58 bc	1.06 c	8.75 b	10.64 bcd
Malathion at the rate 10 ppm	1.93 c	3.06 c	0.48 c	0.76 d	7.88 bcd	9.04 a
Deltamithrin at the rate 0.75 ppm	0.50 d	0.75 d	0.18 d	0.18 d	2.50 c	3.77 c
Deltamithrin at the rate 1.00 ppm	0.50 d	0.75 d	0.12 d	0.18 d	1.58 c	2.87 cd
Deltamithrin at the rate 1.25 ppm	0.25 d	0.50 d	0.06 d	0.12 d	0.83d	2.56
F. test	*	*	*	*	*	*
NLSD at 5 %	0.63	0.94	0.15	0.23	4.11	4.75

Storage periods of wheat grains (3 and 6 months after harvesting) had a significant effect on storage efficacy traits (number of infected wheat grains, damage grains percentage and grains weight loss percentage**)**. Increasing storage periods of wheat grains from 3 to 6 months significantly increased number of infected wheat grains, damage grains percentage, grains weight loss percentage over all studied grain treatments Table 2.

- **Effect of treating wheat grains with phosphine:**

From obtained results, treating wheat grains with phosphine at the rate 5.0, 7.0 and 9 ppm after 3 months of storage gave the best results of storage efficacy traits (number of infected wheat grains, damage grains percentage and grains weight loss percentage) without significant differences among them (as shown in figrs 3,4 and 5) .

The statistical analysis of obtained results showed that treating grains with phosphine at the rate 5.0, 7.0 and 9 ppm resulted in the best results of storage efficacy traits (number of infected wheat grains, damage grains percentage and grains weight loss percentage) after 6 months of storage without significant differences among them (as shown in figrs 3,4 and 5).

The best storage efficacy of wheat grains after 3 or 6 month of storage and combined over storage periods due to treating wheat grains before beginning of storage with phosphine at the rates of 7 or 9 ppm may be owing to phosphine gas had a slow-acting poison for different insect pests of stored products (Winks, 1984 ; Zeng, 1999 ; Chaudhry, 2000 and Collins *et al.,* 2005) which prevented the insects piercing and entering into grains and also the deleterious effect of phosphine on fungus development (Birck *et al.*, 2006). In addition, phosphine is relatively easy to use, versatile, cheap, and accepted internationally as a low-residue treatment (Collins *et al.,* 2005).

Table 2: Number of infected wheat grains, damage grains and grains weight loss percentages as affected by storage periods and treating grains with some chemical insecticides.

Character / Treatments	Number of infected grains	Damage grains (%)	Grains weight loss (%)
A-Storage periods			
3 Months	1.55	0.39	4.87
6 Months	2.79	0.69	7.42
F.test	*	*	*
B-Grains treatments			
Control 1	7.00 a	1.74 a	16.34 a
Control 2	4.56 b	1.13 b	12.06 ab
Phosphine at the rate 5 ppm	0.38 d	0.09 d	1.33 cd
Phosphine at the rate 7 ppm	0.25 d	0.06 d	1.16 cd
Phosphine at the rate 9 ppm	0.13 d	0.03 d	0.39 d
Malathion at the rate 6 ppm	4.15 b	1.04 b	11.16 abc
Malathion at the rate 8 ppm	3.31 bc	0.82 bc	9.70 abcd
Malathion at the rate 10 ppm	2.50 c	0.62 c	8.46 abcd
Deltamithrin at the rate 0.75 ppm	0.63 d	0.18 d	3.14bcd
Deltamithrin at the rate 1.00 ppm	0.63 d	0.15 d	2.23 bcd
Deltamithrin at the rate 1.25 ppm	0.38 d	0.09 d	1.70 cd
F. test	*	*	*
NLSD at 5 %	0.55	0.13	3.07
C-Interaction:	*	*	*

- **Effect of treating wheat grains with malathion:**

Results were obtained after analyzing data of grains that has been treated with malathion rates (6, 8 and 10 ppm) after three months of storage placed in the third rank after phosphine and deltamithrin insecticides with respect of storage efficiency (number and the percentage of infected wheat grains). As for the percentage of weight loss results have been better than control, but it is considered not good (as shown in figrs 3,4 and 5).

