USE OF CERTAIN NATURAL CONTROL AGENTS FOR MANAGEMENT OF THE LESSER GRAIN BORER, *RHYZOPERTHA DOMINICA* (F.) AND RICE WEEVIL *SITOPHILUS ORYZAE* (L.) ON WHEAT AND MAIZE GRAINS

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INTRODUCTION

Cereal grains should be handled and stored under conditions that minimize the opportunity for stored product pests to cause economic damage. This could be achieved by good design and maintenance of stores, regular inspection and quality control of stored commodities, good storage practices and performance of appropriate pest control measures (El-Lakwah and Abdel-Latif 1998).

Chemicals such as malathion and Sumithion can be used for grain pests control but they cause certain adverse effects on product security and the environment. Malathion is particularly valuable for the protection of stored products from mites, flour beetles, grain weevils and other pests. This may be due to the low acute toxicity to humans and other warm blooded animals. Many investigators have studied the effect of organophosphorus insecticides on stored product insects [e.g. Abo El-Ghar and Badawy (1961); Godavari Boi *et al.* (1964); Strong *et al.* (1969); Williame *et al.* (1978); Ahmed and Delmon (1979); Abdel-Kader *et al.* (1982); Barbara and Linda (1983) and Patoural and Joyeb (1988)].

The use of edible oils in protecting grains is the most suitable because of its commercial availability, low cost besides being non-toxic to humans, do not affect seed germination and do not create off flavors in cooked products (Abdel-Latif, 2003).

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

pests in the warehouses of food grains and conducted research on the use of (Bb) for pest management in post-harvest food grains (Pham Thi Thuy *et al.*, 1994).

The present work is aimed to study the effect of certain natural control agents (plant oils, bio-products, pesticides and mixture of pesticides and bio-products) for management the lesser grain borer *Rhyzopertha dominica* (F.) and rice weevil *Sitophilus oryzae* (L.) on wheat and maize grains.

MATERIAL AND METHODS

Wheat variety Giza 168 and maize variety single cross 10 were used in the test. Grains were fumigated with fostoxin at 3 tablets/m^3 for 5 days. Seven to fourteen days old (uncounted) adults of *R. dominica* and *S. oryzae*, reared under laboratory conditions at 26 ± 2°C and 60 ± 5% R.H. were applied to induce infestation in bags of both wheat and maize grains. Plastic bags (16 X 24 cm) were filled with 1/2 Kg each of grains and kept in storage conditions. The moisture content of the grains was approximately 13 % at the beginning of the experiment. The experiment was repeated in two locations (Qalubia and Sharkia governorates), to clarify the effect of the used materials under different conditions. Three replicates were used for each treatment under open-storages in both locations.

Two plant oils (i.e. garlic and onion natural oils) at 10, 20 ml/Kg; Biover as an entomopathogenic fungi (32000 viable spores/mg) containing the fungus *B. bassiana* dust as 1.5, 2 and 4 g/Kg; organophosphorous compound malathion 1% dust at 2, 8 and 16 mg/Kg; mixture of Biover + malathion at 1.5 g + 2 mg/Kg and the untreated (control) were conducted at monthly intervals. Twenty adults (a group of mixed male and female) of *R. dominica* and *S. oryzae*, were released into each bag at zero and 45 days storage periods.

After 3, 5, 7, 9, 11 and 12 months of storage, the number of alive and dead *R. dominica* and *S. oryzae*, inside each sample of wheat and maize grains were inspected. Samples were returned back to the bags after inspection. The efficiency of the tested materials in reducing population of *R. dominica* and *S. oryzae*, were calculated as percentage reduction of adult population in the grain samples at the various storage periods as follows (El-Lakwah and Abdel-Latif 1998):

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

Percentage of weight loss was also determined for both grain types at various storage periods 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 used. Germination of grains was recorded after 7 days.

Determination of total lipids, carbohydrates and protein as major biochemical components as carried out for wheat grains treated with the highest concentration of each treatment according to Knight *et al.* (1972); Cromptop and Birt (1967) and Bradford (1976).

Obtained data were statistically analyzed using ANOVA in SAS program (Anonymous, 1988). Means separation was conducted using L.S.D. in the same program. Population counts were subjected to log transformation before conducting the analysis because the high variability within numbers.

