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Periodic Research

Management of American Bollworm, *Helicoverpa Armigera* (Hubner) by *Beauveria Bassiana* (Balsamo) in Cotton Crop

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Abstract

Effect of *Beauveria bassiana* (Five concentrations i.e. 0.15, 0.20, 0.25, 0.30 & 0.35 %) and Cypermethrin (0.01 %) were studied against *Heliocoverpa armigera* both *in vitro* and *in situ* on Cotton crop. It was observed that percent mortality of *H. armigera* increased from 26.66 to 66.66 percent respectively as the dose of B. *Bassiana* increased from 0.20 to 0.35 percent. The maximum reduction of population of *H. armigera* was also observed after first and second spray on 3rd, 5th & 7th day. It was recorded that highest population reduction percent was done after spray crop with Cypermethrin 0.01 % followed by *B. bassiana* 0.35 % over control.The maximum boll damage was observed in Cypermethrin 0.01 percent (17%) followed by *B. bassiana 0*.35 percent (19 %) as compared to the natural boll damage of 38 % being noticed in untreated control. The highest boll yield of 1728.33 kg/ha was registered in Cypermethrin, which was followed by B. *Bassiana* (0.35 %) 1478.33 kg/ha over control. The net profit (54270 Rs/ha) & benefit cost ratio (1: 17.4) were more with Cypermethrin but net profit (42825 Rs/ha) and benefit cost ratio (Rs 1: 12.9) recorded with *B. bassiana* (0.35 %). As a whole Cypermethrin leaves residual effects, pest resurgence problems & develop resistence in insect so looking toward ecosafe & biofriendly environment *B. bassiana* found more effective for controlling of H. Armigera in cotton.

Keywords: *Helicoverpa Armigera, Beaveria Bassiana* & Mortlity

Introduction

Cotton (Gossypium spp.), "white gold" is the most important fibre and cash crop of India and is cultivated over an area of 8.0 to 9.5 million ha. with average productivity of 439 kg of lint per ha. It is back bone of textile industry, accounting for 70 percent of total fibre consumption in textile sector and 38 percent of country's export, fetching Rs.42, 000 crores. Cotton crop is attacked by large number of polyphagous pest, out of these jassid (Amrasca biguttula), whitefly (Bemisia tabaci), pink bollworm (Pectinophora gossypiella), spotted and spiny bollworms (Earias vittella and E.insulana), and American bollworm [Heliothis (Helicoverpa) armigera] are the serious pest (Dhawan, 1993). Among them Helicoverpa armigera , belonging to order (Lepidoptera: Noctuidae, is the most notorious pest causing heavy losses to cotton crops in different part of the country. The extents of damage have been reported to be approximately 90.95 % of total damage to boll by caterpillar.Various Insecticides have been recommended all over the country against this pest viz.,Methomyl (Das and Mishra,1991), Endosulfan, Carbaryl,Quinalphos, Chloropyriphos and synthetic pyrethroids (Basu et al.1983).Since the indiscriminate and continuous use of these insecticides has posed serious problems like emergence of resistant strains of insect pests, deleterious effect on predators and parasites and residual hazards to man and domestic animals. It has now assumed the status of national pest in India as it feeds on several economically important crops .Thus it is known to develop resistance to almost all the insecticides used for its control.

The main reason for Helicoverpa armigera becoming such a chronic pest is the development of resistance to many insecticides. The caterpillars of Cotton boll worm not only defoliate the tender leaves but also make the holes in the boll and feeds upon the developing seeds. While caterpillar feed on developing boll, it's nearly half of anterior body portion remains inside while the rest of the half body remains hanging outside the

ball.The caterpillars feed gregariously on the lower surface of leaves and skeletonize them i.e. leaving their veins only. After a week, when they are grown up disperse over the field and eat the leaves and top shoot of plants. In case of heavy infestation the crops are completely defoliated. It has been observed that crops grown in rainfed areas having light soil receive more frequent endemic and epidemic of this pest. So it was thought desirable to replace such insecticides with some biofriendly insecticides particularly entomopathogenic fungus. It is now generally agreed that insecticide application should be replaced by pest management strategies integrating biological, chemical and other methods to reduce the pest population below economic threshold levels. In this context, use of biological agents, especially microbial pathogens, is safe and suitable for a ecosystem. The worldwide awareness about the environment and contamination problems associated with the use of chemical pesticides, it is now opportune time to restructure the future pests control measures using the concept of biological control method.

