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MANAGEMENT OF KHABRA BEETLE ADULTS, *Trogoderma granarium* (EVERTS) ON WHEAT GRAIN USING SOME SAFE PHYSICAL AND CHEMICAL MEASURES OF CONTROL UNDER LABORATORY CONDITIONS

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ABSTRACT

Laboratory experiments was conducted to evaluate the adverse action of six plant powders (red pepper, nigella, kidney bean, green peas, cumin and clove), three chemical insecticides (pirimiphos methyl ,spinosad and lufenuron) and four environmental temperatures (10,15,25 and 40 ^{o}C)against the insect species under study, *Trogoderma granarium* using an incubator. Two types of packages ,glass jars and plastic bags were also used for investigating the effect of package kind on the tested insect under the four tested temperatures

The capacity of packaging were studied to prevent tested insect from infesting wheat grain ,two assay methods were used ,package of one layer and package of two layers. Percentage of damage was estimated. The results revealed that the two layer bags greatly reduced the damage of wheat grain *by T. gnanarium* adults compared to that of one layer only. Results demonstrated that the high mortality percentages of *T. granarium* adults were found in polyethylene bags after 3 and 7 days of exposure periods at 40 ,25,15 and 10 ^{o}C respectively. The highest mortality was found with 10 ^{o}C followed by 40,15 and 25 ^{o}C .

The effect of three tested factors together(kind of package, temperatures and insecticides) was higher than that of the two factors of package and temperatures only. The obtained data also revealed that pirimiphos-methyl had the highest effect on *T. granarium* adults compared to spinosad and lufenuron. Lufenuron produced the least effect on the tested insect species among the tested insecticides.

INTRODUCTION

Cereal crops are subjected to attack by the khapra beetle (*Trogoderma granarium* Everts) which is one of the most serious insect pests in tropical and subtropical regions of Asia and Africa (Salunkhe *et al*., 1985 and Viljoen, 1990). Synthetic insecticides have been used since the 1950,s to control stored-products insects (Subramanyam and Hagstrum 1995). Pirimiphos-methyl (Actellic) and malathion were used as a potential protectants for grain and their products against stored product insects

Resistance to traditional insecticides used in stored-product treatments as well as the public's growing demand for residue free products has led researchers to evaluate alternative methods for the control of insects that infest stored products. Cheap and effective method are needed for reducing *T. granarium* damage. Damaged grain has reduced nutritional value, low germination percentage, reduced weight and lowered market value.

Protection of stored products generally involves mixing grains with protectants made up of plant materials .

Fresh, dry or processed plant materials can be applied as insecticides or to repel the pest insects. Plant powders can have a protective effect on the seeds based on several mechanisms. In addition, to direct toxic effects, the plant material may produce odours that repel or confuse the adult beetles, which could prevent invasion or cause emigration from the treated stock. Many plants have been tested in laboratories for their toxic effects on storage beetles, but few of them were tested for their repellent effect. (Okonkwo and Ewete, 2000, Fields *et al*, 2001, Ofuya and Salami, 2002, Umoetok and Gerd, 2003, Abdullahi and Muhammad, 2004, Emeasor et al, 2005, Echezona, 2006 and Selase and Getu (2009) .

Spinosad, a broad-spectrum insecticide of low mammalian toxicity, is based on metabolites of the actinomycete *Saccharopolyspora spinosa* Mertz and Yao (1990). Spinosad, the first active ingredient in the naturalyte class of insect control product was introduced by Dow Agrisciences for control of Lepidopterous pests in cotton in 1997 under the trade name of tracer, spinosad is a naturally occurring mixture of two active components, spinosyn A and spinosyn D (Salgado, 1998).