RESULTS AND DISCUSSION

Results concerning the toxic effect of garlic and onion natural oils at 10 and 20 ml/Kg, Biover at 1.5, 2 and 4 g/Kg, malathion at 2, 8 and 16 mg/Kg as well as mixture of Biover + malathion at 1.5 g: 2 mg/Kg on adult population of *R. dominica* and *S. oryzae*, and percentage reduction of grains in Qalubia and Sharkia governorates are present in Tables (1, 2, 5 and 6). In addition, the Sharkia governorate recorded the a higher but not significantly different population than Qalubia governorate for both the lesser grain borer *R. dominica* and rice weevil *S. oryzae* to stored wheat and maize grains

Results revealed that the number of *R. dominica* per 1/2 Kg bag of wheat and maize grains as obviously reduced in various treatment at different storage periods compared with the control. There is evident that insect population was also concentration dependent. At the higher concentrations used,(i.e. malathion at 16 mg, garlic oil at 20 ml, onion oil at 20 ml, Biover at 4 g and control, respectively) the overall means of insect population were (103.3, 165.2, 210.7, 286.2, 799.5), (109,

TABLE (I)

Number of *Rhyzopertha dominica* adults per 0.5 Kg bag of wheat or maize grains and % reduction (in brackets) at after various Storage periods in Qalubia governorate

Grain	Treatment	Conc.	Months						Mean	
			3	5	7	9	11	12		
Wheat grains	Garlic oil	10ml	14(92.9)	55(78.8)	92(76.1)	139(74.5)	685(54.1)	1119(41.7)	350.7(56.1)	f
		20ml	9(95.4)	21(91.9)	48(87.5)	90(83.5)	289(80.6)	534(72.2)	165.2(79.3)	i
	Onion oil	10ml	16(91.8)	68 (73.7)	108(71.9)	179(67.2)	735(50.7)	1202(37.4)	384.7(51.9)	e f
		20ml	11(94.4)	32(87.6)	57(85.2)	92(83.2)	321(78.5)	751(60.9)	210.7(73.6)	i h
	Biover	1.5g	32(83.7)	127(51)	196(49.1)	325(40.5)	927(37.9)	1385(27.8)	498.7(37.6)	c b
		2g	29(86.7)	100(61.4)	163(57.7)	241(55.9)	892(40.2)	1295(32.5)	453.3(43.3)	c d
		4g	13(93.4)	52(79.9)	94(75.6)	173(68.3)	496(66.8)	889(53.7)	286.2(64.2)	g f
	Biover+ Malathion	1.5g+2mg	22(88.8)	90(65.3)	137(64.4)	213(61)	835(44)	1254(34.7)	425.2(46.8)	e d
	Malathion	2mg	39(80.1)	135(47.9)	225(41.6)	400(26.7)	1150(22.9)	1489(22.4)	573(28.3)	b
		8mg	10(94.9)	40(84.6)	70(81.8)	110(79.9)	428(71.3)	989(48.5)	274.5(65.7)	g h
		16mg	3(98.5)	12(95.4)	29(92.5)	55(89.9)	162(89.1)	359(81.3)	103.3(87.1)	j
	Control	--	196(--)	259(--)	385(--)	546(--)	1492(--)	1919(--)	799.5(--)	a
Maize grains	Garlic oil	10ml	22(83.7)	85(70.3)	131(67.1)	203(58.1)	405(31.2)	603(24.4)	241.5(46.2)	e d
		20ml	12(91.1)	28(90.2)	43(89.2)	93(80.8)	270(54.2)	381(52.3)	137.8(69.3)	g
	Onion oil	10ml	25(81.5)	98(63.2)	159(60.1)	218(55.1)	419(28.9)	638(20.1)	259.5(42.1)	d
		20ml	14(89.6)	32(88.8)	64(83.9)	129(73.4)	329(44.1)	495(38)	177.2(60.5)	f g
	Biover	1.5g	39(71.1)	129(51.5)	226(43.2)	314(35.3)	500(15.1)	702(12)	318.3(29)	b
		2g	31(77)	119(58.4)	209(47.5)	298(38.6)	485(17.7)	692(13.3)	304(32.2)	c b d
		4g	17(87.4)	37(87.1)	79(80.2)	153(68.5)	419(28.9)	571(28.4)	212.7(52.6)	f e
	Biover+Malathion	1.5g+2mg	27(80)	102(61.7)	169(57.5)	231(52.4)	441(25.1)	653(18.2)	270.5(39.7)	c d
	Malathion	2mg	41(69.6)	142(46.6)	239(39.9)	327(32.6)	539(8.5)	735(7.9)	337.2(24.8)	c b
		8mg	19(85.9)	51(80.8)	82(79.4)	135(72.2)	291(50.6)	483(39.5)	176.8(60.6)	f
		16mg	5(96.3)	14(95.1)	32(92)	62(87.2)	169(71.3)	372(53.4)	109(75.7)	h
	Control	--	135(--)	286(--)	398(--)	485(--)	589(--)	798(--)	448.5(--)	A

Not: Means followed with the same letters are not significantly different.

