USE OF SOME BIOLOGICAL CONTROL AGENTS FOR CONTROLLING THE ANGOUMOIS GRAIN MOTH, *SITOTROGA CEREALELLA* (OLIVIER) (LEPIDOTERA: GELECHIIDAE) ON WHEAT AND MAIZE GRAINS

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INTRODUCTION

The angoumois grain moth, *Sitotroga cerealella* (Olivier), is a serious pest of cereal grains in many countries including Egypt. It is widespread throughout the tropics and in most temperate areas of all continents. The larva develops inside a single cereal grain and larval damage is thus hidden until emergence of the adult. The loss in weight of an individual maize grain attacked by one larva is more than 10 %, in smaller cereal grain this weight loss is proportionately greater. In store, this pest attacks the surface layers of stored grains (El-Lakwah *et al.*, 2001). Scientists and public in general are now aware of problems that insecticides can create. Instead of depending mainly on synthetic insecticides, many researchers encourage the use of certain plant product (plant oil, plant extract and powders) and biological control such as (parasites, predators, fungi and bacteria) to avoid using of conventional insecticides. (Pham Thi Thuy *et al.*, 1994, Mummigatti *et al.*, 1994, El-Lakwah *et al.*, 2001and Steidle *et al.*, 2001).

An alternative control method could be the release of parasitic wasps of the genus *Trichogramma*. Worldwide, *Trichogramma* species are the most frequently used natural enemy for control of lepidopteran pests of fruits and cereals in agriculture (Steidle *et al.*, 2001).

The use of bio-product based on the fungus, *Beauveria bassiana* (Bb) has been widely applied for pest management. Effective control measures for pest management in pre-harvest pests by (Bb) were found by some researches. In late 1993 the Post-harvest Technology Institute carried out surveys of the composition of pests in the warehouses of food grains in Vietnam and the use of (Bb) for pest

management in post-harvest food grain (Pham Thi Thuy *et al.*, 1994 and Akbar *et al.*, 2004).

Biological pest control agents such as *Bacillus thuringiensis* are gaining prominence for the control of insect pests in agriculture and forestry. The susceptible insect species stop feeding and eventually die (Mummigatti *et al.*, 1994).

The present work is carried to study certain responses of the angoumois grain moth, *S. cerealella* to bio-products (fungi and bacteria), and release of parasitic wasps *T. evanescens* as a contribution to integrated pest management for combating these insect pests.

MATERIAL AND METHODS

Wheat variety Giza 168 and maize variety (single cross 10) were used. Grains were fumigated with fostoxin at 3 tablets/m^3 for 5 days for each variety. Rearing of the angoumois grain moth, *S. cerealella* culture and tests were performed under controlled conditions of 28 ± 1°C and 65 ± 5% R.H. Insects were reared on wheat kernels of around 13 % moisture content inside one liter capacity glass jars , covered with muslin cloth. For the isolation of the eggs, moths were collected from rearing jars by sucking through polyethylene tube into a dessicator in which the deposited eggs were separated through a sieve to be collected in the lower part of the dessicator. The air current was produced by a pump. Eggs (0-24 hrs old) were applied to induce infestation inside or outside bags of both wheat and maize grains. The initial culture of *T. evanescens* started with parasitised egg masses of *Chilo agamemnon* collected from sugar cane fields. These egg masses were placed in glass tubes (of 2.5 x 12 cm.), stoppered with cheese cloth-wrapped cotton plugs. As the adults began to emerge, sheets of gummy paper (2 x 6 cm.), containing fresh *S. cerealella* eggs were introduced to serve as host. Emerging parasitic adults were provided with 20 % sucrose solution for nutritional purpose. To, avoid super parasitism, host eggs were replaced daily and parasitised host eggs were kept at constant conditions of 27 °C and 70 % R.H., in clean tubes until emerging of parasitoids. Three generations were reared before obtaining parasitic adults for experimental purposes. Plastic bags (16 X 24 cm) were filled with 1/2 Kg of each type of grains and kept in storage conditions; the moisture content of the grains was approximately 13 % at the beginning of the experiment. Trials were triplicated in the Qalubia and Sharkia governorates under open-storages. The experiment was repeated in two locations (Qalubia and Sharkia governorates).