Statistical analysis of the results that have been obtained after 6 months of storage showed that treating grains with malathion at rates of 6, 8 and 10 ppm has given the third-best results of the storage efficacy traits (number and the percentage of infected wheat grains as well the percentage of loss grain weight). Among the rates of malathion using of highest rate (10 ppm) gave the best results (as shown in figrs 3,4 and 5).

Treating wheat grains with malathion insecticide at different rates (6, 8 and 10 ppm) associated with slight effect on storage efficacy as compared treating with phosphine or deltamethrin after 3 and 6 month of storage as well combined over storage periods, these results may be due to its it is moderately toxic to mammals (WHO, 1997), as well as, neurotoxin action that causes insect death by inhibiting the acetylcholinesterase enzyme (Kwong , 2002). Although, malathion was formerly widely used, but the increasing resistance of many stored product pests to this pesticide has resulted in the need for alternative control agents (Storey *et al.,* 1984).

Effect of treating wheat grains with deltamethrin:

Results were obtained after analyzing data of grain that has been treated with deltamethrin with rates of 0.75, 1.00 and 1.25 ppm after 3 months of storage gave the second best results from storage efficacy traits (number and the percentage of grains wheat infected and the percentage of weight loss grain) (as shown in figrs 3,4 and 5).

The statistical analysis of obtained results after 6 months of storage clearly showed that the processing of wheat grains with deltamethrin insecticide with the rates of 0.75, 1.00 and 1.25 ppm gave the second best results after phosphine insecticide concerning storage efficacy traits (number and percentage of infected grains and the percentage of weight loss).

Good storage efficacy of wheat grains due to treating grains with deltamithrin at the rates of 1.00 or 1.25 ppm after 3 and 6 month of storage as well combined over storage periods may be attributed to deltamethrin is chemically designed to be more toxic with lower break down times (Thatheyus and Selvam, 2013), as a results of its effects on nervous, respiratory, and hematological systems (Pimpão *et al*., 2007). Hence, deltamethrin had more effectiveness in protecting grains from attack by the major stored-product (Arthur, 2002 ; Nayak *et al*., 2002 and Korunic *et al.*, 2012).

Effect of control treatments:

Studied control treatments (storing wheat grains in jute sacks without any treatment "control 1" and storing wheat grains in metal containers without any treatment with sealing "control 2") recorded the lowest values of storage efficacy traits (number of infected wheat grains, damage grains percentage and grains weight loss percentage) after 3 months of storage. The lowest values of studied storage efficacy traits were resulted from control 1 treatment *i.e.* storing wheat grains in jute sacks without any treatment after 3 months of storage storing. Whereas, control 2 treatment was better than control 1 treatment, which exceeded it in all studied traits.

After 6 months of storage, the statistical analysis of obtained results showed that storage wheat grains in jute sacks without any treatment (control treatment 1) recorded the lowest values of storage efficacy traits (number of infected wheat grains, damage grains percentage and grains weight loss percentage). Storing wheat grains in metal containers without any treatment with sealing (control treatment 2) was ranked after malathion insecticide and before control 1 treatment.

The reduction on storage efficacy when storing wheat grains in jute sacks without any treatment (control treatment 1) or storing wheat grains in metal containers without any treatment with sealing (control treatment 2) as compared treating grains with some chemical insecticides (phosphine, malathion and deltamithrin) after 3 and 6 month of storage as well combined over storage periods may be owing to appropriate conditions for the growth, establishment, development and spread of insects, and at the same time, absence of factors that limit the growth of insects.