TABLE (II)

Number of *Rhyzopertha dominica* adults per 0.5 Kg bag of wheat or maize grains and % reduction (in brackets) at after various Storage periods in Sharkia governorate

Grain	Treatment	Conc.	Months						Mean	
			3	5	7	9	11	12		
Wheat grains	Garlic oil	10ml	24(88.3)	70(74.5)	112(72.3)	159(71.9)	705(53.4)	1139(41.3)	368.2(54.9)	f
		20ml	19(90.8)	36(86.9)	68(83.2)	110(80.6)	309(79.6)	554(71.9)	182.7(77.6)	i
	Onion oil	10ml	26(87.4)	83(69.7)	128(68.4)	199(64.8)	755(50.1)	1222(37)	402.2(50.8)	e f
		20ml	21(89.8)	47(82.8)	77(81)	112(80.2)	341(77.4)	771(60.2)	228.2(72.1)	i h
	Biover	1.5g	42(79.6)	142(48.2)	216(46.7)	345(39)	947(37.4)	1405(27.5)	516.2(36.8)	c b
		2g	39(81.1)	115(58)	183(54.8)	266(53)	912(39.7)	1315(32.2)	471.7(48.9)	c d
		4g	23(88.8)	67(75.5)	114(71.9)	193(65.9)	530(64.9)	909(53.1)	306(62.5)	g f
	Biover+Malathion	1.5g+2mg	32(84.5)	103(62.4)	157(61.2)	233(58.8)	855(43.5)	1274(34.3)	442.3 (45.9)	e d
	Malathion	2mg	49(76.2)	150(45.3)	245(39.5)	400(29.3)	1170(22.6)	1509(22.2)	587.2(28.1)	b
		8mg	20(90.3)	55(79.9)	90(77.8)	132(76.7)	448(70.4)	1009(48)	292.3(64.2)	g h
		16mg	13(93.7)	27(90.1)	49(87.9)	75(87.3)	203(86.6)	379(80.5)	124.3(84.8)	j
	Control	--	206(--)	274(--)	405(--)	566(--)	1512(--)	1939(--)	817(--)	a
Maize grains	Garlic oil	10ml	32(77.9)	107(64.5)	151(63.9)	223(55.8)	425(30.2)	623(23.8)	260.2(44.2)	e
		20ml	18(87.6)	39(87)	63(84.9)	113(77.6)	311(48.9)	430(47.4)	160.8(65.5)	g h
	Onion oil	10ml	35(75.9)	113(62.4)	179(57.2)	238(52.9)	439(27.9)	658(19.6)	277(40.6)	e d
		20ml	20(86.2)	44(85.4)	84(79.9)	149(70.5)	349(42.7)	515(37)	193.5(58.5)	g f
	Biover	1.5g	49(66.2)	144(52.2)	246(41.1)	334(33.9)	520(14.6)	722(11.7)	335.8(27.9)	c b
		2g	41(71.7)	134(55.5)	229(45.2)	318(37)	505(20.6)	712(13)	323.2(30.6)	c b d
		4g	24(83.4)	52(82.7)	99(76.3)	173(65.7)	439(27.9)	596(27.1)	230.5(50.5)	f
	Biover+Malathion	1.5g+2mg	37(74.5)	117(61.1)	189(54.8)	251(50.3)	461(24.3)	673(17.7)	288(38.2)	c e d
	Malathion	2mg	51(64.8)	157(47.8)	259(38)	347(31.3)	559(8.2)	755(7.7)	354.7(23.9)	b
		8mg	29(80)	66(78)	98(76.6)	155(69.3)	311(48.9)	503(38.5)	193.7(58.4)	f
		16mg	15(89.7)	36(88)	52(87.6)	82(83.8)	189(69)	392(52.1)	127.7(72.6)	h
	Control	--	145(--)	301(--)	418(--)	505(--)	609(--)	818(--)	466(--)	a

Not: Means followed with the same letters are not significantly different.

137.8, 177.2, 212.7, 448.5), (124.3, 182.7, 228.2, 306, 817) and (127.7, 160.8, 193.5, 230.5, 466) per 1/2 Kg of wheat and maize grains in Qalubia and Sharkia governorates, respectively during storage periods of 12 months. The corresponding percent reduction values were (87.1, 79.3, 73.6, 64.2), (75.7, 69.3, 60.5, 52.6), (84.8, 77.6, 72.1, 62.5) and (72.6, 65.5, 58.5, 50.5) for tested materials, respectively (Tables 1 and 2). The mixture (Biover+ malathion) gave 425.2, 270.5, 442.3 and 288 as population and 46.8, 39.7, 45.9 and 38.2 as reduction. These values were less than what was obtained by the higher concentration for either Biover or malathion only.

TABLE (III)

Percentage weight loss of wheat and maize grains by feeding of *Rhyzopertha dominica* adults resulted following treatments of grains at various storage periods in Qalubia governorate