Lufenuron is a benzoylphenyl-urea (BPU) class of insecticides, which acts as a chitin synthesis inhibitor (CSI). Dean *et al.* (1998), CSI have gained significant popularity due to their low mammalian toxicity and absence of mutagenic and teratogenic effects on warm-blooded animals (Mondal and Parween, 2000)

Physical control measures such as high temperature or packing materials are needed. Since most stored product insects cannot tolerate extereme temperature, heating and cooling are logical approaches to insect control. The insect become inactive and eventually die at a temperature below 12Cº. Lowt emperature is also important in maintaining seed viability (Zewar, 1993, Ayad and Alyousef, 1994, Ali *et al*, 1997, Dohino *et al* (1999), Lale and Vidal, 2003, Arthur, 2006, Burges, 2008 and Xial *et al* (2009).

In recent years, Plastic film also protects food from changes in composition (Fernandez, 2000).

Consequently, this study aims to investigate the following points:

- The toxic activity of nine compounds: one chemical insecticide organophosphorus (pirimiphos-methyl), one biocide [tracer (spinosad)], one insect growth regulator [match (Lufenuron)], and six botanical plant dusts (red pepper, nigella, green peas,cumin, clove and kidney bean).
- Evaluation of efficacy of temperature against the tested insect.
- To evaluate the combined effect of temperature with packages
- To evaluate some of packing materials.
- To evaluate the different packaging manners.

MATERIALS AND METHODS

Insects used:

(*Trogoderma granarium*) :

T. granarium adults tested in this study were continuously reared free of any insecticidal contamination for several years at 30 + 2°C and 70 + 5 R.H at Department of Stored Product Pests, Plant Protection Research Institute, Sakha Agriculture Research Station. The subculture was maintained under the same conditions, 200-400 adults from the previous culture were added in 850 ml glass jars containing 400 gm of crushed and whole wheat grain (*Triticium aestivum* L.) (variety of Sakha 69 with initial moisture content of 14%) as a culture medium. The jars were covered with muslin cloth to be tightly closed and was ranged by rubber bands. Newly emerged adults (1-2 weeks old) were used in the experiments

Chemicals used:

Pirimiphos-methyl (actellic, 50%EC).

Chemical name: O-2 diethyl amino-6-methyl-pyrimidin-4-yl-o,o-dimethyl phosphorthioate.

Spinosad (tracer,24%SC):

Chemical name: Mixture of spinosyn A and spinosyn D. Spinosyn A: (2R, 3as, 5bs, 9s, 13s, 14R, 16bR)-2-(6-deoxy-2,3,3,4, Tri-O-methyl-α-L-Mannopyranosyloxy)-13-(4-dimethylam-ino-2,3,3a, 2, 3, 4, 6-tratdeoxy-B-D-erythropyranosyloxy)-g-ethyl-2,3,3,a 5a, 5b, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16a,16b-hexadecahydro-14-methyl-1H-8-oxacyclododeca[b]as-indacene-7, 15-dione.

Spinosyn D: (2s, 3aR, 5as, 5bs, 9s, 13s, 14R, 16as, 16bR)-2-(6-deoxy-2,3,4-tri-o-methyl-α-L-Mannopyranosyloxy)13-(4-dimethylamino-2,3,4,6-tetradeoxy-β-D-erythropyranosylo-xy)-9-ethyl-2,3 3a, 5a, 5b, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16a, 16b-hexadecahydro-4, 14-dimethyl-1H-8-oxacyclododeca[b]as-indacene-7, 15-dioine.

Lufenuron☹(match 5% EC)

Chemical name: (RS)-1-[2,5-dichloro-4-(1,1,2,3,3,3-hexafluoro-propoxy) phenyl]-3-(2-6, difluorobenzoyl) urea.

Botanical dusts:

Six plant materials were used as dusts against stored product insect (*T.granarium*).The target plant part was dried and finally ground into a fine powder in an electrical blender for five minutes. The powder was thoroughly sieved (300 mech) for obtaining the dust. Mixing of media bioassay method was used.10 gm of whole wheat grain was mixed with the desired amount of a plant powder in 1/4Kg glass jar and ten unsexed insects of *T. granarium* adults were introduced in glass jar which contains the treated wheat grain and tightly covered.% correct mortality was calculate according control treatment.