The entomopathogenic fungus, Beauvaria bassiana is one of important fungi that are of particular research interest because of its potential as commercial bioinsecticides. Some studies had focused on identifying nutrient substrates that B. bassiana can utilize with application to industrial production, while others focused on the pathogenic processes of B. bassiana and interactions with insect cuticle **(**Bidochia et al., 1990). Entomopathogenic fungi are found worldwide associated to insects and phytophagous mite populations, contributing to biological control of these arthropods on several economically important crops **(**Sabbour and Sahab, 2007).

Marerials and Methods

The present experiment was conducted at department of plant protection, College of Allahabad School of Agriculture (U.P.) from June 2011 to April 2012. The details of the various material and methods adopted in the present investigation both in vitro and in situ are as below.

In Vitro

Rearing of Larvae of American Bollworm, *Helicoverpa Armigera* (Hubner)

Larvae of *Helicoverpa* were collected from the field of chickpea and kept in separate glass vial. The fresh leaves of gram were given as feed to larvae at 2 to 3 days intervals. Laboratory reared larvae can be used for study. The essential ingredients for insect developments of artificial diets include protein, carbohydrates, fats, cholesterol, glucose, vitamins, minerals and preservatives *etc*. Singh and Rembold **(1988)** reported that rate of survival and development period of *H. armigera* larvae were different depending upon diet ingredients *i.e*., cotton, soybean or maize. Environmental conditions, nutritive and feeding preference may also affect the intake of food by larvae.The petriplates, pipettes, conical flasks, test tube etc. use in experiments were thoroughly washed with the help of detergent powder and tap water and then dried. The petriplates and pipettes were wrapped in clean paper and sterilized in an oven at a temperature of 160^0 C for 2 hour.

Preparation of Medium

For isolation and culturing of fungi PDA (potato dextrose agar) medium was used, procedure adopted for the preparation was as follows

PDA (Potato Dextrose Agar) Composition

Ingredients	Potatoes	Dextrose	Agar	Distilled water	PH
Amount in gm/l	200	20	15.0-20.0	1000	5.6-6.5

Preparation

The constituents were put into distilled water and boiled. The PH was adjusted around 5.6-6.5. The prepared medium was poured into conical flasks and culture tubes then sterilized at 15 lbs pressure for 20 minute in the autoclave.

Isolation of *Beauveria Bassiana* (Balsamo)

The fungus was isolated from the dead guava bark eating caterpillar larvae, Inderballa quadrinotata , the culture was then purified on potato dextrose agar (PDA) medium and maintained for use in the various experiments.

Identification of *Beauveria Bassiana* (Balsamo)

In culture, B. bassiana grows as a white mould. On most common cultural media, it produces many dry, powdery conidia in distinctive white spore balls. Each spore ball is composed of a cluster of conidiogenous cells. The conidiogenous cells of B. bassiana are short and ovoid, and terminate in a narrow apical extension called rachis. The rachis elongates after each conidium is produced, resulting in a long zig-zag extension. The conidia are single-celled, haploid and hydrophobic.

In - situ

A field experiment was conducted during the year 2011-12 at farm of College of Allahabad School of Agriculture (U.P.) .Cotton variety hybrid 6588 BG II was sown on 25.06.11 using Randomized block design, there were 7 treatments including control and each was replicated 3 times. So total numbers of plots were 21, the size of plot was 2 X 1 M^2.Cotton crop was sprayed two times *ie.*10.11.11 and 20.11.11. All the package and practice for crop were followed.