Grain	Treatment	Conc.	Months						Mean	
			3	5	7	9	11	12		
Wheat grains	Garlic oil	10ml	0.0	0.9	2.1	5.2	19.1	33.5	10.1	c b
		20ml	0.0	0.0	0.0	1.8	3.2	15.9	3.5	d
	Onion oil	10ml	0.0	1.1	2.3	5.4	19.9	35.6	10.7	c b
		20ml	0.0	0.0	0.0	2.0	3.9	17.2	3.9	d
	Biover	1.5g	0.0	1.9	3.1	6.1	21.5	37.9	11.8	b
		2g	0.0	1.4	2.8	5.9	20.9	37.1	11.4	b
		4g	0.0	0.0	0.9	3.1	5.1	19.1	4.7	c d
	Biover+ Malathion	1.5g+ 2mg	0.0	1.3	2.6	5.7	20.2	36.4	11.0	b
	Malathion	2mg	0.0	2.2	3.3	6.3	22.1	38.5	12.1	b
		8mg	0.0	0.0	1.1	2.1	10.2	22.9	6.1	c b d
		16mg	0.0	0.0	0.0	0.0	2.4	11.8	2.4	d
	Control	--	2.4	6.4	18.9	31.5	42.8	53.9	26.0	a
Maize grains	Garlic oil	10ml	0.0	0.6	1.9	4.6	15.8	21.9	7.5	c e b d
		20ml	0.0	0.0	0.0	1.9	3.3	14.8	3.3	e f
	Onion oil	10ml	0.0	0.9	2.1	4.9	16.1	22.7	7.8	c b d
		20ml	0.0	0.0	0.0	2.1	3.5	15.9	3.6	e f
	Biover	1.5g	0.0	1.6	3.0	5.9	18.2	25.2	9.0	c b
		2g	0.0	1.1	2.5	5.5	17.1	24.8	8.5	c b d
		4g	0.0	0.0	1.2	3.4	5.2	17.3	4.5	e f d
	Biover+ Malathion	1.5g+ 2mg	0.0	1.0	2.4	5.4	17.7	23.1	8.3	c b d
	Malathion	2mg	0.0	1.9	3.1	6.2	20.2	28.3	10.0	b
		8mg	0.0	0.0	1.0	2.0	10.1	16.8	5.0	c e f d
		16mg	0.0	0.0	0.0	0.0	2.4	12.2	2.4	f
	Control	--	2.3	6.7	12.4	25.1	33.7	39.5	20.0	a

The effect of the treatment of the grains into the bags with the aforementioned various materials on adult population of *S. oryzae* and reduction percentage for stored wheat and maize grains in Qalubia and Sharkia governorates is

presented in Tables (5 and 6). Results showed that the number of *S. oryzae* adults per 1/2 Kg bag of wheat and maize grains increased with rising storage period and was also concentration dependent. The overall mean population was markedly reduced in different treatments in comparison with the control. At the higher concentrations used,(i.e. malathion at 16 mg, garlic oil at 20 ml, onion oil at 20 ml, Biover at 4 g and control, respectively) the mean adult population was (0.0., 0.0, 0.0, 0.0, 840.3), (0.0, 0.0, 0.0, 0.0, 489.3), (0.0, 0.0, 0.0, 0.0, 857.8) and (0.0, 0.0, 0.0, 0.0, 506.8) per 1/2 Kg of wheat and maize grains in Qalubia and Sharkia governorates, respectively during storage periods of 12 months. The corresponding percent reduction values were (100, 100, 100, 100), (100, 100, 100, 100), (100, 100, 100, 100) and (100, 100, 100, 100) for tested materials respectively. The mixture (Biover+ malathion) gave 473.8, 311.3, 493 and 328.8 as population and 43.6, 36.4, 42.5 and 35.1 as reduction. These values were less than what was obtained by the higher concentration for either Biover or malathion only. Results indicated that malathion at 16 mg/Kg was the most effective treatment in reducing insects infestation and population in the stored wheat or maize grains followed by garlic oil at 20 ml/Kg, onion oil 20 ml/Kg, Biover at 4 g/Kg and mixture (Biover + malathion). In this respect Pham Thi Thuy *et al.* (1994) reported that the use of chemical protectants such as malathion and Sumithion, gave good control of pests. Mohamed 1996 and Abdel-Gawad and Abdel-Aziz 2004 evaluated malathion as grain protectant against two species *Callosobruchus maculatus* (F.) and *Callosobruchus. chinensis* (L.). The results showed that malathion was effective.

Recently, oils have used in the protection of stored grains. Many plant oils have insecticidal activities against various stored-product insects and useful as candidates for the control of insect pests in stored-product such as *R. dominica*, *S. oryzae* and *C. maculatus* (El- Nahal *et al.* 1989, Hedin *et al.* 1997, Ahn *et al.*1997 and Abdel- Latif 2003). Abdel-Gawad ana Abdel-Aziz (2004) reported that garlic and onion oils as grain protectant against C. *maculatus* and *C. chinensis* were effective.

The present results were in harmony with that of (Pham Thi Thuy, *et al.* 1994, Moino *et al.*1998, Rice and Cogburn 1999 and Abdel-Gawad and Abdel-Aziz 2004). They reported the use of bioinsecticides such as *B. bassinana* is highly effective for the control of storage pests as C. *maculatus* and *C. chinensis* on beans and *R. dominica* and *S. oryzae* on cereals (wheat and maize).