Effect of temperature on the *T. granarium*

A laboratory experiment was conducted to evaluate the adverse action of four environmental temperatures (10, 15, 25 and 40^{o}C) against *T. granarium*, where the temperatures were maintained using an incubator. Two types of packages, glass jars and plastic bags were also used for investigating the effect of package kind on the tested insects under the four tested temperatures. Ten adult of *T. granarium* were introduced into glass jar or plastic bag. Glass jars or plastic bags which contain 10 g of whole wheat (untreated) and 10 adult insects of *T. granarium* were kept in an incubator at 10, 15, 25 and 40^{o}C) for 3 and 7 days. mortality Percentages were recorded and corrected by Abbott's formula (1925).

Combined effect of temperature with used insecticides on *T. granarium*

For each tested insecticide (Pirimiphos methyl, spinosad and Lufenuron), the suitable required series of concentrations were prepared by adding the desired amount of each material in distilled water, then 10 g of sterilized wheat grain were treated with the above mentioned concentrations. Ten adult of *T. granarium* (1-2 weeks old) were separately introduced into either glass jars or plastic bags each contain the treated wheat grain . Both glass jars or plastic bags were kept in an incubator at different rates of temperature, 10, 15, 25 and 40^{o}C. Treatments which have no insecticide were used as control. Three replicates of each concentration were used for each incubated period (3 and 7 days). After each incubated period, samples of treatments were withdrawn and percent of corrected mortality was calculated .LC_{50}'s were estimated and used for comparison between the potential activities of the tested toxic agents at the different degrees of temperature.

Effect of packaging on % damage infestation:

To prevent invasion of insect pests into stored grains and their products, the capacity of packaging were studied to prevent insects from infesting food products.

Four plant powders (red pepper, nigella, kidney bean and green peas)were selected based on their efficacy to carry out further studies in combination with the backing materials.

Two assay methods i.e. the first, was the common packaging method where the wall of package is one layer. The second, was uncommon method where the wall of package contains two layers, the internal face of the two layers was treated with the selected plant powders. Untreated internal faces of package material was used for comparison.

A. The first method: (package of one layer):

In this experiment polyethelene package was used. **½** kg polyethylene bags contain treated wheat grain with the powders of the tested plants (LC_{50} of each) were used. For check treatment, bags containing untreated wheat grain were used. The all treatments were transferred into glass jars (50 x 50 x 30 cm), number of 300 adult insects of *T. granarium* was introduced into the used glass jars and covered with lids. After 45 days of treatment, the bags were inspected and the percent of damage infestation was estimated.

The second method assay (package of two layers):

In this uncommon method, packages of the polyethelene consist of two layers were used. The internal side faces of the two layers were treated with the LC_{50} of each plant powder which prior produced in the experiment of toxicity. ½ kg polyethylene bags which have treated wall of two layers contain untreated wheat grains were used. For control treatment, another packages (have wall of two layers) free of the plant powder between the two layers of package contain untreated wheat grain were used. The treated bags or control replicated three times. The all treatments were introduced into glass jars (50 x 50 x 30) contain 300 adult insects of *T. granarium*. The jars were covered with their lids, 45 days post-treatment, the bags were opened and wheat grains were inspected to determine the damage percentage using the following equation:

$$\% \text{ Damage} = \frac{\text{Number of infested wheat grain}}{\text{Number of total wheat grain}} \times 100$$

RESULTS AND DISCUSSION

Efficacy of the tested chemical insecticides and plant powders against *T. granarium* adults

Based on results obtained in Tables (1and2) red pepper powder with Lc_{50} of 0.13% w/w had the highest effect on *T. granarium* adults followed by green peas, kidney bean, nigella, cumin and clove, while pirimiphos-methyl was the strongest insecticides compared to spinosad and match with Lc_{50} of 2.49, 19.23 and 82.47 ug/g wheat grain, respectively.