Detail of Treatments

following treatments were taken during present investigation.

S.No.	Treatment Number	Chemical Name	Concentration Dose (%) Recommended by Karthikeyan and Selvanarayanan, (2011)
1	**T_0**	Control	**0.0**
2	**T_1**	Beauveria bassiana	**0.15**
3	**T_2**	Beauveria bassiana	**0.20**
4	**T_3**	Beauveria bassiana	**0.25**
5	**T_4**	Beauveria bassiana	**0.30**
6	**T_5**	Beauveria bassiana	**0.35**
7	**T_6**	Cypermethrin 25Ec	**0.01**

Table1. Detail of Treatments

Methos of Recording Observation

The treatment was imposed when there was peak infestation of Americon boll worm (*Helicoverpa armigera,* Hubner). For recording the population of Americon boll worm (*Helicoverpa armigera*, Hubner), five plants on each plot were selected randomly for each

replication. The pre determined quantity of Beauveria bassiana formulation were applied thoroughly using manually hand sprayer .The Pretreatment count of number of larvae present were recorded 24 hours before application of Beauveria bassiana and Cypermethrin formulation. The treatment counts of number of dead larvae were recorded at three, five, and seven days after treatment.

The Percentage of Mortality and per cent reduction will be presented here:

$$\% \text{ mortality} = \frac{\text{No. of larvae/adults killed}}{\text{Total no. of larvae/adults treated}} \times 100$$

$$\%\text{Net mortality} = \frac{\%\text{Mortality in test} - \%\text{ mortality in normal}}{\%\text{ mortality in normal}} \times 100$$

Bio –Efficacy

The percent reduction in damage due to the American boll worm(Helicoverpa armigera,Hubner) to in different treatment over control will calculated by modified abbott'

$$\text{Population Reduction (\%)} = 1 - \frac{\text{Post treatment population in treatment}}{\text{pre treatmen population in control}} \times \frac{\text{pre-treatment population in treatment}}{\text{post treatment population in control}} \times 100$$

Boll Damage

Data obtained on the cumulative percent Boll damage based on number obtained from pickings was subjected to analysis of variance after transforming the percent boll damage into the corresponding values. the percent reduction in boll damage over untreated control for each treatment was calculated by using the following formula.

$$\text{Percent reduction of boll Damage in treatment over Untreated control} = \frac{\text{percent boll damage in untreated control} - \text{percent boll damage in treatment}}{\text{Percent boll damage in untreated control}} \times 100$$

Yield

The cumulative yield of cotton obtained from pickings was subjected to analysis of variance to test the significance in different treatments. The percent increase in yield over untreated control for each treatment will calculated by using the following formula.

$$\text{Percent increase of Yield in treatment over Untreated control} = \frac{\text{Yield in treatment} - \text{Yield in untreated control}}{\text{yield in untreated control}} \times 100$$

Cost Benefit Ratio

The value of B:C of different treatments were calculated by following formula.

$$\text{B: C} = \frac{\text{Net return}}{\text{Cost of treatment}}$$

$$\text{ICBR} = \frac{\text{Additional return}}{\text{Cost of treatment}}$$

Where,
BC=Benefit cost ratio
ICBR=Increment cost Benefit Ratio

Results and Discussion

In Vitro

Effect of *Beauveria bassiana* and Cypermethrin on Net mortality per cent of *Helicoverpa armigera.*