Biover as an entomopathogenic fungi (32000 viable spores/mg) containing the fungus *B. bassiana* (Bb) dust 1, 2 and 4 g; Protecto as an entomopathogenic bacteria (32000 IU/mg) containing the *B. thuringiensis* (B.t) dust 0.075, 0.15 and 0.3 g and 5,10 and 20 eggs of parasitic wasps *T. evanescens* were conducted at monthly intervals. 50 eggs of the angoumois grain moth, were released into each bag in case of Biover and Protecto and inside or outside bags in case of *T. evanescens* at zero and 45 days storage periods.

After 3, 5, 7, 9, 11 and 12 months of storage, the number of alive and dead angoumois grain moth, inside a 1/2 kg sample of wheat and maize grains was inspected. Samples were returned back to the bags after inspection. The efficiency of the tested materials in reducing infestation and population of the angoumois grain moth, were calculated as percentage reduction of adult population in the seed samples at the various storage periods as follows:

$$\% \text{ Reduction} = \frac{\text{Adults number in controlled} - \text{Adults number in the treatment}}{\text{Adult number in control}} \times 100$$

Percentage weight loss was also determined for both grain types at various storage periods by feeding of the angoumois grain moth, using the standard volume/weight method by Harris and Lindblad, (1978). The weight loss of both grains was calculated as dry weight loss which by definition excludes moisture content change. The moisture content of grains was determined by an electronic rapid moisture meter (El-Lakwah and Abdel-Latif 1998).

After initial treatment and after 12 months storage period of wheat and maize, 25 grains were placed on absorbing cotton pad soaked with water in Petri dishes. Three replicates for each treatment were made. Germination of grains was recorded after 7 days.

Determination of total lipids, carbohydrates and protein as major biochemical components were carried out in wheat grain treated with the highest concentration according to Knight et al., (1972); Cromptop, & Birt (1967) and Bradford (1976)

The data was subjected to analysis of variance (ANOVA) and the means were compared by L.S.D. test at 0.05 level, using SAS program (Anonymous, 1988).

RESULTS AND DISCUSSION

Results concerning the effect of Biover at 1, 2 and 4 g, Protecto at 0.075, 0.15 and 0.3 g, as well as *T. evanescens* at 5, 10 and 20 eggs of parasitic wasps *T.*

evanescens on adult population of the angoumois grain moth, *S. cerealella* and percentage reduction for stored wheat and maize grains in Qalubia and Sharkia governorates are given in Tables (1 and 2). In addition, the Sharkia governorate recorded the higher number of population than Qalubia governorate for the angoumois grain moth, to stored wheat and maize grains.

Results revealed that the number of the angoumois grain moth, per 1/2 Kg of wheat and maize grains were obviously reduced in the various treatment at different storage periods compared to the control. This is evident that insect population was also on the concentration of the tested bio-control agent dependent. At the highest concentrations used against the angoumois grain moth, the overall means of the pest population were (123.2, 150.7, 159.7, 210.7, 423.5), (103, 145.3, 157.7, 182.3, 367.2), (137.3, 168.2, 177.2, 228.7,441) and (121, 162.8, 175.2, 201.2, 384.7) per 1/2 Kg of wheat and maize grains in Qalubia and Sharkia governorates, respectively during storage periods of 12 months for *T. evanescens* (inside bags) at 20 eggs of parasitic wasps *T. evanescens*, Biover at 4 g, Protecto at 0.3 g, *T. evanescens* (outside bags) at 20 eggs of parasitic wasps *T. evanescens* and control, respectively. The corresponding reduction values of population were (70.9, 64.4, 62.3, 50.2), (71.9, 60.4, 57.1, 50.4), (68.9, 61.9, 61.2, 48.1) and (68.5, 57.7, 54.5, 47.7) for tested materials, respectively (Tables 1 and 2). In this respect Steidle *et al.*, (2001) reported that *Trichogramma* species (*T. brassicae, T. pretiosum and T carverae)* were assessed for their suitability as bio-control agents against *Ephestia cautella* and *E. kuehniella* which are important pests in food manufacturing and processing facilities in Australia.