Table (1): Toxicity of the tested plant powders to *T. granarium* exposed to treated media (after 3 days).

Plant powders	LC_{50} w/w%	Slope value S.V	C.L Lower	C.L Upper	Toxicity index
Red pepper	0.13	0.93	0.03	0.23	100
Cumin	0.6	0.24	0.36	0.90	21.67
Clove	0.85	1.59	0.70	1.04	15.29
Nigella	0.36	9.70	0.14	0.55	36.11
Green peas	0.18	1.01	0.07	0.28	72.22
Kidney bean	0.24	1.04	0.12	0.35	54.17

Table (2): Toxicity of the tested insecticides to *T. granarium* exposured to treated media (after 24 hours).

Toxicants	LC_{50} µg/g	Slope value S.V	C.L Lower	C.L Upper	Toxicity index
Pirimiphos-methyl	2.49	2.31	2.13	2.87	100
Spinosad	19.23	1.40	10.34	27.1	12.95
Lufenuron	82.47	1.58	63.47	100.76	3.02

Efficacy of the tested chemical insecticides and plant powders against *T. granarium* adults.

From the present results it is observed that all dry plant powders achieved good protection for wheat grain against adults of *T. granarium*. Plant products are seem to be an effective means of (appropriate technology) suitable to small hold farmers for protecting stored grain from insect damage. There is now overwhelming evidence that many plant species exert diverse biological effects on insects, i.e killing, attracting, repelling, feeding dekerring, growth inhibiting and sterilizing effects (Abbassy, 1981 & 1982, Saleh, 1984 & 1986 and Meisner Nemny, 1992 and Ursula *et al* (2009).

Paul (2006) studied the effect of yellow field pea (*Pisum sativum*) fractions that were mainly protein (50%), fibre (90%) as starch (85%) were obtained from a commerce hial pea mill and mixed with wheat kernels or wheat flow against nine stored grain beetles. He found that the all fractions tested had toxic action against the all tested insect beetles for 8 months at 30 C^o , 70 % r. h.

Spinosad is a (soft) chemical in the sense that it degrades rapidly in the environment and has minimal impact on non-target organisms (Thompson *et al* 2000). Although spinosad breaks down quickly in sunlight, limited published data suggest that spinosad in stored grain will be stable and loss of efficacy will be negligible (Fang *et al* 2002).

Subsequently, spinosad many exploited for insect control of stored product insects and is likely to be a safe alternative of chemical insecticide, pirimiphos-methyl. The high lighted in this study is that concerned in use powders of kidney bean and green peas which demonstrated great detrimental effect on *T. granarium* adults, these it is may be successful adoption for control of stored grain insects .

Effect of packaging process on adults of *T. granarium*:

Results obtained showed that polyethylene treatment damage ratio ranged from 3.0% (green peas) to 8.0 %(red pepper) compared with that of untreated which had 13.0% damage.

Based on the infestation percentage green peas was the most effective plant powder followed by nigella, kidney bean and red pepper either with one layer or two layer polyethelene bags (Table 3).

Table (3): Infestation percentage of *T. granarium* adults after 45 days of exposure to treated wheat grain.

Plant Powders	Treatments			
	Treated		Untreated	
	One layer Polyethylene	Two layers Polyethylene	One layer Polyethylene	Two layers Polyethylene
Red pepper	8.0	6.0	13.0	12.0
Nigella	3.0	2.0	13.0	12.0
Kidney bean	8.0	3.0	13.0	12.0
Green peas	3.0	2.0	13.0	12.0

The treatment of package only had level of damage higher than that of in combination with plant powders. In conclusion, bags of two layers were the better treatment in reducing the damage level of adults of *T. granarium* if compared with that of customary bags which has one layer only. The sacs which has a wall of two layers contain plant powder between their inside faces had the highest effect in minimizing the damage level compared with that of no plant powders. The use of the second type (of two layers with plant powders) was found to be a rational mean in threat cease of stored grain insects, in addition, this method of application reduce the hazard of insecticidal contamination or toxicant materials which do not direct reach to stored products.