Effect of Treatment

From the bioassay a linear relation between per cent mortality and dose of concentrations were observed. In the bioassay with *B.bassiana* against *H. armigera*, percent mortality increased from 26.66 to 66.66 per cent respectively as the dose was increased from 0.20 to 0.35per cent. In the present study among the applied doses higher concentration recorded the highest mortality where as in less concentration various morphological abnormalities such as malformed larvae pupae and adults were noticed, larvae became sluggish and stopped feeding after 24hrs. The cuticle of treated larvae blackened which may due to excessive melanization indicating direct attack of fungus on the defence system of these insects. After 72 hrs.In the present bioassay, the per cent mortality increased from 46.66 to 66.66 respectively as the dose level increased from 0.15 to 0.35 per cent (Table 2) compared of cypermethrin. From the results obtained, among various concentrations 0.35 per cent recorded the highest per cent mortality and proved its best performance against the *Helicoverpa armigera*. Hence this concentration of *B. bassiana* and cypermethr in could be suggested in managing the *Helicoverpa armigera* $T_0<T_1<T_2<T_3<T_4<T_5<T_6$

Table 2

Effect of *Beauveria Bassiana* and Cypermethrin on Net Mortality Percent of *Helicoverpa Armigera*

Effect of Time Period

Effect of Time Period

From the results of present study it was observed that different time periods (24,48 and 72 hrs) showed significant difference between them. Highest mortality rate was recorded in 72 hours followed by 48hours and 24 hours respectively. 72hours> 48hours>24hours.

Treatment	Mortality % at different hrs of intervals (Mean of the replicates)		
	24 hrs	48 hrs	72 hrs
T_0 (Control)	0(0.0)	0(0.0)	0(0.0)
T_1 B. bassiana(0.15%)	33.33 (35.18)	33.33 (35.18)	46.66 (43.05)
T_2 B. bassiana(0.20%)	26.66 (31.05)	33.33 (35.18)	53.33 (46.89)
T_3 B. bassiana(0.25%)	46.66 (43.05)	53.33 (46.89)	60.00 (50.77)
T_4 B. bassiana(0.30%)	33.33 (35.18)	33.33 (35.18)	46.66 (43.05)
T_5 B. bassiana(0.35%)	46.66 (43.05)	53.33 (46.89)	66.66 (54.70)
T_6 Cypermethrin (0.01%)	53.33 (46.89)	66.66 (43.05)	93.33 (75.00)
F- test	S	S	S
S. Ed. (±)	0.436	0.448	0.509
C. D. (P = 0.05)	0.925	0.951	1.079

In-situ

Evaluation of Efficacy of *Beauveria Bassiana* and Cypermethrin Against *Helicoverpa Armigera* infesting on Cotton

The efficacy of different concentrations of *Beauveria bassiana* and Cypermethrin is depicted in (Table 3 & 4)

First & Second Spray

3rd Day

The data presented in (table 3 & 4) reveals that the maximum population reduction at 3 DAS was recorded, T_6 treatment with Cypermethrin 0.01percent (73.61& 69.59 %) followed by T_5 0.35 percent *Beauveria bassiana* (66.46 & 56.55%), T_4 0.30 percent *Beauveria bassiana* (57.63 & 49.48%), T_3 0.25 percent *Beauveria bassiana* (51.49 & 29.63 %), T_2 0.20 percent *Beauveria bassiana*. (50.03& 41.58 %) and T_1 0.15 percent *Beauveria bassiana.* (30.78 & 22.67 %) as compared to T_0 , Control (0.0 %)after first and second spray respectively. The highest population reduction percent was recorded in T_6. T_2 and T_3 was non-significant in compared Among the treatments and significant results were found in the treatments T_6, T_5, T_4 and T1. All the treatments were significantly superior over control.

5th Day

The data presented in (table 3 & 4) reveals that the maximum population reduction at 5 DAS was recorded T_6 treatment with Cypermethrin 0.01percent (74.61& 77.89%) followed by T_5 0.35 percent *Beauveria bassiana* (69.32& 64.4%), T_4 0.30 percent *Beauveria bassiana* (66.25 & 56.89%), $T_{3\ 0.25}$ percent *Beauveria bassiana* (60.86& 35.44 %), T_2 0.20 percent *Beauveria bassiana* (52.97 & 41.11%) and T_1 0.15 percent *Beauveria bassiana*. (48.58& 23.47 %) as compared to T0, Control (0.0 %) after first and second spray respectively. The highest population reduction percent was recorded in T_6. T_1, T_2, T_4 and T_5 were non-significant in compared Among the treatments and significant results were found in the treatments T_6 and T_3 . All the treatments were significantly superior over control.

