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Effect of *Beauveria bassiana* against Diamondback Moth (*Plutella xylostella* Linn.) on Cabbage (*Brassica oleracea* var *capitata*)

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Abstract A field and green house experiments were conducted during *rabi* season, 2013-14 to find out the effect of different concentration of the bio-agent *Beauveria bassiana* (2.4×10^8, 2.4×10^7, 2.4×10^6, 2.4×10^5, 2.4×10^4, 2.4×10^3, 2.4×10^2 conidia/ml) were sprayed, Cypermethrin 25 EC (0.07%) also sprayed including a untreated control. Cypermethrin 25 EC (0.07%) shows significant reduction in the larval population of *Plutella xylostella* (DBM) in field, and also recorded highest mortality percentage in Screen house condition. Among the different concentration of *B. bassiana. B. bassiana* 7% performed significant reduction as compared with other *B. bassiana* concentration. However, Cypermethrin 25 EC (0.07%) was recorded the highest cost benefit ratio (1:6.35). Among *B. bassiana* 2.4×10^8 recorded the highest cost benifit ratio (1:6.04), followed by *B. bassiana* 2.4×10^7 (1:5.66), *B. bassiana* 2.4×10^6 (1:5.41), *B. bassiana* 2.4×10^5 (1:5.26), *B. bassiana* 2.4×10^4 (1:5.03), *B. bassiana* 2.4×10^3 (1:4.89), *B. bassiana* 2.4×10^2 (1:4.76) as compared to control plot (1:3.17).

Keywords *Beauveria bassiana*, *Brassica oleravea* var *capitata, Plutella xylostella*.

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Introduction

Cole vegetables grown mostly in winter season occupy an important position in meeting the dietary requirements of most of the people all over the world. Among the winter vegetables, cabbage *Brassica oleracea* var *capitata* Linn. is a popular and extensively cultivated crop because of its nutritional and economical values. It is grown for its edible enlarged terminal buds, which is a rich source of Ca, P, Na, K, S Vitamin A, Vitamin C and dietary fiber. Cabbage is commonly used fresh as salad, cole slaw, boiled vegetable, cooked in curries and processed. Cabbage is known to possess medicinal properties. Diamondback moth (*Plutella xylostella* L.) is the most destructive and cosmopolitan pest [1] and is the limiting factor for the successful cultivation of cruciferous crops. In India, diamondback moth has national importance on cabbage as it causes 50–80% annual loss in the marketable yield [2] and a loss of US $ 16 million every

Table 1. Effect of *Beauveria bassiana* in reduction the larval population of Diamond backmoth, *Plutella xylostella* after (1st and 2nd spray). BS–Before Spray, DAS–Days After Spray. Figures in parentheses are √(X+0.5 transformed values, Figures in parentheses are arc sine transformed values. In a column means followed bycommon letter (s) are not significantly different by DMRT (p=0.05).

