BIOLOGICAL EFFECTS OF THE ENTOMOPATHOGENIC FUNGUS, BEAUVERIA BASSIANA ON THE POTATO TUBER MOTH PHTHORIMAEA OPERCULELLA (SELLER)

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SUMMARY: The series of investigations have been carried out on the effect of the entomopathogenic fungi Beauveria bassiana on the various developmental stages of Phthorimaea operculella. Both first and second instar larvae were more susceptible than the third of fourth instars. The infected prepupae and pupae resulted in marked decreases in the emergence and longevity of moths, deposited eggs and their egg hatchability. An obvious increase in the pupal duration was observed and the resulting malformed adults were also recorded. The latent were markedly obvious, specially in high doses of B. bassiana.

Key Words: Beauveria bassiana.

INTRODUCTION

Using of pathogens, as biological control agents of some insect species, has been increased during the last few years. Beauveria bassiana, as an entomopathogenic fungus, has been used to suppress the population of the European corn borer, Ostrinia nubilalis (Hubner) (1,4,6,9,11,14). More than 30 entomopathogenic fungi have been tested as biological control preparations of different insect pests (2,3,5,7,8,10, 12,13).

The present work was carried out to study the effect of B. bassiana on the different larval developmental stages of the potato tuber moth Phthorimaea operculella.

MATERIALS AND METHODS

To assess the virulence of Beauveria bassiana, the commercial formulation Boverol was used in the present study. Cohorts of newly moulted or hatched 1st, 2nd, 3rd, and 4th instar larvae of P. operculella were used. These were infected by spraying 10 ml of an aqueous suspension of Beauveria conidia-spore, containing 16.5×10^8, 8.25×10^8, 4.12×10^8, 2.06×10^8, 1.03×10^8, and 0.5×10^8 conidia/ml on the inner surface of sterile plastic Petri-dishes. Into each dish, 10 individuals were introduced and left in contact with the inoculum cohorts of each instar (50 larvae per cohort) were used for each concentration of Beauveria. The larvae were then placed in clean Petri-dishes (15 cm diameter by 4 cm deep) and fed potato tubers. Control larvae were fed also potato tubers, and reared at 26 ± 2 c and 70% R.H.

Cohorts of prepupae and pupae (50 per cohort) were treated with a conidial inoculum, using a Camel, s hair brush.

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Table 1: Effect of B. bassiana on different larval instars of P. operculella.

Larval instar	LC_{50} conidia/ml	Slope	Variance	Confidence limits (95%)
First	1.98×10^8	1.209	0.0065	1.26×10^8-2.75×10^8
Second	2.13×10^8	1.070	0.0077	1.30×10^8-3.09×10^8
Third	4.08×10^8	0.906	0.0121	1.97×10^8-6.19×10^8
Fourth	4.71×10^8	1.242	0.0073	2.85×10^8-6.56×10^8

RESULTS AND DISCUSSION

Mortalities of P. operculella larvae exposed to a concentrations of $16.5x10^8$ of B. bassiana indicated that these larvae were susceptible to the pathogen. The calculated LC 50's for B. bassiana were ($4.7x10^8$) conidia/ml, for the 1st, 2nd, 3rd, and 4th instar larvae, respectively (Table 1).

The duration of the treated pupae was significantly prolonged at concentrations ranged from $16.5x10^8$ to $2.06x10^8$ conidia/ml as compared with the control, while at low concentrations of $1.03x10^8$ to $0.26x10^8$ conidia/ml, there was no obvious effect as compared to the control.

The percentage of moth emergence showed a highly progressive decrease with the increase of concentration of B. bassiana. Thus emergence decreased from 100% in the control to 0% at $16.5x10^8$ conidia/ml. An obvious malformation was observed among the emerged moths after treatment of the prepupae with any of the used concentrations.

The longevity of the emerged adults was significantly affected being shorter after exposure of the prepupae to B. bassiana. The egg production of the female, progressively decreased from 90.83±10.93 to 32.00±1.12 eggs/female, with the increase in the concentration of B. bassiana from 0.26 to 4.12 ($x10^8$) conidia/ml as compared to 179.93±23.99 eggs/female, in the control. At concentrations of $16.5x10^8$, $8.5x10^8$ conidia/ml, no eggs were obtained (Table 2).

