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Comparing the effect of Seven isolated *Bacillus thuringiensis* against The Indian mealmoth (Plodia interpunctella), infesting during storage

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Abstract : Seven bacterial isolated strains, Bacillus thuringiensis B.T Dendrolimus , B.t thuringiensis , Bt Sotto 4A/4B , BT IP thurizide, Bt Toloworthi, Bt HD 210 and Bt HD 128 tested agist the Indian meal moth (Plodia interpunctella, the LC50 of the different bacterial strains , 103X104, 98 X104, 44 X104, 40 X104, 42 X104, 110 X104 and 177 X104 after treated with different concentrations of bacterial strains, Bacillus thuringiensis B.T Dendrolimus , B.t thuringiensis , Bt Sotto 4A/4B , BT IP thurizide, Bt Toloworthi, Bt HD 210 and Bt HD 128,.

The effect of the number of eggs laid/ female of (Plodia interpunctella were significantly decreased to 10.1±1.6 after treated with Bt Toloworthi as compared to 98.4±4.9 in the control after 120 days of the storage . The percentage of adult emergence significantly decreased to 10 after Bt Toloworthi treatments after 120 days as compared to 99% in the control. .

Keywords . Indian meal moth, (Plodia interpunctella), Bacillus thuringiensis

1. Introduction

The Indian meal moth, *Plodia interpunctella* (Hübner), is a very common household pest, feeding principally on stored food products. In fact, it has been called the most important pest of stored products that is commonly found in the home or in grocery stores in the Egypt. The larvae are general feeders, as they can be found in grain products, seeds, dried fruit, dog food, and spices Sabbour, 2003[1]. [2,3,4,5. 6]used the nanoparticles against the stored product insect pests, they found that the infections were significantly decreased when treated with the nanoparticles.

[7&8] found that, under laboratory conditions, the LC_{50}s, were significantly decreased when the adult female of grasshopper *Hetiracris littoralis*treated with nano-destruxin and reached to 153X10^4spores/ml. Under semi field condition, the LC_{50}s of newly hatched nymphs, last nymphal stage and adult stages, 210 X 10^4, 227 X 10^4and224 X 10^4 spores/ml [8].

[9] Lisansky suggested that the cutinophilic properties of the oil could allow a greater number of fungal conidia to penetrate the mouth parts of insects. Oil carriers can also distribute the inoculum over the thin intersegmental membranes, which are more rapidly penetrated by entomopathogenous fungi [9]. In addition, [10] found that the fungus *Beauveria bassiana* (Bals.-Criv.) Vuill. (Deuteromycotina: Hyphomycetes) killed the insect pests through the cuticle and it was not needed to be consumed by them. It is also mentioned

The present work aimed to explore the protective potency of

2. Material and methods

2.1.Rearing the Insect Pests

The target insect pests *Plodia interpunctella* was reared under laboratory conditions 28 ± 2°C and 60 ± 5% R.H on semi artificial diet (fine wheat with some endosperm), with 20% glycerin and 5% yeast powder. Groups of 100 one-day old eggs were placed each in 15 cm peteridishes comprising a thin layer of diet.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 B.T Dendrolimus B.t thuringiensis Bt Sotto 4A/4B *BT IP thurizide Bt Toloworthi Bt* HD 210 and *Bt* HD 128, were used in this study. The bacterial cultures were maintained on nutrient agar slants at 4^{o}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^{o}C for 72h.

2.4. Effect of the Microbial Control Agents: Isolated *Bacillus thuringiensis (Bt) B.T Dendrolimus , B.t thuringiensis, Bt Sotto,* 4A/4B *,BT IP thurizide, Bt Toloworthi, Bt* HD 210 and *Bt* HD 128*;* were used to test their activities on stored insect pests *B. incarnatus* adult beetles. The dead larvae of *B. incarnatus* were collected from the colony. The pathogen were isolated according to Salama et al [24]. 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 [17], while LC50 were calculated through probit analysis according to [18]. The experiments were carried under laboratory conditions; 26 ± 2o C and 60- 70% R.H.

2.5. Effect of Storage Period on Weight Loss: To determine the impact of storage period on weight loss in the studied cultivars, samples of seeds were tested and as previously mentioned above during storage and weight loss was calculated according to Harris and Lindblad : Weight loss %= (wu x nd) - (wd x nu) X 10

Wu (nd + nu)

Where:

Wd= weight of damaged seeds

nu= number of undamaged seeds

wu= weight of undamaged seeds

nd= number of damaged seeds

Data were subjected to analysis of variance (ANOVA)and means were compared by a least significant different test.

Results and Discussions

Table 1 show that the LC50 of the different bacterial strains , 103X10^{4}, 98 X10^{4}, 44 X10^{4,} 40 X10^{4}, 42 X10^{4}, 110 X10^{4} and 177 X10^{4} after treated with different concentrations of bacterial strains, *Bacillus thuringiensis B.T Dendrolimus , B.t thuringiensis , Bt Sotto* 4A/4B , *BT IP thurizide, Bt Toloworthi, Bt* HD 210 and *Bt* HD 128,.