The present results were in harmony with that of (Pham Thi Thuy, *et al.* 1994, Moino *et al.*1998, Rice and Cogburn 1999, Abdel-Gawad and Abdel-Aziz 2004 and Abdel-Aziz and Abdel-Gawad 2005). The use of bioinsecticides such as the fungus *B. bassinana* is highly effective for the control of storage pests *Callosobruchus maculatus* and *C. chinensis* on beans and the lesser grain borer *Rhizopertha dominica*, rice weevil *Sitophilus oryzae* and the angoumois grain moth, *S. cerealella* on cereals (wheat and maize).

The majority of stored-product insect pests are destructive. Control of stored-product insect pests using biocide formulations based on *B. thuringiensis* is an emerging area in pest management and has been successfully used in controlling some stored-product insect pests infesting grains (Mummigatti *et al.*, 1994). In this respect, Mummigatti *et al.*, (1994) the use of bio-insecticides such as

TABLE (I)

Number of *Sitotroga cerealella* adults in wheat and maize grains and % reduction at various storage periods in Qalubia governorate

Treatment	Conc.	Number of adults in half kilo gram of grains and % reduction at indicated storage periods (months)						
		Wheat grains						
		3	5	7	9	11	12	Mean
T.evanescens Inside bags	5	25(87.4)	49(81.8)	98(71.2)	298(34.9)	420(28.2)	545(24.1)	239.2(43.5)
	10	20(89.5)	30(88.8)	50(85.3)	220(49.9)	305(47.9)	409(43)	172.3(59.3)
	20	15(92.1)	24(91.1)	41(87.9)	159(63.8)	220(62.4)	280(61)	123.2(70.9)
T.vanescens Outside bags	5	20(89.5)	35(88.8)	85(75)	320(27)	478(18.3)	625(13)	260.5(38.5)
	10	15(92.1)	28(89.6)	45(86.8)	285(35.1)	420(28.2)	600(16.4)	232.2(45.2)
	20	10(94.7)	23(91.4)	32(90.6)	229(47.8)	395(32.5)	575(20)	210.7(50.2)
Biover	1.0g	72(62.1)	110(59.1)	209(38.5)	319(27.3)	443(24.3)	576(19.8)	288.2(31.9)
	2g	44(76.8)	65(75.8)	120(64.7)	205(53.3)	295(49.6)	475(36.4)	200.7(52.6)
	4g	19(90)	39(85.5)	98(71.2)	159(63.8)	230(60.7)	359(50)	150.7(64.4)
Protecto	0.075g	82(56.8)	130(51.7)	229(32.6)	338(23)	465(20.5)	590(17.8)	305.7(27.8)
	0.15g	60(68.4)	90(66.5)	128(62.4)	225(48.7)	320(45.3)	495(31.1)	219.7(48.1)
	0.3g	22(88.4)	42(84.4)	105(69.1)	165(62.4)	245(58.1)	379(47.2)	159.7(62.3)
Control	--	190(--)	269(--)	340(--)	439(--)	585(--)	718(--)	423.5(--)
LSD = 0.14 at 5% level		P<0.0001						
		Maize grains						
T.evanescens Inside bags	5	30(81.8)	52(78.2)	85(73.8)	260(32.3)	352(28.9)	465(21.8)	207.3(43.5)
	10	24(85.5)	38(84.1)	54(83.4)	173(54.9)	282(43)	350(41.2)	153.5(58.2)
	20	19(88.5)	29(87.9)	44(86.5)	125(67.4)	180(63.6)	221(62.9)	103(71.9)
T.vanescens Outside bags	5	25(84.8)	42(82.4)	80(75.4)	280(27.1)	405(18.2)	505(15.1)	222.8(39.3)
	10	18(89.1)	31(87)	49(84.9)	225(41.4)	385(22.2)	488(18)	199.3(45.7)
	20	13(92.1)	26(89.1)	38(88.3)	187(51.3)	363(26.7)	467(21.5)	182.3(50.4)
Biover	1.0g	51(69.1)	105(56.1)	161(50.5)	245(36.2)	385(22.2)	517(13.1)	244(33.6)
	2g	29(82.4)	74(69)	141(56.6)	182(52.6)	265(46.5)	395(33.6)	181(50.7)
	4g	14(91.5)	47(80.3)	98(69.8)	169(56)	239(51.7)	305(48.7)	145.3(60.4)
Protecto	0.075g	61(63)	115(51.9)	177(45.5)	265(31)	397(19.8)	531(10.8)	257.7(29.8)
	0.15g	38(77)	91(61.9)	154(52.6)	194(49.5)	279(43.6)	415(30.3)	195.2(46.8)
	0.3g	18(89.1)	54(77.4)	109(66.5)	178(53.6)	257(48.1)	330(44.5)	157.7(57.1)
Control	--	165(--)	239(--)	325(--)	384(--)	495(--)	595(--)	367.2(--)
LSD = 0.10 at 5% level		P<0.0001						