Treatments Conidia/ml	B S	% Reduction in larval population of Diamond back moth 3DAS	7DAS	10DAS	Mean	B S	% Reduction in larval population of Diamond back moth 3DAS	7DAS	10DAS	Mean
2.4×10^2	3.6	14.53 (22.40)^{g}	32.70 (34.86)^{f}	48.48 (44.13)^{f}	31.90	3.2	50.22 (45.12)^{f}	54.63 (47.65)^{g}	58.18 (49.71)^{f}	54.34
2.4×10^3	4	18.25 (25.36)^{f}	40.90 (39.53)^{e}	52.62 (46.50)^{e}	37.25	3	54.93 (47.58)^{e}	58.46 (49.87)^{f}	60.29 (50.93)^{f}	58.09
2.4×10^4	3.8	19.31 (26.06)^{f}	41.20 (39.87)^{e}	53.30 (46.89)^{e}	37.93	2.8	55.33 (48.06)^{e}	60.29 (50.94)^{e}	65.55 (54.10)^{e}	60.39
2.4×10^5	3.2	24.29 (29.52)^{e}	42.05 (40.60)^{e}	54.54 (47.60)^{e}	40.29	2.5	59.35 (50.38)^{d}	64.39 (53.36)^{d}	68.32 (55.75)^{d}	64.02
2.4×10^6	2.4	28.35 (32.17)^{d}	47.21 (43.40)^{d}	59.31 (50.36)^{d}	44.95	2	62.33 (52.14)^{c}	66.35 (54.54)^{c}	72.40 (57.05)^{c}	67.02
2.4×10^7	2.4	32.67 (34.85)^{c}	53.30 (46.80)^{c}	63.32 (52.72)^{c}	49.76 49.76	1.8	65.42 (53.98)^{b}	69.28 (56.26)^{b}	73.45 (58.31)^{bc}	69.38
2.4×10^8	3.2	38.37 (37.68)^{b}	56.59 (48.78)^{b}	67.13 (55.01)^{b}	54.03	1.4	68.36 (55.77)^{a}	72.34 (56.34)^{b}	77.24 (58.98)^{b}	72.64
Cypermethrin 25 EC	3.4	46.57 (43.03)^{a}	6029 (50.94)^{a}	71.14 (57.51)^{a}	59.33	1	66.47 (55.84)^{a}	69.15 (58.27)^{a}	70.42 (61.51)^{a}	69.34
Control	3.4	11.32 (19.64)^{h}	14.31 (22.22)^{g}	17.53 (24.74)^{g}	14.38	3.4	10.38 (18.62)^{g}	15.31 (23.03)^{h}	17.65 (24.37)^{g}	14.44
F-test		S	S	S			S	S	S	
SEd (±)	–	3.42	0.45	0.62		–	0.52	0.37	0.62	
CD (p=0.05)	–	1.66	1.13	1.25			1.17	0.79	1.30	

year. The rapid development of resistance is probably associated with the very rapid reproduction of DBM i.e. more than 25 generations per year in the tropics. The problems of insecticide resistance as well as the environmental and consumer health hazards associated with insecticide residues in plant material have focused attention on alternative methods for the control of DBM, hence the search of biocontrol agents for incorporation into IPM programs against this insect is a direneed.

Materials and Methods

Isolation of *B. bassiana* and preparation of different concentrations

The fungus was isolated from cadavers of *Inderbella quadrinotata*, (Guava bark eating caterpillar) larvae collected from guava orchards of Sam Higginbottom Institute of Agriculture, Technology and Sciences (Deemed-to-be university) Allahabad. The culture of *B. bassiana* were cultivated and maintained on potato dextrose agar (PDA) medium. For conducting various experiments, 2–3 weeks old fungal culture were used. Conidia were harvested by scrapping the surface of culture with a sterile loop in 10 ml distilled water. A drop of 0.01% Tween 80 were added to it. The spore suspension were filtered through muslin cloth to removed mycelia and different concentration were prepared i.e. (2.4×10^8, 2.4×10^7, 2.4×10^6, 2.4×10^5, 2.4×10^4, 2.4×10^3, 2.4×10^2 conidia/ml).

Collection and rearing of insect

The larvae of the DBM were collected from infested cabbage field of Sam Higginbottom Institute of Agriculture, Technology and Sciences (Deemed-to-be university) Allahabad; and maintain laboratory culture, field collected larvae were reared in glass jars

Table 2. Economics of treatments in different concentration of *B. Bassiana.*

Treatments Conidia/ml	Production in q/ha	Cost of production per quintol	Total cost (Rs) of production	Common cost (Rs)	Treatment cost (Rs)	Total cost (Rs)	C:B ratio
2.4×10^2	151.67	700	106169	21670	600	22270	1:4.76
2.4×10^3	155.61	700	108927	21670	600	22270	1:4.89
2.4×10^4	160.18	700	112126	21670	600	22270	1:5.03
2.4×10^5	167.38	700	117166	21670	600	22270	1:5.26
2.4×10^6	172.43	700	120701	21670	600	22270	1:5.41
2.4×10^7	180.15	700	126105	21670	600	22270	1:5.66
2.4×10^8	192.23	700	134561	21670	600	22270	1:6.04
Cypermethrin 25 EC	212.28	700	148596	21670	1720	23390	1:6.35
Control	98.33	700	68831	21670	–	21670	1:3.17