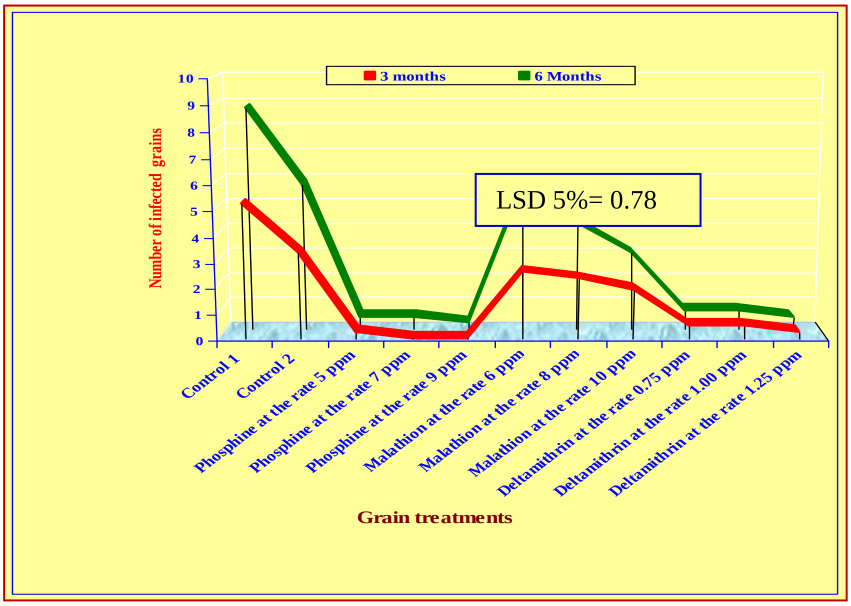

Fig.3: Number of infected wheat grains as affected by the interaction between storage periods and treating grains with some chemical insecticides treatment.

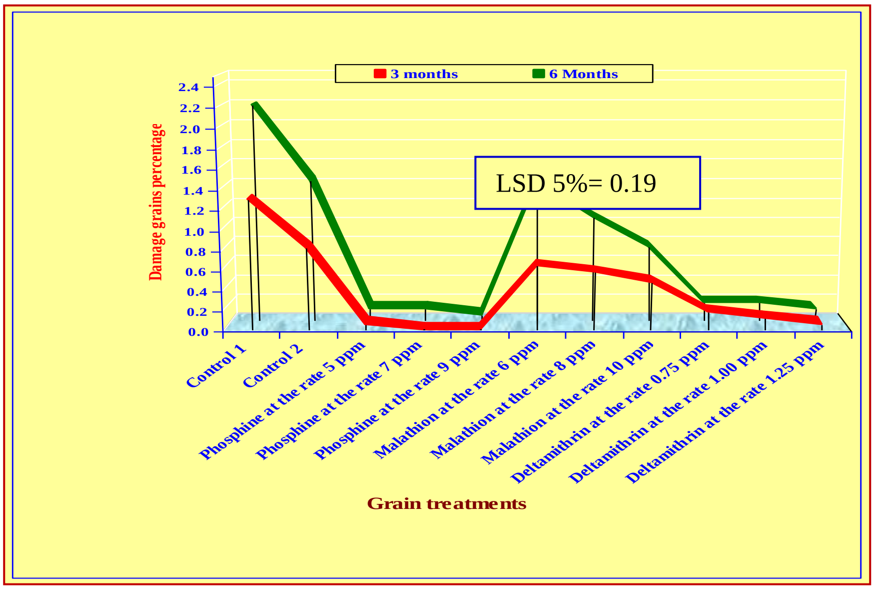

Fig. 4: Damage grains percentage as affected by the interaction between storage periods and treating grains with some chemical insecticides treatment.