Values has been transferred to log values before conducting the statistical procedures

Relcased of parasitic wasps *T. evanescens* 3 times inside or outside bags at zero, 45 and 80 days storage periods.

( ) %Reduction in adults population

TABLE (II)

Number of *Sitotroga cerealella* adults in wheat and maize grains and % reduction at various storage periods in Sharkia governorate

Treatment	Conc.	Number of adults in half kilo gram of grains and % reduction at indicated storage periods (months)						
		Wheat grains						
		3	5	7	9	11	12	Mean
T.evanescens Inside bags	5	35(82.5)	64(77.5)	113(68.2)	318(30.7)	440(27.3)	570(23.3)	256.7(41.8)
	10	30(85)	39(86.3)	62(82.5)	240(47.7)	325(46.3)	434(41.6)	188.3(57.3)
	20	25(87.5)	37(87)	53(85.1)	179(61)	225(62.9)	305(59)	137.3(68.9)
T.vanescens Outside bags	5	30(85)	50(82.4)	100(71.8)	340(25.9)	498(17.7)	650(12.5)	278(37)
	10	25(87.5)	43(84.9)	60(83.1)	305(33.6)	440(27.3)	625(15.9)	249.7(43.4)
	20	20(90)	38(86.7)	50(85.9)	249(45.8)	415(31.4)	600(19.2)	228.7(48.1)
Biover	1.0g	82(59)	125(56)	224(36.9)	339(26.1)	463(23.5)	601(19.1)	305.7(30.7)
	2g	54(73)	80(71.8)	135(62)	225(51)	315(47.9)	500(32.7)	218.2(50.5)
	4g	29(85.5)	54(81)	113(68.2)	179(61)	250(58.7)	384(48.3)	168.2(61.9)
Protecto	0.075g	92(54)	145(48.9)	244(31.3)	358(22)	485(19.8)	615(17.2)	323.2(26.7)
	0.15g	70(65)	105(63)	143(59.7)	245(46.6)	340(43.8)	520(30)	237.2(46.2)
	0.3g	32(84)	57(79.9)	120(66.2)	185(64.1)	265(56.2)	404(45.6)	177.2(61.2)
Control	--	200(--)	284(--)	355(--)	459(--)	605(--)	743(--)	441(--)
LSD = 0.09 at 5% level		P<0.0001						
		Maize grains						
T.evanescens Inside bags	5	40(77.1)	67(73.6)	100(70.6)	280(30.7)	372(27.8)	490(21)	224.8(41.6)
	10	34(80.6)	53(79.1)	73(78.5)	193(52.2)	302(41.4)	375(39.5)	171.7(55.4)
	20	29(83.4)	44(82.7)	62(81.8)	145(64.1)	200(61.2)	246(60.3)	121(68.5)
T.vanescens Outside bags	5	35(80)	57(77.6)	95(72.1)	300(25.7)	425(17.5)	530(14.5)	240.3(37.5)
	10	28(84)	46(81.9)	64(81.2)	245(39.4)	405(21.4)	513(17.3)	216.8(43.6)
	20	23(86.9)	41(83.9)	61(82.1)	207(48.8)	383(25.6)	492(20.6)	201.2(47.7)
Biover	1.0g	61(65.1)	120(52.8)	176(48.2)	265(34.4)	405(21.4)	542(12.6)	261.5(32)
	2g	39(77.7)	89(65)	156(54.1)	202(50)	285(44.7)	420(32.2)	198.5(48.4)
	4g	24(86.3)	62(75.6)	113(66.8)	189(53.2)	259(49.7)	330(46.8)	162.8(57.7)
Protecto	0.075g	71(59.4)	130(48.8)	192(43.5)	285(29.5)	417(19)	556(10.3)	275.2(28.5)
	0.15g	48(72.6)	106(58.3)	169(50.3)	214(47)	299(41.9)	440(29)	212.7(44.7)
	0.3g	28(84)	69(72.8)	124(63.5)	198(51)	277(46.2)	355(42.7)	175.2(54.5)
Control	--	175(--)	254(--)	340(--)	404(--)	515(--)	620(--)	384.7(--)
LSD = 0.06 at 5% level		P<0.0001						