with filter paper on the bottom, mouth closed with muslin cloth. They were provided with fresh cabbage leaves as food and reared until adult emergence. Adult moths were fed with 10% honey solution by cotton swab soaked inside the jar and fortified with multivitamin for allowed to lay eggs on cabbage leaves. The weather conditions that prevailed in the laboratory were, maximum temperature 22°C ± 10°C and minimum temperature 8°C ± 7°C and relative humidity 69% ± 6%.

Beauveria bassiana against DBM in field condition

Field experiment was conducted with cabbage var "Golden Acre" in the experimental field of Department of Entomology, SHIATS, Allahabad during *rabi* season of 2013-14. The experiment was laid out in a randomized block design (RBD) with 9 treatments including untreated control and replicated 3 times. The crop was raised with recommended agronomic practices with a plot size of $4m^2$ (2×2m) at 60 × 45 cm spacing. The treatments evaluated were different concentration of *Beauveria bassiana* (2.4×10^8, 2.4×10^7, 2.4×10^6, 2.4×10^5, 2.4×10^4, 2.4×10^3, 2.4×10^2 conidia/ml) along with one conventional insecticide, cypermethrin as check. The appearance of diamondback moth was keenly monitored and when the population crossed ETL level. The test treatments were applied as foliar spray by a high volume knapsack sprayer twice at 10 days interval. Water was sprayed in the untreated control plots. Observation on the lerval population of diamondback moth were recorded at 24 hours before application (pre-treatment count) and 3rd, 7th and 10th days after application (post-treatment count) on five randomly selected plants in each plot, direct visual counting method was used. The cabbage head harvested from each plot was recorded and computed to quintal/ha. To estimate the reduction larval population of diamondback moth use of following formula:-

$$P = [\ T_a - T_b / T_a\ ] \times 100$$

Where, P = Percent reduction in the population of pest, T_a = Number of pest individuals before application (Pre-treatment count), T_b = Number of surviving pest individuals on particular day after application.

Beauveria bassiana against DBM in green house condition

For green house studies, the test plants @ one plant per pot were maintained in earthen pots of 30 cm height and 30 cm diameter. The pots were filled with potting mixture comprising two parts of soil, one part of red earth and one part of FYM. For the evaluated mortality percentage of DBM, 20 larvae were released in to each cabbage grown pots, after that dead larvae were counted and calculate mortality percentage at 3rd and 7th days after spray by the use of following formula :

$$\text{Mortality } \% = [\text{No. of dead larvae/No. of released larvae}] \times 100$$

Table 3. Percent net mortality of 3rd instar larvae of *Plutella xylostella* at 3rd, 5th and 7th days in green house conditions after spray. DAS–Days After Spray. Figures in parentheses are √(X+0.5) transformed values, Figures in parentheses sine transformed values, In a column means followed by common letter (s) are not significantly different by DMRT (p=0.05).

Treatments Conidia/ml	Percent mortality of *P. Xylostella* in cabbage 3 DAS	5 DAS	7 DAS	Mean
2.4×10^2	70.00 (56.83)^d	80.00 (63.54)^c	90.00 (71.95)^d	80.00
2.4×10^3	78.33 (62.28)^{cd}	83.33 (65.95)^{dc}	93.33 (75.24)^{cd}	84.99
2.4×10^4	83.33 (65.95)^{bc}	90.00 (71.95)^{cd}	95.00 (79.45)^{bcd}	89.44
2.4×10^5	85.00 (67.40)^{bc}	91.66 (73.40)^{cd}	96.66 (81.29)^{abc}	91.10
2.4×10^6	90.00 (71.95)^b	95.00 (79.45)^{bc}	98.33 (85.50)^{ab}	94.44
2.4×10^7	93.33 (71.95)^b	93.33 (85.50)^{ab}	100.00 (89.71)^a	95.55
2.4×10^8	98.33 (85.50)^a	100.00 (89.71)^a	100.00 (89.71)^a	99.44
Cypermethrin 25 EC	100.00 (89.71)^a	100.00 (89.71)^a	100.00 (89.71)^a	100.00
Control	5.00 (12.92)^c	6.66 (14.75)^f	11.66 (19.88)^c	7.77
F-test	S	S	S	
SEd (±	3.28	3.96	4.13	
CD (p=0.05)	6.90	8.29	8.59	