Table 2 show the effect of the number of eggs laid/ female of P. incarnatus were significantly decreased to 10.1±1.6 after treated with *Bt Toloworthi* as compared to 98.4±4.9 in the control after 120 days of the storage . The percentage of adult emergence significantly decreased to 10 after *Bt Toloworthi treatments after 120 days as compared to 99% in the control (Table2).*

The effect of the different bacterial strains on seeds infections show that after different bacterial strains , the percentage of seeds infestation at the end of experiment were, 1, 4, 2, 1, 2, 15and 20% after *Bacillus thuringiensis B.T Dendrolimus , B.t thuringiensis , Bt Sotto* 4A/4B , *BT IP thurizide, Bt Toloworthi, Bt* HD 210 and *Bt* HD 128, treatments as compared to 98 in the control (Table3).

Figure 1 show that beans seeds infestations were significantly decreased after all the bacterial strains treatments as compared to the control under store conditions .

The same results obtained by [15,16, 17,18,19,20,21,22,23, 24] applied different doses of the essential oils *Acorus calamus* to seeds of green gram Viga radiate to protect them against *Callosobruchus chinensis* (L.) (Coleoptera: Bruchidae) and found that 1 ml/kg offered a high degree of protection up to a period of 135 days. Prolonged protection of the seeds was mainly due to a high adult mortality besides reduced oviposition and low hatching. [16] reported that foam sprayed with clove oil (5%) and placed between sacks caused the highest mortality. [25] reported that edible oils are potential control agents against *P. interpunctella* and play an important role in stored-grain protection. [15] mentioned that clove and eucalyptus oil vapours impaired the fecundity of bruchid beetles. Data proved promising oviposition deterrence toxicity and suppression of eggs and adult emergence. The effect of tested microbial control agents vapours on the reproduction of *P. interpunctella* was studied using the no choice test [5,6,7,8]. The reproduction of the weevils was reduced by the treatments with *B. bassiana*, followed by *M. anisopliae* and *B. thuringiensis*. Weevils laid eggs on treated seeds with *B. bassiana* but the number of eggs is always lower in treated seeds than in the control. [25]reported that edible oils are potential control agents against *P. interpunctella* and play an important role in stored-grain protection.[16] mentioned that clove and eucalyptus oil vapours impaired the fecundity of bruchid beetles. Data proved promising oviposition deterrence toxicity and suppression of eggs and adult emergence. [9], recorded that the LD50 for some formulations of *B. bassiana* was reduced It was suggested that the cutinophilic properties of the oil could allow a greater number of fungal conidia to penetrate the mouth parts of insects. Oil carriers can also distribute the inoculum over the thin intersegmental membranes, which are more readily penetrated by entomopathogic fungi [9]. The increase in the pathogenicity of *B. bassiana* combined with mustard oil to *C. maculatus* beetles may be attributed to some degradation occurring at the structural level of the integument, which could have facilitated the penetration of the cuticle by the germ tube of the fungus. Similar results were obtained by [26] in *Manduca sexta* treated with *M. anisopliae* and the chitin-synthesis inhibit or dimilin. Synergistic effects of a combined application of *B. bassiana* and the chloronicotinyl insecticide imidiaclopride on *Diaprepes abbreviatus* L. (Coleoptera: Curculionidae) were reported by [27].. Similar results obtained by [28,29]. In this respect, [23] applied different doses of essential oils of *Acorus catamus* seeds of green beans to protect them against pest infestation. Also, [21] reported that foam sprayed with clove oil (5%) and placed between sacks caused the highest mortality to *C. maculatus*. Similar results obtained by [30, 31, 32], and Similar results were found by [28, 29, 33, 34].We choose gunny bags for further experiments due to their resistance compared to all other packing materials.the usage of the nano material were studied by[35] who used the nano chitosan and controlled the soya beans insects pests. Also, [36] who suggested that ,the application of the bioinsecticides which affected on decreasing the infestation, the number of infestations of *O. nubilalis, C. agamemnon* and *Sesamia cretica* significantly decreased; [37] Using of entomopathogenic fungi due to reduction the number of eggs laid / female after being treated with *B. brongniartii* and N. rileyi as compared the control. The emerged adults were decreased and the yield weight of potatoes increased in plots treated with *B. brongniartii* and *N. rileyi*. The yields weight of potatoes were significantly in plots treated with *B. brongniartii* and *N. rileyi* as compared in the control during seasons 2013 & 2014. [38] When *T. confusum* treated with the nano imidaclorprid corresponding concentrations, the mortality percentage were significantly decreased to 70, 65 and 49 as compared to 2, 2 and 2 in the control. The mean number of the eggs laid /female of *T. castaneum* significantly decreased to when treated with imidaclorprid and nano imidaclorprid to 118.5 ± 2.1 and 18.6 ± 3.1 as compared to 289.9 ± 3.2 eggs/ female in the control .Larvae of *T. confusum* was more susceptible to the treatments than *T. castaneum* larvae, Nano-DE was more effective than natural-DE. The fecundity of tested insects was highly affected with both DE and nano-DE. The egg production was highly suppressed by nano-DE under stored conditions [39] .