Values has been transferred to log values before conducting the statistical procedures

Released of parasitic wasps *T. evanescens* 3 times inside or outside bags at zero, 45 and 80 days storage periods.

( ) %Reduction in adults population

the *B. thuringiensis* as highly effective for the control of the lesser grain borer *R. dominica* on wheat grains.

TABLE (III)

Percentage weight loss for wheat and maize grains through infestation with *Sitotroga cerealella*, adults resulted following treatments of grains at various storage periods in Qalubia governorate

Treatment	Conc.	% Weight loss for Wheat and Maize grains at indicated storage periods (months						
		Wheat grains						
		3	5	7	9	11	12	% Decrease in weight loss after 12 months
T. evanescens Inside bags	5	0.0	0.0	0.9	10.9	14.3	19.3	12.6
	10	0.0	0.0	0.5	6.8	11.8	16.6	15.3
	20	0.0	0.0	0.0	4.2	8.9	12.9	19
T. evanescens Outside bags	5	0.0	0.0	1.2	11.8	19.9	24.9	7.0
	10	0.0	0.0	1.0	10.3	17.8	22.1	9.8
	20	0.0	0.0	0.6	8.1	14.6	18.9	13
Biover	1.0g	0.0	1.0	4.4	8.2	17.3	28.6	3.3
	2g	0.0	0.5	1.8	5.1	9.8	18.9	13
	4g	0.0	0.0	0.0	2.3	5.7	14.6	17.3
Protecto	0.075g	0.6	1.2	5.1	9.0	18.1	29.1	2.8
	0.15g	0.0	0.7	2.1	5.4	10.1	19.7	12.2
	0.3g	0.0	0.5	0.9	2.8	6.4	15.4	16.5
Control	--	1.3	3.1	8.5	15.4	22.8	31.9	---
		Maize grains						
T. evanescens Inside bags	5	0.0	0.0	1.1	8.3	12.1	15.7	8.8
	10	0.0	0.0	0.6	6.0	10	12.2	12.3
	20	0.0	0.0	0.4	4.0	6.7	9.8	14.7
T. evanescens Outside bags	5	0.0	0.0	1.3	9.3	16.5	20.2	4.3
	10	0.0	0.0	0.9	7.1	14.6	18	6.5
	20	00	0.0	0.6	5.2	11.5	14.1	10.4
Biover	1.0g	0.0	0.8	3.3	5.8	13.4	19.7	4.8
	2g	0.0	0.0	1.8	3.6	8.4	12.4	12.1
	4g	0.0	0.0	0.9	2.5	6.0	10	14.5
Protecto	0.075g	0.0	0.9	3.8	6.2	13.9	20.9	3.6
	0.15g	0.0	0.0	2.1	3.9	8.6	12.6	11.9
	0.3g	0.0	0.0	1.3	2.7	6.2	10.3	14.2
Control	--	1.0	2.1	6.3	11.4	18.4	24.5	---

TABLE (IV)

Percentage weight loss for wheat and maize grains through infestation with *Sitotroga cerealella*, adults resulted following treatments of grains at various storage periods in Sharkia governorate.