The possibility of mixing *B. bassinana* and *Verticillium lecanii* with insecticides is an important concept in the use of the fungus in integrated pest

management programs (IPM)(Sewify 1989 and Abdel-Gawad 2000). It is also important to point out that the stability of fungal infectivity in a mixture with insecticides is particularly related to certain isolates of the fungus. This has been confirmed by previous reports of Olmert & Kenneth (1974) and Hall (1981a). An increased efficacy of application was observed in the case of fungus combined with low concentration of insecticides (Foschi and Grassi 1985 and Abdel-Gawad and Abdel-Aziz 2004). The infection of host with fungi caused weakness of host, and chemical control was highly effective at low dose.

TABLE (IV)

Percentage weight loss of *wheat* and maize grains by feeding of *Rhyzopertha dominica* adults resulted following treatments of grains at various storage periods in Sharkia governorate

Grain	Treatment	Conc.	Months						Mean	
			3	5	7	9	11	12		
Wheat grains	Garlic oil	10ml	0.0	1.1	2.3	5.5	19.45	33.9	10.4	c b
		20ml	0.0	0.2	0.2	2.1	3.55	16.3	3.7	d
	Onion oil	10ml	0.0	1.3	2.5	5.7	20.25	36	11.0	c b
		20ml	0.0	0.2	0.2	2.3	4.25	17.6	4.1	d
	Biover	1.5g	0.0	2.1	3.3	6.4	21.85	38.3	12.0	b
		2g	0.0	1.6	3	6.2	21.25	37.5	11.6	b
		4g	0.0	0.2	1.1	3.4	5.45	19.5	4.9	c d
	Biover+ Malathion	1.5g+ 2mg	0.0	1.5	2.8	6	20.55	36.8	11.3	b
	Malathion	2mg	0.0	2.4	3.5	6.6	22.45	38.9	12.3	b
		8mg	0.0	0.2	1.3	2.4	10.55	23.3	6.3	c b d
		16mg	0.0	0.2	0.2	0.3	2.75	12.2	2.6	d
	Control	--	2.5	6.6	19.1	31.8	43.15	54.3	26.2	a
Maize grains	Garlic oil	10ml	0.0	0.8	2.1	4.9	16.15	22.3	7.7	c e b d
		20ml	0.0	0.2	0.2	2.2	3.65	15.2	3.6	e f
	Onion oil	10ml	0.0	1.1	2.3	5.2	16.45	23.1	8.0	c b d
		20ml	0.0	0.2	0.2	2.4	3.85	16.3	3.8	e f
	Biover	1.5g	0.0	1.8	3.2	6.2	18.55	25.6	9.2	c b
		2g	0.0	1.3	2.7	5.8	17.45	25.2	8.7	c b d
		4g	0.0	0.2	1.4	3.7	5.55	17.7	4.8	e f d
	Biover+ Malathion	1.5g+ 2mg	0.0	1.2	2.6	5.7	18.05	23.5	8.5	c b d
	Malathion	2mg	0.0	2.1	3.3	6.5	20.55	28.7	10.2	b
		8mg	0.0	0.2	1.2	2.3	10.45	17.2	5.2	c e f d
		16mg	0.0	0.2	0.2	0.3	2.75	12.6	2.7	f
	Control	--	2.4	6.9	12.6	25.4	34.05	39.9	20.2	a

Results of percentages weight loss by the feeding of *R. dominica* and *S. oryzae*, on wheat and maize grains after various treatments were given in Tables (3, 4, 7 and 8). Results showed clearly that the treatments of various materials resulted

TABLE (V)

Number of *Sitophilus oryzae* adults per 0.5 Kg bag of wheat or maize grains and % reduction (in brackets) at after various storage periods in Qalubia governorate

Grain	Treatment	Conc.	Months						Mean	
			3	5	7	9	11	12		
Wheat grains	Garlic oil	10ml	19(90.5)	90(68.9)	137(68.1)	198(66.8)	740(52.2)	1179(40.4)	393.8(53.1)	b c
		20ml	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	d
	Onion oil	10ml	21(89.6)	100(65.4)	153(64.4)	229(61.6)	790(48.9)	1262(36.2)	425.8(49.3)	b c
		20ml	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	d
	Biover	1.5g	37(81.6)	157(45.7)	241(44)	400(32.9)	1124(27.3)	1445(27)	567.3(32.5)	b a
		2g	34(83.1)	141(51.2)	228(47)	325(45.5)	947(38.8)	1355(31.5)	505(39.9)	b a c
		4g	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	d
	Biover+Malathion	1.5g+2mg	27(86.6)	128(55.7)	198(54)	286(52)	890(42.5)	1314(33.6)	473.8(43.6)	b c
	Malathion	2mg	44(78.1)	165(42.9)	270(37.2)	482(19.1)	1286(16.9)	1669(15.7)	652.7(22.3)	b a
		8mg	15(92.5)	60(79.2)	95(77.9)	142(76.2)	483(71.7)	1049(47)	307.3(63.4)	c
		16mg	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	D
	Control	--	201(--)	289(--)	430(--)	596(--)	1547(--)	1979(--)	840.3(--)	a
Maize grains	Garlic oil	10ml	27(80.7)	122(61.4)	176(60.3)	253(52.7)	460(28.6)	663(22.7)	283.5(42.1)	b c
		20ml	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	d
	Onion oil	10ml	30(78.6)	128(59.5)	204(54)	268(49.9)	474(26.4)	698(18.6)	300.3(38.6)	b c
		20ml	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	d
	Biover	1.5g	44(68.6)	159(49.7)	271(38.8)	364(32)	578(10.2)	780(9.1)	366(25.2)	b a
		2g	36(74.3)	149(52.8)	254(42.7)	348(35)	540(16.1)	752(12.4)	346.5(29.2)	b a c
		4g	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	d
	Biover+Malathion	1.5g+2mg	32(77.1)	132(58.2)	214(51.7)	281(47.5)	496(23)	713(16.9)	311.3(36.4)	b c
	Malathion	2mg	46(67.1)	172(45.6)	284(35.9)	377(29.5)	594(7.8)	795(7.3)	378(22.7)	b a
		8mg	24(82.9)	81(74.4)	116(73.8)	185(65.4)	346(46.3)	543(36.7)	215.8(55.9)	c
		16mg	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	D
	Control	--	140(--)	316(--)	443(--)	535(--)	644(--)	858(--)	489.3(--)	a

