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Evaluations of *Bacillus* species against red flour beetle *Tribolium castaneum* and confused flour beetle, *Tribolium confusum* (Coleoptera: Tenebrionidae) under laboratory and store conditions

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Abstract: The effect of five bacteria *Bacillus thuringiensis* were tested against the two stored products the *Tribolium castaneum and T. confusum*. Results obtained show that, the LC50s of the different bacterial strain recorded, 79, 67, 66, 44 and 74 Ug/ml afte *T. confusum* treated with different concentrations of *B.T J, B.t 0900, Bt NRRL 2172, BT IP thurizide* and *Bt HD112.*, respectively. The corresponding LC50s of *T. castaneum* are, 77, 65, 65, 39 and 44 Ug/ml ., respectively . Under store conditions, after bacterial treatments, the number of eggs laid / female of *T. confusum* were significantly decreased to 11.0±3.7 and17.3±2.5 after 120 days b of *BT IP thurizide* and *Bt HD112.*, respectively as compared to 99.8±1.9 in the control. Reults showed also, that the *T. castaneum* significantly decreased under store conditions to 11.8±1.7 as compared to 98.8±1.9 in the control after 120 days.

Keywords: *Bacillus* species, *Bacillus* species, B.T J; *B.t 0900; Bt NRRL 2172; BT IP thurizide; Bt HD112;, Tribolium castaneum, Tribolium confusum*

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1. Introduction

Tribolium castaneum (Herbst) is an important worldwide pest of stored products that is observed among several commodities. This pest may cause considerable economical losses if not adequately controlled because it has a very high rate of population increase [1] [2]. [3,4] Although oil seeds are not the preferred hosts of *T. castaneum*, it was observed in some parts of Egypt, such as Use of residual insecticides is becoming less desirable because of the development of resistance in major insect pests. Regulatory restrictions on the use of insecticides, awareness of environmental pollution, the increasing cost of storage, erratic supplies, worker safety, and consumer desire for a pesticide-free product have led to pest management specialists to evaluate alternative methods for the pest control of stored products [5,6].

2. Materials and Methods

2.1. Tested Insects

Larvae of *T. castaneum* and *T. confusum* were used in the experiments. The target insects were reared under laboratory conditions on semi-artificial diet (fine wheat with some adherent endosperm) with 20% glycin and 5% yeast powder. All cultures and experiments were held at 26 ± 2 °C and 70-80% r.h. with 16 hours light and 8 hours dark.

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2.2. Microorganisms

Bacillus thuringiensis 09001, *Bacillus thuringiensis* NRRL 2172, *Bacillus thuringiensis* IP thuricide, *Bacillus thuringiensis* HD 112, and *Bacillus thuringiensis* J were used in this study. The bacterial cultures were maintained on nutrient agar slants at 4°C.

2.3. Bacterial culture media

The conventional laboratory culture broth, Nutrient broth , was used for culture preparation by mixing 5g peptone and 3g beef extract/ 1 L dist water. 50 ml of sterile medium was inoculated with one loopful of bacterial strain and incubated under shaking growth conditions on an orbital rotary shaker (125rpm) at 30°C for 72h.

2.4. Effect of the Microbial Control Agents

Isolated *Bacillus thuringiensis (Bt)* B.T J; *B.t 0900; Bt NRRL 2172; BT IP thurizide; Bt HD112;* were used to test their activities on stored insect pests *T. castaneum* & *T. confusum* adult beetles. The dead larvae of *T. castaneum T. confusum* were collected from the colony. The pathogen were isolated according to [6]. The of Bt the tested concentrations were (500, 250, 125, 63, 32 and 16 ug/ml) (w/v). The rice pots were sprayed by tested concentrations of fungi or Bt and left to dry under laboratory conditions. Control treatment was made by feeding the larvae on untreated rice. The percentages of mortality were counted and calculated according to 50 [7], while LC50 were calculated through probit analysis according to [8]. The experiments were carried under laboratory conditions; 26 ± 2o C and 60- 70% R.H.

3. Results

Table 1, show that the LC50s of the different bacterial starian recorded, 79, 67, 66, 44 and 74 Ug/ml afte *T. confusum* treated with different concentrations of *B.T J, B.t 0900, Bt NRRL 2172, BT IP thurizide* and *Bt HD112.*, respectively. The corresponding LC50s of *T. castaneum* are, 77, 65, 65, 39 and 44 Ug/ml ., respectively (Table 2).