The level of damage adults of *T. granarium* with polyethylene bags may depends on the chemical composition of polyethylene, the numbers of holes in mm^2 and the number of wall layers of bag (Highland 1991)

These advantages of two layer sacs which contain plant powders in their internal face are likely to be an important factor in integrated pest management programs. Insect pests may be prevented from entering large or small quantities of stored grain by sealing or packaging.. It will probably depends on several factors including pest pressure, size of holes in the barrier, and tolerance of infestation. Four small bulks of up to a few kilograms, packaging and sealing are widely used to prevent invasion of insect pests into cereal grain and products. There has been extensive work on the capacity of packaging to prevent insects from infesting food products and there are several reviews on this topics (Wohlgemuth, 1979; Newton, 1988; Highland, 1978, 1981 and1991)

Packaging provides a physical barrier that prevents or impedes infestation by insects. There are three factors that determine if a commodity will be infested: insect species, packaging material, and commodity packaged. Insects vary in their capacity to penetrate packaging, *Trogoderma variable* (Ballion) are all capable of penetrating intact packages. *R. dominica* is also capable of penetrating but is rarely found in packaged foods. Other stored-product insects (e.g. *T. castaneum, T. confusum,* and *O. surinamensis*) must have an opening to enter most packaged foods (Highland, 1991). Holes larger than 2 mm^2 will allow most stored-product adult insects to enter packages, whereas holes smaller than 0.3 mm^2 will prevent entry (Cline and Highland, 1981). Packaging materials differ in their capacity to prevent penetration. Listed in order of decreasing case of penetration they are: cellophane, polyethylene, paper, polyvinyl chloride, aluminum foil, polyester and polycarbonate (Cline, 1978). Insecticides can be inserted into the packaging materials to render them more resistant insects. Multiwall packages are necessary to prevent the migration of the pesticide into the commodity.

The widespread protection practice at the farmer level in West and Central Africa regions remains that of mixing grains with locally available natural substances such as wood-ash or dried plant leaves (Chiranjeevi, 1991; Rajapakse and Van Emden, 1997) which they consider less hazardous and of no cost.

Effect of temperature and its combination with the tested chemicals in different storage equipments against adults *T. granarium*:

The principle factors that lead to the proliferation of insects in stored grain are temperature and humidity. In general, the condition suitable for most insect pests is around 30^{o}C, with a relative humidity of 40 to 80 percent. Above 40^{o}C, all species will eventually be killed, while reproduction ceases at temperature below 20^{o}C, with dormancy induced at temperature below 10^{o}C.. Alternatively, brief, high-temperature treatment of grain has been found to disinfest all stages of *S. granarius* in wheat (20 minutes at 70^{o}C) (Zewar, 1993) and other storage insects (two minutes at 55^{o}C (Lapp *et al.*, 1986).

Therefore, laboratory treatments were set to investigate the efficiency of together three factors for suppressing the damage of the tested insect species. The studied factors were, four various temperatures (10, 15, 25, 40^{o}C), two package types (polyethylene, glass jars) and three insecticides (pirimiphos methyl, spinosad and lufenuron). Two treatments were conducted: in the first treatment, *T. granarium* adults were exposed to untreated media either in glass jars or in polyethylene bags under the four tested temperatures. The second treatment was exposing the *T. granarium* adults to treated media by the tested insecticides either in polyethyelene bags or in glass jars under the four tested temperatures. Results of the first treatment in Table (4) demonstrated that the high percent of mortalities (83.3, 100), (53.3, 73.3), (76.7, 90) and (90, 93.3) of *T. granarium* adults were found in polyethylene bags after 3 and 7 days of exposure periods at 40, 25, 15 and 10^{o}C, respectively. The highest mortality was found with 10^{o}C followed by 40^{o}C, 15^{o}C and 25^{o}C especially with 3 days post treatment either with package type or with the tested insect species.. Results in Table (4) showed that the mortality percentages increased with the increasing of exposure period with the all tested temperatures, and the two types of package. While, the highest effect of polyethylene bags on the tested insects may be due to the different properties between glass and polyethylene, in addition, the effect of package volume where the volume of polyethylene bags was smaller than that of glass jars during the experiment, this means that the amount of oxygen in polyethylene bags was less than that of glass jars