Not: Means followed with the same letters are not significantly different.

TABLE (VI)

Number of *Sitophilus oryzae* adults per 0.5 Kg bag of wheat or maize grains and % reduction (in brackets) at after various storage periods in Sharkia governorate

Grain	Treatment	Conc.	Months						Mean	
			3	5	7	9	11	12		
Wheat grains	Garlic oil	10ml	29(86.3)	110(63.8)	167(62.9)	259(58)	760(51.5)	1199(40)	420.7(51)	b c
		20ml	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	d
	Onion oil	10ml	31(85.3)	120(60.5)	183(59.3)	269(56.3)	810(48.3)	1282(35.9)	449.2(47.6)	b c
		20ml	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	d
	Biover	1.5g	47(77.7)	172(43.4)	261(42)	455(26.1)	1202(23.3)	1567(21.6)	616.5(28.1)	b a
		2g	44(79.1)	150(50.7)	228(49.3)	320(48.1)	967(38.3)	1375(31.2)	514(40.1)	b c
		4g	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	d
	Biover+Malathion	1.5g+2mg	37(82.5)	140(543)	222(50.7)	315(48.9)	910(41.9)	1334(33.3)	493(42.5)	b c
	Malathion	2mg	54(74.4)	180(40.8)	290(35.6)	480(22.1)	1225(21.8)	1580(21)	634.8(26)	b a
		8mg	25(88.2)	75(75.3)	115(74.4)	162(73.7)	503(67.9)	1069(46.5)	324.8(62.1)	c
		16mg	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	D
	Control	--	211(--)	304(--)	450(--)	616(--)	1567(--)	1999(--)	857.8(--)	a
Maize grains	Garlic oil	10ml	37(75.3)	137(58.6)	196(57.7)	273(50.8)	480(27.7)	683(22.2)	37(75.3)	b c
		20ml	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	d
	Onion oil	10ml	40(73.3)	143(56.8)	224(51.6)	288(48.1)	494(25.6)	718(18.2)	40(73.3)	b c
		20ml	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	d
	Biover	1.5g	54(64)	174(47.4)	291(37.1)	384(30.8)	580(12.7)	782(10.9)	54(64)	b a c
		2g	46(69.3)	164(50.5)	274(40.8)	368(33.7)	560(15.7)	772(12.1)	46(69.3)	b a c
		4g	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	d
	Biover+Malathion	1.5g+2mg	42(60)	147(55.6)	234(49.5)	301(45.8)	516(22.3)	733(16.5)	42(60)	b c
	Malathion	2mg	56(62.7)	187(43.5)	304(34.3)	397(28.5)	614(7.5)	815(7.2)	56(62.7)	b a
		8mg	34(40)	96(71)	136(70.6)	205(63.1)	366(44.9)	563(35.9)	34(40)	c
		16mg	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	D
	Control	--	150(--)	331(--)	463(--)	555(--)	664(--)	878(--)	150(--)	a

Not: Means followed with the same letters are not significantly different.

TABLE (VII)

Percentage weight loss of wheat and maize grains by feeding of *Sitophilus oryzae* adults resulted following treatments of grains at various storage periods in Qalubia governorate