Under store conditions, after bacterial treatments, the number of eggs laid / female of *T. confusum* were significantly decreased to 11.0±3.7 and17.3±2.5 after 120 days b of *BT IP thurizide* and *Bt HD112.*, respectively as compared to 99.8±1.9 in the control (Table 3).

Table 4 show that the*Tribolium castaneum* significantly decreased under store conditions to 11.8±1.7 as compared to 98.8±1.9 in the control after 120 days.

Fig (1) show that the infestations with both the target insect pests were significantly decreased at the end of the experiment.

4. Discussion

The same results obtained by[9,10,11,12] [23] reported that under laboratory conditions results showed that the LC_{50} of *Phyllotreta cruciferaem, Pegomyia hyoscami* and *Cassidavittata*of the tested fungi *Verticillium lecanii (V.l), Nomuraea rileyii (N.r)* and *Paecilomyces farinosuss* (*P.f*), respectively against the three pests ranged between $5.4x10^6$ and $1.43x10^7$ spores/ml. Satisfactory results with the entomopathogenic fungi were reported by [14,15,16,17,18] [31] and [32] [33], [8] as they found that the fungi; *B. bassiana* and *M. anisopliae* reduced the LC_{50} of *S. littoralis* under laboratory conditions. [19,20,21,22,23] reported that the biological control agents reduced the percentage of the store infestations under store condition.

The obtained results are similar to other studies carried out by[33]

[22]and on their work on*C. Capitata* and increased the yield. These results agree with [8], [14], and [35], who proved that the application with bioinsecticides increased the yield and decreased the infestation with insect pests. Also, results were in accordance with [30] who reported that the virulence of *B. bassiana* against *C. capitata* ranged between 8 to 30% and decrease the infestation among the olive fruits.[36] recorded that *C. capitata* mortality ranged between 69 and 78% after bioinsecticides treatments.

kg/Feddan during seasons 2011 1nd 2012, respectively Table 4. The same results [41] control the potato tuber moth by two entomopathogenic *Paecilomyces* sp. [43], [44].[42], controlled cereal aphids with entomopathogenic fungi. They found that the infestation was reduced after fungi applications under laboratory and field conditions [39], [10] , [40]and [36] found that the fungi *B. bassiana, M. anisopliae, Pacilomyces fumosoroseus Verticillium lecanii*; reduced insect infestations of cabbage and tomato pests under laboratory and field conditions.

The same findings obtained by ([39], [10] ,[38] , [39] [40] [44]and [13], found that the fungi *B. bassiana, M. anisopliae, Pacilomyces fumosoroseus Verticillium lecanii*; reduced insect infestations of cabbage and tomato pests under laboratory and field conditions. [6] found that,in all treatments the number of corn pests were significantly decreased. loss of the yield by [8] and 15), proved that applications with bioinsecticides increased the yield and decreased the infestations. Sabbour & Sahab ([39], [10] and [36]) found that the fungi reduced insect infestations of cabbage and tomato pests under laboratory and field conditions. These results agree with , ([8] and [35]), proved that applications with bioinsecticides increased the yield and decreased the the infestation with insect pests.

Table 1: Effect of the entomopathogenic Bacteria against *Tribolium confusum* larvae under laboratory conditions

Insects	$LC_{50\ Ug/ml}$	Slope	Variance	95%confidence limits
B.T J	79	0.1	1.01	99-56
B.t 0900	67	0.2	1.00	88-45
Bt NRRL 2172	66	0.1	1.03	77-50
BT IP thurizide	44	0.4	0.1	66-33
Bt HD112	74	0.5	1.2	100-69

Table 2: Effect of the entomopathogenic Bacteria against *Tribolium castaneum* larvae under laboratory conditions

Insects	$LC_{50\ Ug/ml}$	Slope	Variance	95%confidence limits
B.T J	77	0.1	1.01	99-66
B.t 0900	65	0.1	1.00	89-55
Bt NRRL 2172	65	0.1	1.03	88-57
BT IP thurizide	39	0.1	0.1	78-40
Bt HD112	45	0.2	1.2	99-38

Table 3: Effect of different treatments *Tribolium confusum* under store conditions