Treatment	Conc.	% Weight loss for Wheat and Maize grains at indicated storage periods (months						
		Wheat grains						
		3	5	7	9	11	12	% Decrease in weight loss after 12 months
T. vanescens Inside bags	5	0.0	0.0	1.05	11.07	14.49	19.5	14.7
	10	0.0	0.0	0.65	6.97	11.99	16.8	17.4
	20	0.0	0.0	0.0	4.37	9.09	13.1	21.1
T. vanescens Outside bags	5	0.0	0.0	1.35	11.97	20.09	25.1	9.1
	10	0.0	0.0	1.15	10.47	17.99	22.3	11.9
	20	0.0	0.0	0.75	8.27	14.79	19.1	15.1
Biover	1.0g	0.0	1.1	4.55	8.37	17.49	28.8	5.4
	2g	0.0	0.6	1.95	5.27	9.99	19.1	15.1
	4g	0.0	0.0	0.0	2.47	5.89	14.8	19.4
Protecto	0.075g	0.7	1.3	5.25	9.17	18.29	29.3	4.9
	0.15g	0.0	0.8	2.25	5.57	10.29	19.9	14.3
	0.3g	0.0	0.6	1.05	2.97	6.59	15.6	18.6
Control	--	1.6	3.8	9.2	16.4	24.2	34.2	---
		Maize grains						
T. vanescens Inside bags	5	0.0	0.0	1.25	8.47	12.29	15.9	11.0
	10	0.0	0.0	0.75	6.17	10.19	12.4	14.5
	20	0.0	0.0	0.55	4.17	6.89	10.0	16.9
T. vanescens Outside bags	5	0.0	0.0	1.45	9.47	16.69	20.4	6.5
	10	0.0	0.0	1.05	7.27	14.79	18.2	8.7
	20	0.0	0.0	0.75	5.37	11.69	14.3	12.6
Biover	1.0g	0.0	0.9	3.45	5.97	13.59	19.9	7.0
	2g	0.0	0.0	1.95	3.77	8.59	12.6	14.3
	4g	0.0	0.0	1.05	2.67	6.19	10.2	16.7
Protecto	0.075g	0.0	1.0	3.95	6.37	14.09	21.1	5.8
	0.15g	0.0	0.0	2.25	4.07	8.79	12.8	14.1
	0.3g	0.0	0.0	1.45	2.87	6.39	10.5	16.4
Control	--	1.1	2.6	8.2	13.5	20.5	26.9	---

TABLE (V)

Effect of different treatments on major biochemical components in tested wheat grains

Treatments	Mean ± S.E	Percentage observation	
Total Lipids			
T. evanescens	0.41 ± 0.0003 (c)	102.5	+ 2.5 %
Biover	0.55 ± 0.002 (b)	137.5	+ 37.5 %
Protecto	0.5 ± 0.0004 (b)	125	+ 25 %
Control	0.40 ± 0.0003 (c)	100.00	-
LSD 0.08 at 5% level	P<0.05		
Carbohydrates			
T. evanescens	28.23 ± 1.62 (f)	100.4	+ 0.4 %
Biover	48.74 ± 0.1 (a)	173.3	+ 73.3%
Protecto	39.3 ± 2.3 (c)	139.7	+ 39.7 %
Control	28.13 ± 1.58 (f)	100.00	-
LSD = 1.94 at 5% level	P<0.05		
Total Proteins			
T. evanescens	8.4 ± 0.03 (a b)	102.2	+ 2.2 %
Biover	8.47 ± 0.03 (a b)	103.04	+ 3.04 %
Protecto	8.3 ± 0.02 (a b)	101	+ 1.0 %
Control	8.22 ± 0.02 (a b)	100.00	-
LSD = 0.51 at 5% level	P<0.05		

Value is expressed as mg/gm body weight

Means followed with the same letters are not significantly different.