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4. Conclusion

Using of the bacteria *B. thuringiensis* against (*Plodia interpunctella* showed significantly decrease of the inset pest infestations especially under store conditions.

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Table1.Effect of the tested *B. thuringiensis* on *P. interpunctella*.

Target pathogen	**LC_{50}**	***S***	***V***	**95% C*onfidence limits***
B.T Dendrolimus	$103X10^4$	0.1	1.4	89-149
B.t thuringiensis	$98\ X10^4$	2.0	1.3	77-133
Bt Sotto 4A/4B	$44\ X10^4$	0.1	1.2	66-121
BT IP thurizide	$40\ X10^4$	0.1	1.2	33-122
Bt Toloworthi	$42\ X10^4$	0.1	1.1	35-124
Bt HD 210	$110\ X10^4$	0.2	1.2	99-145
Bt HD 128	$177\ X10^4$	1.1	1. 3	57-189

Table 2. Effect of different bacterial strains treatments *Plodia interpunctella* under laboratory conditions.

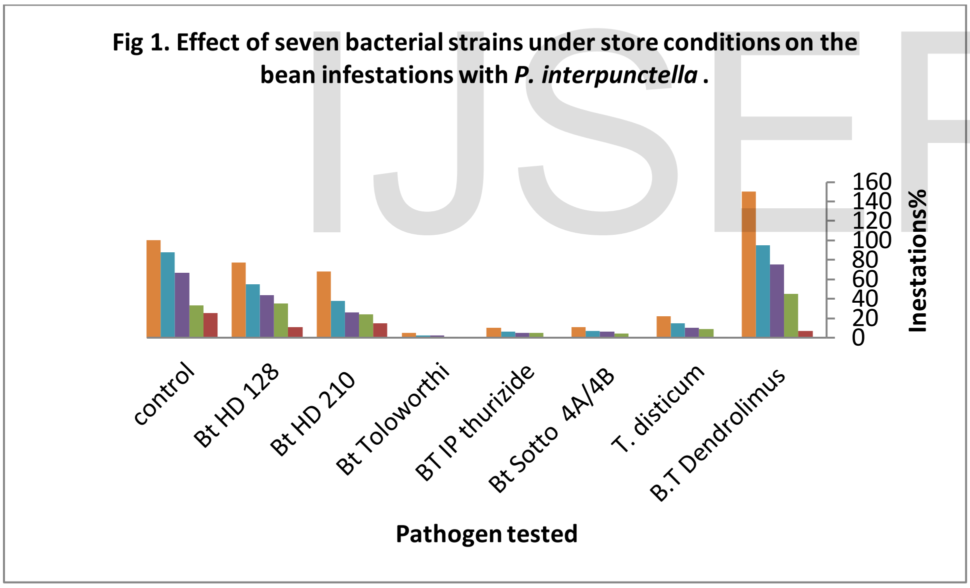
Insects	*Days* Storage interval							
	25		*45*		*90*		*120*	
	no. of eggs /♀±S.E.	% adult emergence (F1)	no. of eggs /♀±S.E.	% adult emergence (F1)	no. of eggs /♀±S.E.	% adult emergence (F1)	no. of eggs /♀±S.E.	% adult emergence (F1)
B.T Dendrolimus	19.8±1.5	7	20.8±1.9	10	23.8±1.2	10	27.1±1.4	12
B.t thuringiensis	18.8±1.6	4	18.8±3.7	7	11.8±1.3	10	19.8±4.9	11
Bt Sotto 4A/4B	7.8±1.1	4	7.8±3.1	9	11.3±1.2	10	15.1±3.9	11
BT IP thurizide	9.7±5.9	6	7.8±2.8	8	11.3±5.1	8	12.1±1.4	10
Bt Toloworthi	6.8±1.5	5	6.4±6.9	7	8.1±1.7	8	10.1±1.6	10
Bt HD 210	22.6±1.4	55	21.8±1.4	26	28.8±1.9	58	28.9±1.7	60

Bt HD 128	38.4±5.1	60	25.8±1.8	29	29.8±6.9	59	29.1±8.9	69
Control	99.9±5.9	100	9.8±1.8	100	98.8±3.9	99	98.4±4.9	99

Table 3. The effect of the storage period on seed infestations after bacterial treatments during storage.

Treatments	% of seeds infestations Start of Experiment	% of seeds infestations End of experiments	% of seeds wt loss Start of Experiment	% of seeds wt loss End of experiments
B.T Dendrolimus	0	1	0	6
B.t thuringiensis	0	4	0	2
Bt Sotto 4A/4B	0	2	0	0
BT IP thurizide	0	1	0	0
Bt Toloworthi	0	2	0	0
Bt HD 210	0	15	0	20
Bt HD 128	0	20	0	37
Control	5	98	0	87

Fig 1. Effect of seven bacterial strains under store conditions on the bean infestations with *P. interpunctella*.



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