Storage interval days	Control		*B.t 0900*		*Bt NRRL 2172*		*BT IP thurizide*		*Bt HD112*		*B.T J*	
	no. of eggs /♀±S.E.	% adult emergence (F1)	no. of eggs /♀±S.E.	% adult emergence (F1)	no. of eggs /♀±S.E.	% adult emergence (F1)	no. of eggs /♀±S.E.	% adult emergence (F1)	no. of eggs /♀±S.E.	% adult emergence (F1)	no. of eggs /♀±S.E.	% adult emergence (F1)
20	11.8±2.5	89	8.8±2.5	15	13.8±1.5	12	1.7±2.7	1	3.3±1.5	2	4.8±7.5	5
45	99.3±4.5	90	28.8±8.5	24	24.8±1.8	15	4.8±0.5	1	5.8±1.7	4	8.9.8±4.5	11
90	96.5±5.5	96	31.8±2.5	28	37.8±7.5	27	9.8±6.5	4	10.4±6.5	11	12.7±6.5	14
120	99.8±1.9	100	39.8±3.9	36	46.6±3.5	38	11.0±3.7	5	17.3±2.5	13	20.1±4.7	22
F value	20.2		21.3		12.1		8.1		9.6		10.7	
Lsd5%	12		17		10		7		8		5	

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Table 2: Effect of different treatments on *Tribolium castaneum* under store conditions

Storage interval days	Control		*B.t 0900*		*Bt NRRL 2172*		*BT IP thurizide*		*Bt HD112*		*B.T J*	
	no. of eggs /♀±S.E.	% adult emergence (F1)	no. of eggs /♀±S.E.	% adult emergence (F1)	no. of eggs /♀±S.E.	% adult emergence (F1)	no. of eggs /♀±S.E.	% adult emergence (F1)	no. of eggs /♀±S.E.	% adult emergence (F1)	no. of eggs /♀±S.E.	% adult emergence (F1)
20	89.8±1.9	87	8.8±1.5	12	11.8±1.5	12	1.8±1.7	1	5.7±7.5	2	7.8±7.5	5
45	92.3±4.5	90	28.8±8.5	22	22.8±1.8	16	5.8±1.5	1	7.8±1.7	4	9.9.8±4.5	11
90	94.5±5.5	95	31.8±1.5	29	38.8±7.5	28	10.8±6.5	4	10.4±6.5	11	13.7±6.5	14
120	98.8±1.9	100	38.8±3.9	35	48.8±1.5	38	11.8±1.7	6	18.8±5.5	12	21.8±2.7	21
F value	22.1		23.1		13.1		8.8		10.3		11.7	
Lsd5%	11		16		10		7		7		6	

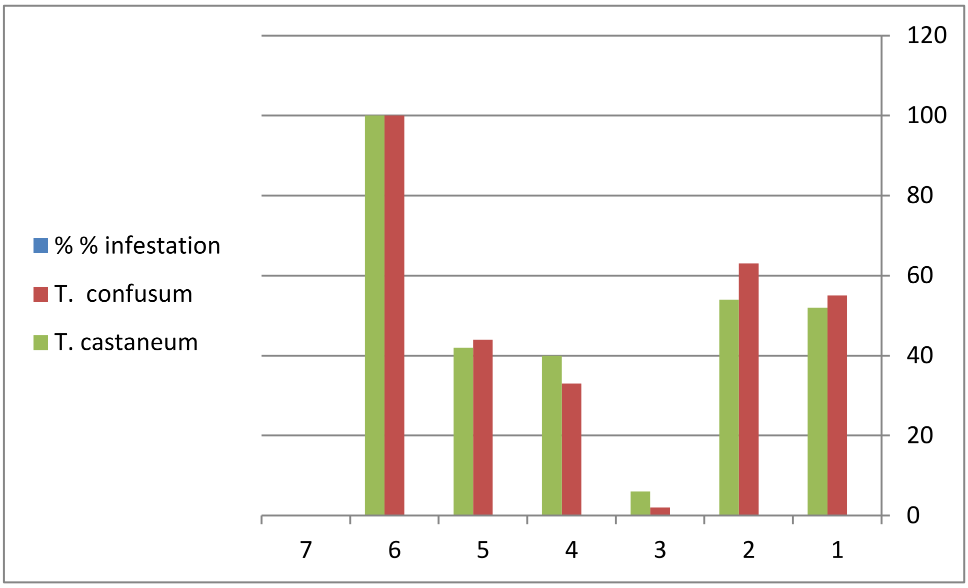

Fig 1: Infestation percentages under store conditions of the target insect pests

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