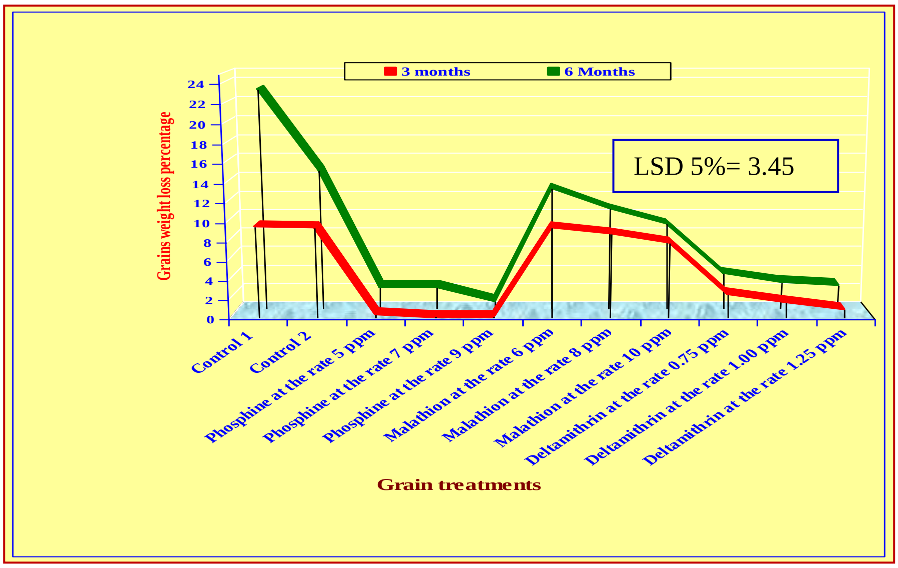

Fig. 5: Grains weight loss percentage as affected by the interaction between storage periods and treating grains with some chemical insecticides treatment.

CONCLUSION

It can be concluded that treating grains of wheat (Gemmiza 10) with 7 or 9 ppm of pesticide phosphine or 1.00 or 1.25 ppm of deltamethrin to increase storage efficacy under the environmental conditions of Dakahlia Governorate, Egypt.

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فعالية تخزين حبوب القمح وتأثرها ببعض المبيدات الحشرية الكيميائية

أحمد نادر السيد عطيه[1]، محسن عبدالعزيزبدوى[1] ، صالح السيدالسيدسعده[1] و سلام ناجي حمه غريب روزبياني[2]
١- قسم المحاصيل – كلية الزراعة – جامعة المنصورة
٢- الشركة العامة لتجارة الحبوب- وزارة التجارة- العراق

تمت هذه التجربة المعملية تحت الظروف البيئية للمحطة التجريبية بقسم المحاصيل ، كلية الزراعة، جامعة المنصورة، مصر ، من فترة ١٥ مايو الى ١٥ نوفمبر ٢٠١٣.
الغرض من التجربة كان لمعرفة تأثير بعض المبيدات الكيميائية (فوسفين ,ملاثيون .دلتامايثرين) بمعدلات مختلفة على فعالية التخزين لحبوب القمح المخزونة تحت ظروف البيئية لمحافظة الدقهلية ، مصر ,خلال فترات مختلفة من التخزين (٠ , ٣, ٦اشهر بعد الحصاد)
ويمكننا تلخيص أهم النتائج التي تم الحصول عليها من هذاالبحث على النحوالتالي:

- فترات تخزين الحبوب القمح كانت لها تأثير معنوي على صفات كفاءة التخزين. زيادة فترات التخزين من ٣ الى ٦ اشهر كان لها تاثير معنوي بشكل ملحوظ على انخفاض صفات فعالية تخزين على جميع معاملات الحبوب المدروسة.
- معاملة حبوب القمح ببعض المبيدات الكيميائية مثل الفوسفين بمعدلات ٥ ،٧، ٩ جزء بالمليون والملاثيون بمعدلات ٦, ٨، ١٠ جزء بالمليون والدلتامايثرين بمعدلات ٠.٧٥ ، ١، ١.٢٥ جزء بالمليون كان لها تاثير معنوي على صفات فعالية التخزين بالمقارنة مع كلتا معاملتي الكونترول.

يمكن التوصية معاملة حبوب القمح صنف (جميزة ١٠) مع مبيد الفوسفين بمعدلات ٧ أو ٩ جزء بالمليون ومبيد الدلتامايثرين بمعدلات ١.٠٠ و ١.٢٥ جزء بالمليون لزيادة صفات فعالية التخزين تحت ظروف البيئية لمحافظة دقهلية ، مصر .

مفتاح الكلمات : قمح ، فعالية التخزين ، مبيدات كيميائية ، فوسفين ، ملاثيون، دلتامايثرين.

وعليه فاننا نوصي بمعاملة حبوبا لقمح صنف (Gemmiza 10) مع ٧ أو ٩ جزءفي المليون من مبيدالفوسفين أو ١.٠٠ أو ١.٢٥ جزءمن المليون من الدلتاميثرين لزيادة كفاءة التخزين تحت الظروف البيئية لحافظة الدقهلية ، مصر.