Results and Discussion

Effect of *B. bassiana* on larval population of diamondback moth

The mean diamondback moth population reduction data recorded after the post treatment counts (3, 7 and 10 DAS) revealed that Cypermethrin 25 EC (59.33%) after 1st spray and *B. bassiana* 2.4×10^8 (72.64%) after 2nd spray recorded the highest reduction of larval population and proved to be the most effective treatment, followed by *B. bassiana* 2.4×10^7 (69.38%) and of *B. bassiana* 2.4×10^6 (67.02%) respectively. While, lowest reduction (14.44%) in untreated control respectively. It was revealed that all the insecticidal treatments resulted in significant reduction of the diamondback moth population over control (Table 1).

Effect of *B. bassiana* on cost and benefit ratio

The highest production was recorded in Cypermethrin 25 EC (212.28 q/ha), as compared with different concentration of *B. bassiana* i.e. 2.4×10^8 (192.23 q/ha), 2.4×10^7 (180.15 q/ha), 2.4×10^6 (172.43 q/ha). When cost benefit ratio was worked out, interesting result was achieved. Among the treatment studied, the best and most economical treatment was Cypermethrin 25 EC (1:6.35) followed by *B. bassiana 2.4 × 10*^{8} (1:6.04), *B. bassiana* 2.4×10^7 (1:5.66), *B. bassiana* 2.4×10^6 (1:5.41), *B. bassiana* 2.4×10^5 (1:5.26), *B. bassiana* 2.4×10^4 (1:5.03), *B. bassiana* 2.4×10^3 (1: 4.89), *B. bassiana* 2.4×10^2 (1:4.76) as compared to control plot (1:3.17). Among all the treatment *B. bassiana* 2.4×10^2 was the least effective but all the treatments were significantly superior over control (Table 2) These results were similar to the earlier findings [3, 4] also showed that cypermethrin was quite effective against sucking pest of okra Godonou et al. [5] showed that the spray of *B. bassiana* products were to be effective against *Spodoptera litura* and showed that the highest cost benefit ratio was obtained in the treatment of Cypermethrin 25 EC (0.07%). These results were corrabated with my results (1 : 6.35).

Effect of *B. bassiana* on mortality percentage of diamondback moth

Significantly higher mortality was achieved Cypermethrin 25 EC (100%). All the treatments were superior in mortality of diamondback moth in comparison to untreated contol. Among all the treatments of *B. bassiana. B. bassiana* 2.4×10^8 (99.44%) recorded the highest larval mortality and proved to be the most effective treatment, followed by *B. bassiana* 2.4×10^7 (95.55%) and of *B. bassiana* 2.4×10^6 (94.44%) respectively. Among all the treatments *B. bassiana* 2.4×10^2 recorded lowest mortality (80.00%) (Table 3). *B. bassiana* induced significant increase in larval mortality of *P. xylostella*. The concentration of *Beauveria bassiana* 7% was found to be very effective against the larval stage. A significant positive correlation was recorded between concentration and mortality. Studied on mortality % of *P. xylostella*. His results were corrabated with my results that Cypermethrin 25 EC and *Beauvearia bassiana* 2.4×10^8 gave highest mortality % in 3 days (100% and 98%), 5 days (100% and 100%) and 7 days (100% and 100%) after spraying respectively. Similar results for caterpillars of *Indarbela quadrinotata* Walker were also documented earlier.

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