Results of percentages weight loss by infestation with of the angoumois grain moth, in wheat and maize grains after various control treatments are given in Tables (3 and 4). The treatments of various materials resulted in considerable drop of the losses in tested wheat and maize grains compared to control. In addition, the Sharkia governorate recorded a higher number in percentages of weight loss than Qalubia governorate for the angoumois grain moth. The rate of decrease was (19.0, 17.3, 16.5, 13.0), (14.7, 14.5,14.2, 10.4), (21.1, 19.4, 18.6, 15.1)and (16.9, 16.7, 16.4, 12.6) at the highest concentrations used per 1/2 Kg of wheat and maize grains in Qalubia and Sharkia governorates, respectively during storage periods of 12 months for *T. evanescens* (inside bags) at 20 eggs of parasitic wasps *T. evanescens*, Biover at 4 g, Protecto at 0.3 g and *T. evanescens* (outside bags) at 20 eggs of parasitic wasps *T. evanescens* , respectively. Meanwhile, a pronounced increase in of weight loss was recorded with increasing storage period and insect population in the grains. The obtained data revealed clearly that percentage of weight loss of both wheat and maize grains was positively related to the population density of insects in

the grains and the length of storage period. The protection with different treatments for wheat and maize grains was mainly due to reduced oviposition, low adult emergence and high adult mortality, and it agrees completely with the results of El-Lakwah and Abdel-Latif 1998, Abdel- Latif 2003, Abdel-Gawad and Abdel-Aziz 2004 and, Abdel-Aziz and Abdel-Gawad 2005.

Grain germination percentage of wheat and maize grains in Qalubia and Sharkia governorates resulted from the different treatments nearly germinated normally (95-93 %, 89-87 %) and (94-92 %, 88-86 %), respectively. On the other hand, after 12 months it was (93-92 %, 87-86 %) and (92-91 %, 88-87 %), respectively. These results indicated that there was no effect of the tested materials on the percentage of seed germination and the results were confirmed with Shemais 2000, Abdel- Latif 2003, Abdel-Gawad and Abdel-Aziz 2004 and Abdel-Aziz and Abdel-Gawad 2005.

The observed results showed that constant increase of total lipids in wheat grains with *T. evanescens*, Biover and Protecto (2.5, 37.5 and 25 %) compared with control. On the other hand, the results showed that different increase with different treatments (0.4, 73.3 and 39.7 %), respectively in case of carbohydrates as shown in Table (5). In case of total proteins there was an increase with *T. evanescens*, Biover and Protecto (2.2, 3.04, and 1.0 %), respectively. In general, the data showed that there is significant increase in total lipids and carbohydrates in grain content compared with control (Table 5). Also, the results indicated that there is significant increase in total protein in grain content compared with control in all treatments. In this respect, Jood, *et al.* (1996) showed that nutritional composition viz., fat, protein and carbohydrates of treated sorghum grains with plant products remained unaffected after one month of storage and the change after 6 months in nutritional composition was proportional to insect damage. Abdel-Gawad and Abdel-Aziz (2004) showed that there is positive and negative significance in biochemical components (total lipids, carbohydrates and total proteins) of seed content compared with untreated one. Also Abdel-Aziz and Abdel-Gawad (2005) reported that there is a positive significance in biochemical components (total lipids, carbohydrates and total proteins) grain content compared with untreated one.

SUMMERY

The effect of direct treatments of wheat and maize grains with *T. evanescens* (inside or outside bags), Biover and Protecto on insect population and

percentage weight loss of stored grains due to infestation with the angoumois grain moth, *S. cerealella* was studied.

Results showed that percentage weight loss of both wheat and maize grains was positively correlated with insect population and storage period. Insect population and percentage weight loss of both wheat and maize grains were significantly reduced in treated grains during storage period extended to 12 months in comparison with untreated grains. The results indicated that there was no effect of the tested materials on the percentage of the grain germination. Data showed that there is positive significance in biochemical components (total lipids, carbohydrates and total proteins) of grain content compared with untreated control.

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