7th Day

The data presented in (table 3 & 4) reveals that the maximum population reduction at 7 DAS was recorded T_6 treatment with Cypermethrin 0.01percent (67.52 & 74.24%) followed by T_5 0.35 percent *Beauveria bassiana.* (62.21& 59.01 %, T_4 0.30 percent *Beauveria bassiana* (52.10 & 52.39%) , T_3 0.25 percent *Beauveria bassiana* (46.50 &28.36 %) , T_2 0.20 percent *Beauveria bassiana*. (43.74 & 34.94 %) and T_1 0.15 percent *Beauveria bassiana* (36.87&23.11 %) as compared to T_0 Control (0.0 %) after first and second spray respectively. The highest population reduction percent was recorded in T_6. T_2 and T_3 were non-significant in compared among the treatments and significant results were found in the treatments T_6, T_5, T_4 and T1. All the treatments were significantly superior over control.

Table 3.

Efficacy of *Beauveria bassiana* and Cypermethrin on Population reduction of *Helicoverpa armigera* in Cotton. after first Spray

Treatments	Before	Pop^n of *H.armigera* (3 day)	3 DAS Pop^n reduction over control	Pop^n of *H.armigera* (5 day)	5 DAS Pop^n reduction over control	Pop^n of H.armigera (7 day)	7 DAS Pop^n reduction over control
T0	3.87	21	0.00 (0.0)	23	0.00 (0.0)	26	0.00 (0.0)
T1	4.00	13	30.78 (33.65)	7	48.58 (44.14)	4	36.87 (37.35)
T2	3.60	9	50.03 (45.00)	4	52.97 (46.66)	2	43.74 (41.38)
T3	4.07	10	51.49 (45.80)	4	60.86 (51.24)	2	46.50 (42.94)
T4	3.87	8	57.63 (49.37)	3	66.25 (54.39)	1	52.10 (46.20)
T5	4.27	7	66.46 (54.57)	2	69.32 (56.29)	1	62.21 (52.06)
T6	4.00	5	73.61 (59.08)	2	74.61 (59.67)	1	67.52 (55.24)
Over all mean	**3.95**	**10.42**	**47.14**	**6.42**	**53.22**	**5.28**	**44.13**
F-test	**NS**	**…..**	**S**	**…..**	**S**	**…..**	**S**
SEd (±)	0.369	**…..**	2.18	**…..**	2.38	**…..**	1.58
CD(P=0.5)	---	**…..**	4.55	**…..**	4.97	**…..**	3.29

Table 4.

Efficacy of *Beauveria Bassiana* and Cypermethrin on Population Reduction of *H. Armigera* in Cotton. after Second Spray

Treatments	Before	Pop^n of H.armigera (3 day)	3 DAS Pop^n reduction over control	Pop^n of H.armigera (5 day)	5 DAS Pop^n reduction over control	Pop^n of H.armigera (7 day)	7 DAS Pop^n reduction over control
T0	5.93	32	0.00 (0.0)	35	0.00 (0.0)	39	0.00 (0.0)
T1	2.47	8	22.67 (28.38)	4	23.47 (28.93)	2	23.11 (28.04)