Grain	Treatment	Conc.	Months						Mean	
			3	5	7	9	11	12		
Wheat grains	Garlic oil	10ml	0.0	1.2	2.4	5.55	19.5	33.9	10.4	b
		20ml	0.0	0.0	0.0	0.0	0.0	0.0	0.0	c
	Onion oil	10ml	0.0	1.4	2.6	5.75	20.3	36	11.0	b
		20ml	0.0	0.0	0.0	0.0	0.0	0.0	0.0	c
	Biover	1.5g	0.0	2.2	3.4	6.45	21.9	38.3	12.0	b
		2g	0.0	1.7	3.1	6.25	21.3	37.5	11.6	b
		4g	0.0	0.0	0.0	0.0	0.0	0.0	0.0	c
	Biover+ Malathion	1.5g+ 2mg	0.0	1.6	2.9	6.05	20.6	36.8	11.3	b
	Malathion	2mg	0.0	2.5	3.6	6.65	22.5	38.9	12.4	b
		8mg	0.0	0.3	1.4	2.45	10.6	23.3	6.3	c b
		16mg	0.0	0.0	0.0	0.0	0.0	0.0	0.0	c
	Control	--	2.6	6.7	19.2	31.85	43.2	54.3	26.3	a
Maize grains	Garlic oil	10ml	0.0	0.9	2.2	4.95	16.2	22.3	7.8	b
		20ml	0.0	0.0	0.0	0.0	0.0	0.0	0.0	c
	Onion oil	10ml	0.0	1.2	2.4	5.25	16.5	23.1	8.1	b
		20ml	0.0	0.0	0.0	0.0	0.0	0.0	0.0	c
	Biover	1.5g	0.0	1.9	3.3	6.25	18.6	25.6	9.3	b
		2g	0.0	1.4	2.8	5.85	17.5	25.2	8.8	b
		4g	0.0	0.0	0.0	0.0	0.0	0.0	0.0	c
	Biover+ Malathion	1.5g+2mg	0.0	1.3	2.7	5.75	18.1	23.5	8.6	b
	Malathion	2mg	0.0	2.2	3.4	6.55	20.6	28.7	10.2	b
		8mg	0.0	0.3	1.3	2.35	10.5	17.2	5.3	c b
		16mg	0.0	0.0	0.0	0.0	0.0	0.0	0.0	c
	Control	--	2.5	7	12.7	25.45	34.1	39.9	20.3	a

in considerable drop of the losses in wheat or maize grains tested compared with control. In addition, the Sharkia governorate recorded a higher but not significantly different percentage of weight loss than Qalubia governorate for both studied insects. The mean of weight loss was (2.4, 3.5, 3.9, 4.7, 26), (2.4, 3.3, 3.6, 4.5, 20), (2.6, 3.7, 4.1, 4.9, 26.2), (2.7, 3.6, 3.8, 4.8, 20.2), (0.0, 0.0, 0.0, 0.0, 26.3), (0.0, 0.0, 0.0, 0.0, 20.3), (0.0, 0.0, 0.0, 0.0, 26.6) and (0.0, 0.0, 0.0, 0.0, 20.5) at the higher concentrations used,(i.e. malathion at 16 mg, garlic oil at 20 ml, onion oil at 20 ml, Biover at 4 g and control, respectively) per 1/2 Kg of wheat or maize grains in Qalubia and Sharkia governorates, respectively during storage periods of 12 months. The mixture (Biover+ malathion) gave 11.0, 8.3, 11.3, 8.5, 11.3, 8.6, 11.6 and 8.8 as mean of weight loss. These values were less than what was obtained by the higher concentration for either Biover or malathion only. 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. In is work the protection with different treatments for wheat or maize grains may be attributed to reduced oviposition, low adult emergence and high adult mortality. These results were confirmed with El-Lakwah and Abdel-Latif 1998, Abdel- Latif 2003 and Abdel-Gawad and Abdel-Aziz 2004.

TABLE (VIII)

Percentage weight loss of wheat and maize grains by feeding of *Sitophilus oryzae* adults resulted following treatments of grains at various storage periods in Sharkia governorate

Grain	Treatment	Conc.	Months						Mean	
			3	5	7	9	11	12		
Wheat grains	Garlic oil	10ml	0.0	1.4	2.6	5.85	19.85	34.3	10.7	b
		20ml	0.0	0.0	0.0	0.0	0.0	0.0	0.0	c
	Onion oil	10ml	0.0	1.6	2.8	6.05	20.65	36.4	11.3	b
		20ml	0.0	0.0	0.0	0.0	0.0	0.0	0.0	c
	Biover	1.5g	0.0	2.4	3.6	6.75	22.25	38.7	12.3	b
		2g	0.0	1.9	3.3	6.55	21.65	37.9	11.9	b
		4g	0.0	0.0	0.0	0.0	0.0	0.0	0.0	c
	Biover+ Malathion	1.5g+ 2mg	0.0	1.8	3.1	6.35	20.95	37.2	11.6	b
	Malathion	2mg	0.0	2.7	3.8	6.95	22.85	39.3	12.6	b
		8mg	0.0	0.5	1.6	2.75	10.95	23.7	6.6	c b
		16mg	0.0	0.0	0.0	0.0	0.0	0.0	0.0	c
	Control	--	2.7	6.9	19.4	32.15	43.55	54.7	26.6	a
Maize grains	Garlic oil	10ml	0.0	1.1	2.4	5.25	16.55	22.7	8.0	b
		20ml	0.0	0.0	0.0	0.0	0.0	0.0	0.0	c
	Onion oil	10ml	0.0	1.4	2.6	5.55	16.85	23.5	8.3	b
		20ml	0.0	0.0	0.0	0.0	0.0	0.0	0.0	c
	Biover	1.5g	0.0	2.1	3.5	6.55	18.95	26	9.5	b
		2g	0.0	1.6	3	6.15	17.85	25.6	9.0	b
		4g	0.0	0.0	0.0	0.0	0.0	0.0	0.0	c
	Biover+ Malathion	1.5g+ 2mg	0.0	1.5	2.9	6.05	18.45	23.9	8.8	b
	Malathion	2mg	0.0	2.4	3.6	6.85	20.95	29.1	10.5	b
		8mg	0.0	0.5	1.5	2.65	10.85	17.6	5.5	c b
		16mg	0.0	0.0	0.0	0.0	0.0	0.0	0.0	c
	Control	--	2.6	7.2	12.9	25.75	34.45	40.3	20.5	a