Table (4):Mortality percentage of *T. granarium* at indicated temperatures after 3 and 7 days of treatment (untreated media)

Type of package	40^{o}C		25^{o}C		15^{o}C		10^{o}C	
	3 days	7 days	3 days	7 days	3 days	7 days	3 days	7 days
Glass jars	36.7	73.3	13.3	16.7	46.7	70	46.7	66.7
Polyethylene	83.3	100	53.3	73.3	76.7	90	90	93.3

Results in Tables (5-6) revealed that the effect of the three factors together (temperature, package and insecticides) was higher than that of the two factors of package and temperature only. Data obtained also revealed that pirimiphos-methyl had the highest effect on *T. granarium* compared to spinosad and match Also.Also, the results demonstrated that the toxic effect increased with the increasing of concentrations at the different levels of temperature

T. granarium (Everts) is a common pest of grain and other stored products in the tropics and subtropics. It has been distributed worldwide by trade but requires hot conditions for rapid breeding. Moderately low temperatures slow down development and induce diapause, so that cooling grain is an effective, ecofriendly method to control of *T. granarium* (Burges and Burrell, 1964).

Table (5): Comparative and combined effect of temperatures, insecticides and glass jars on *T. granarium* adults mortality after 24 h of treatment

Tested parameters	Conc.	40°C	25°C	15°C	10°C
T+g+p	10 ppm	96. 7	86.7	86.7	96.7
	5 ppm	90.0	76.7	83.3	93.3
	2.5 ppm	80.0	60.0	76.7	86.7
	1.25 ppm	63.3	26.7	46.7	70.0
T + g + S	150 ppm	83.3	73.3	76.7	86.7
	100 ppm	73.3	60.0	66.7	80.0
	50 ppm	50.0	36.7	43.3	63.3
	25 ppm	33.3	20.0	20.0	43.3
T + g + M	400 ppm	83.3	63.3	80.0	93.3
	200 ppm	76.7	53.3	60.0	83.3
	100 ppm	60.0	36.7	40.0	66.7
	50 ppm	40.0	20.0	46.7	46.7
Control		0	0	0	0

T = Temperature, G =glass jar, P = Pirimiphos-methyl, S = Spinosad, M = Match

Table (6): Comparative and combined effect of temperatures, insecticides and polyethylene on *T. granarium* adults after 24 h of treatment.

Tested parameters	Conc.	40°C	25°C	15°C	10°C
T+Po+p	10 ppm	96.7	86.7	93.3	100.0
	5 ppm	93.3	70.0	83.3	96.4
	2.5 ppm	76.7	63.3	73.3	86.7
	1.25 ppm	60.0	36.7	53.3	76.7
T + Po + S	150 ppm	90.0	66.7	83.3	93.3
	100 ppm	86.7	56.7	73.3	86.7
	50 ppm	63.3	43.3	53.3	66.7
	25 ppm	43.3	26.7	33.3	46.7
T + Po + M	400 ppm	86.7	70.0	76.7	93.3
	200 ppm	76.7	53.3	60.0	86.7
	100 ppm	63.3	36.7	43.3	76.7
	50 ppm	46.7	20.0	26.7	63.3
Control		0	0	0	0

T = Temperature, Po=Polyethylene bags, P = Pirimiphos-methyl, S = Spinosad, M = Match.