T2	2.6	7	41.58 (40.11)	3	41.11 (39.87)	2	34.94 (36.21)
T3	2.4	6	29.63 (32.96)	3	35.44 (36.51)	1	28.36 (32.14)
T4	3.07	6	49.48 (44.66)	2	56.89 (48.91)	1	52.39 (46.32)
T5	3.07	6	56.55 (48.73)	2	64.4 (53.37)	1	59.01 (50.18)
T6	3.53	5	69.59 (56.48)	2	77.89 (61.89)	1	74.24 (59.47)
Over all mean	3.29	10	38.5	7.28	42.74	6.71	38.86
F-test	NS	…..	S	…..	S	…..	S
SEd (±)	0.369	…..	1.95	…..	1.11	…..	1.84
CD(P=0.5)	---	…..	4.06	…..	2.32	…..	3.83

Boll Damage and Yield

The minimum boll damage percentage (17 %) were observed in Cypermethrin (0.01 ml/l) as compared to the natural boll damage of 38 % being noticed in untreated control . In the increasing order , the treatments Cypermethrin (0.01 ml/l) < Beauveria bassiana 0.35 % < Beauveria bassiana 0.30 % < Beauveria bassiana 0.25 % < Beauveria bassiana 0.20 % < Beauveria bassiana 0.15 % recorded pod damage ranging from 17 % to 38 % (table 5).

The highest boll yield of 1728.33 kg/ha was registered in Cypermenthrin which was followed by Beauveria bassiana (T_5) 1478.33 kg/ha, Beauveria bassiana (T_4)1066.66 kg/ha , Beauveria bassiana (T_3) 981.66 kg/ha , Beauveria bassiana(T_2) 966.66 kg/ha , Beauveria bassiana (T_1)733.33 kg/ha. As low as 453.33 kg/ha yield was recorded in untreated control.

In the present investigation, Cypermethrin (0.01%) gave the best result among all the treatments following by Beauveria bassiana (0.35%) , Beauveria bassiana (0.30%), Beauveria bassiana (0.25%), Beauveria bassian (0.20%) and Beauveria bassiana (0.15%) in reducing the crop damage.

Table 5. Influence of Different Beauveria Bassiana. on Boll Damage and Yield in Cotton Crop

Treatments	Boll Damage (%)	Percent Boll damage over UTC	Percent increase in yield over UTC	Yield (kg/ha)
T1	29	23.68	61.76	280
T2	28	36.31	113.23	513.33
T3	26	21.57	116.54	528.33
T4	25	34.21	135.29	613.33
T5	19	50	226.10	1025
T6	17	55.20	281.25	1275
T0	38	0.00	0.00	0.00

UTC= Untreated control

Economics of Different Treatment

Table 6 Indicates that net profit (54270 Rs/ha) and benefit cost ratio (1:17.4) were more with T_6 (Cypermethrin) but net profit (42825 Rs/ha) and benefit cost ration (Rs. 1:12.9) recorded with T_5 { B. bassiana.(0.35%)} was at par with T_6. As a whole Cypermethrin leaves residual effects, pest resurgence problems & develop resistence in insect so looking toward ecosafe & biofriendly environment B. bassiana found more effective for controlling of H. Armigera in cotton.

Table 6.Effect of the Treatments on C:B Ratio Against Cotton

S.N.	Treatment	yield kg/ha	Additional yield over UTC	Additional return Rs/ha	cost of treatment Rs/ha	Net return Rs/ha	B : C	IBC
T1	B. bassiana, (0.15%)	733.33	280	12600	1840	10760	01:05.8	6.84
T2	B. bassiana (0.20%)	966.66	513.33	23099.85	2325	20774.85	01:08.9	9.93
T3	B. bassiana (0.25%)	981.66	528.33	23774.85	2008	21766.85	01:10.8	11.84
T4	B. bassiana (0.30%)	1066.66	613.33	27599.85	2095	25504.85	01:12.1	13.17
T5	B. bassiana (0.35%)	1478.33	1025	46125	3300	42825	01:12.9	13.97
T6	Cypermethrin (0.01%)	1728.33	1275	57375	3105	54270	01:17.4	18.47
T0	Utc	453.33	……	…….	…….	…….	……	……

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