Grain germination percentage of wheat and maize grains stored in Qalubia and Sharkia governorates resulted from the different treatments (initially) nearly

germinated normally (i.e. 94-92 %, 88-86 % and 93-91 %, 87-85 %, respectively). After 12 months it was (i.e. 91 %, 86-85 % and 91-90 %, 87-86 %, respectively). These results indicated that there was no effect of the tested materials on the percentage of grains germination. These results were confirmed previously by Shemais 2000, Abdel- Latif 2003 and Abdel-Gawad and Abdel-Aziz 2004.

TABLE (IX)

Effect of different treatments on major biochemical components

Treatments	Conc.	Mean ± S.E	Percentage	Change
Total Lipids				
Garlic oil	**20 ml**	0.41 ± 0.0004 (c)	102.5	+ 2.5 %
Onion oil	**20 ml**	1.32 ± 0.007(a)	330	+ 230 %
Biover	**4 g**	0.55 ± 0.002 (b)	137.5	+ 37.5 %
Biover+Malathion	**1.5g+2mg**	0.54 ± 0.002 (b)	112.5	+ 12.5 %
Malathion	**16 mg**	0.51 ± 0.002 (b)	127.5	+ 27.5 %
Control	---	0.40 ± 0.0003 (c)	100.00	--
LSD = 0.08 at 5% level		P<0.05		
Carbohydrates				
Garlic oil	**20 ml**	31.89± 1.64 (e)	113.4	+ 13.4 %
Onion oil	**20 ml**	34.34 ± 0.62 (d)	122.1	+ 22.1 %
Biover	**4 g**	48.74 ± 0.1 (a)	173.3	+ 73.3%
Biover+Malathion	**1.5g+2mg**	46.43 ± 0.1 (a b)	165.1	+ 65.1 %
Malathion	**16 mg**	44.09 ± 1.87 (b)	156.7	+ 56.7 %
Control	---	28.13 ± 1.58 (f)	100.00	--
LSD = 1.94 at 5% level		P<0.05		
Total Proteins				
Garlic oil	**20 ml**	7.09 ± 0.04 (c)	86.25	- 13.75 %
Onion oil	**20 ml**	8.01 ± 0.09 (b)	97.45	- 2.55%
Biover	**4 g**	8.47 ± 0.03 (a b)	103.04	+ 3.04 %
Biover+Malathion	**1.5g+2mg**	8.61 ± 0.26 (a b)	104.7	+ 4.7 %
Malathion	**16 mg**	8.75 ± 0.2 (a b)	106.45	+ 6.45 %
Control	---	8.22 ± 0.02 (a b)	100.00	--
LSD = 0.51 at 5% level		P<0.05		

Values are expressed as mg/gm body weight

Means followed with the same letters are not significantly different.

The observed results showed constant increase of total lipids for wheat grains treated with malathion, garlic oil, onion oil, Biover and mixture (Biover + malathion) (27.5, 2.5, 230, 37.5 and 12.5 %) compared with control after 12 months of storage. On the other hand, the results showed different increase with different treatments (56.7, 13.4, 22.1, 73.3 and 65.1 %, respectively) in case of carbohydrates as shown in (Table 9). In case of total proteins there was an increase with malathion, biover and mixture of malathion and Biover treatments (6.45, 3.04, and 4.7 %, respectively). In general the data showed that there was significant increase in total lipids and carbohydrates content compared with control (Table 9). Also, the results indicated that there was significant increase in total protein in grain content compared with control in malathion, Biover and mixture of malathion and Biover

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 was positive and negative significance in biochemical components (total lipids, carbohydrates and total proteins) seed content compared with untreated one.

SUMMERY

The effect of direct treatments of wheat and maize grains with plant oils (i.e. garlic and onion), fungus (Biover), mixture of malathion and Biover and a pesticides (malathion) on insect population and percentage weight loss of stored grains due to infestation with *R. dominica* and *S. oryzae* 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 one. The results indicated that there was no effect of the tested materials on the percentage of the grain germination. Data showed that there was positive significance in biochemical components (total lipids, carbohydrates and total proteins) grain content compared with untreated one.

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