Burges (2008), determined the low temperature limit for breeding of the khapra beetle *T. granarium* at constant temperatures in the laboratory. The length of female adult life, oviposition, egg incubation period and duration of larval plus pupal development were observed at 25, 22.5, 20 and 17.2^{o}C, respectively at 80% R.H. The results show that breeding is slow at 25^{o}C, very slow at 22.5^{o}C and population decline at (20^{o}C and below). Thus cooling of products to 20^{o}C and retention at or below this temperature is a sound, safe, environmental friendly method for controlling of this pest. He also claimed that mortality (sex unknown) increased from 30.3% at 24.9^{o}C to 100% at 17.2^{o}C. These findings are in agreement with our results where the highest mortality of *T. granarium* achieved by 10^{o}C.

In fact, 15^{o}C is now the maximum storage temp. recommended by the Home-Grown Cereals Authority, to ensure control of other pest species (Burges, 2008). A technique that has been used successfully for many years against stored-product pest is the use of extreme temperatures (Fields, 1992). Use of elevated temperatures in heat treatments has long been recognized as an effective strategy for managing stored product insects associated with food-processing facilities (Dean *et al.*, 1998). Nakakital and Ikenaga (1997) studied the low temperatures to control insect pests in storage rice in Japan. They investigated the action of low temperature on the physiology of *S. oryzae* and *S. zeamais* the major insect pests on rice. They found that oxygen consumption by the adults of both species was reduced as temperature was decreased. Both species exhibited a biphasic declined in respiratory rate as the temperature was reduced, giving sharp fall in respiratory response between 30 and 20^{o}C and a moderate fall between 15 and 5^{o}C. Population increase of *S. oryzae* was completely inhibited at 15^{o}C, while a small number of *S. zeamais* emerged. Xial *et al.* (2009) examined the effect of four constant temperature (20, 24, 28 and 32^{o}C) on the physiological properties (survival, development time, sex ratio, fecundity and longevity of females) in the laboratory at 85% RH. The total development time, longevity shortened as temperature increased.

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ادارة حشرة خنفساء الصعيد علي حبوب القمح باستخدام بعض الطرق الطبيعية والكيماوية الآمنة تحت الظروف المعملية

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أجريت تجارب معملية لتقييم فاعلية أربعة درجات حرارة بيئية (10 و15و25و40 درجة مئوية) ضد الحشرة موضع الدراسة وهي خنفساء الصعيد باستخدام الحضان واستخدمت في الدراسة نوعين من العبوات (البرطمانات الزجاجية والأكياس البلاستيكية) لدراسة التأثير المشترك علي الحشرة موضع الدراسة تحت الأربعة درجات الحرارة المدروسة .

تم دراسة مدي قدرة عمليةالتغليف لحماية حبوب القمح من الاصابة بالحشرات باستخدام طريقتين من طرق التقييم وهما

1- التغليف في طبقة واحدة
2- أوالتغليف في طبقتين وتم تقدير النسبة المئوية للاصابة في القمح بالحشرات الكاملة من خنفساء الصعيد في الحالتين وقد أشارت النتائج الي الأتي:
1- مستوي الاصابة تأثر بطريقة التغليف
2-أن النسبة العالية للموت من خنفساء الصعيد وجدت في أكياس البولي اثيلين بعد3و7 أيام من التعرض علي 40و25و15و 10 درجة مئوية علي التوالي
3- ظهرت أعلي نسبة موت عند درجة حرارة10 تليها 40و15 ثم25 درجة مئوية وأشارت النتائج الي أن تأثير ثلاث عوامل معا (العبوات ودرجات الحرارة والمبيدات) أكثر من تأثير عاملي التغليف والحرارة فقط-

وأشارت الي أن البريميفوس ميثيل كان الأشد تأثيرا علي خنفساء الصعيد بالمقارنة بمبيدي السباينوساد و الماتش وأظهر الماتش أقل تأثير علي الحشرة بالمقارنة بالمبيدات الأخري المدروسة.

قام بتحكيم البحث

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