The duration of treated pupae was significantly prolonged at concentrations of $16.5x10^8$, $2.06x10^8$ conidia/ml, as compared to control (Table 3).

Table 2: Effect of different concentrations of B. bassiana as suspension on the prepupae of P. operculella.

Conc. Conidia/ml		16.5	8.25	4.12	2.06	1.03	0.52	0.26	Control
		($x10^8$)							
Pupal duration		8.9 ± 0.47	8.66 ± 0.33	7.5 ± 0.22	7.75 ± 0.25	7.44 ± 0.17	7.2 ± 0.13	6.75 ± 0.25	6.25 ± 0.25
% of emergence		26.6	45	63.5	70	77	80	90	100
% of malformation		60	50	33.3	22.7	20	10	5	-
Average longevity in days	males	3	4.66 ± 0.33	4.25 ± 0.47	5.6 ± 0.37	6.6 ± 0.24	7.5 ± 0.42	9.1 ± 0.3	12.6 ± 1.68
	females	4	4.5 ± 0.5	5.5 ± 0.5	7.2 ± 0.37	7.8 ± 0.37	8.6 ± 0.24	9.3 ± 0.3	3.8 ± 1.8
No of eggs/female		0	0	32 ± 1.1	42.2 ± 10.4	53.8 ± 17.2	71.8 ± 14.5	90.8 ± 10.9	179.9 ± 23.9
% of hatching		0	0	10	22	45	80	85	100

Table 3: Effect of different concentrations of B. bassiana as suspension on the pupae of P. operculella.

Conc. Conidia/ml		16.5	8.25	4.12	2.06	1.03	0.52	0.26	Control
		($x10^8$)							
Pupal duration in days		15	8.99 ± 0.47	8.66 ± 0.33	7.77 ± 0.22	7.44 ± 0.17	6.75 ± 0.21	6.75 ± 0.21	6.75 ± 0.21
% of emergence		10	16	23.3	30	36.6	40	53.3	96.7
% of malformed adults		100	35	30	20	17	15	12	0
Adult longevity	males	1	3	3 ± 0.18	4.2 ± 0.47	5 ± 0.63	6.5 ± 0.42	8.2 ± 0.47	12.26 ± 1.6
	females	-	4	3.66 ± 0.33	4.6 ± 0.5	6.2 ± 0.37	7.83 ± 0.47	9.6 ± 0.37	13.1 ± 1.7
No of eggs/female		0	0	0	66 ± 13.5	80.2 ± 14.8	101 ± 19	138 ± 34.5	189 ± 57.2
% of hatching		0	0	0	70	75	85	88.8	95

Table 4: Effect of different concentrations of B. bassiana on adult P. operculella.

Conc. conidia/ml	Male longevity in days mean ± S.E.	Female longevity in days mean ± S.E.	Deposited eggs/female mean ± S.E.
$16.5x10^8$	9.3 ± 0.4	11.4 ± 0.24	103.3 ± 15.8
$8.25x10^8$	10.2 ± 0.37	11.8 ± 0.37	105.2 ± 23.6
$4.12x10^8$	10.6 ± 0.5	12.2 ± 0.3	112.7 ± 15.9
$2.06x10^8$	11.4 ± 0.5	12.4 ± 0.4	112.8 ± 14.19
$1.03x10^8$	11.5 ± 0.3	12.3 ± 0.66	116.1 ± 15.34
$0.52x10^8$	12.1 ± 0.23	13.0 ± 0.77	135.8 ± 13.43
$0.26x10^8$	12.2 ± 0.57	13.3 ± 0.29	138.9 ± 3.35
Control (Untreated	12.9 ± 0.11	13.6 ± 0.4	146.3 ± 11.43

The percentage of moth emergence showed a highly progressive decrease with the increase in the concentrations of B. bassiana. Thus emergence decreased from 96.7% in the control to 10% at $16.5x10^8$ conidia/ml. An obvious malformation was observed among the emerged moths after treatment of the pupae with any of the used concentrations, also the longevity of emerged adults was significantly affected being shorter. The egg production of the resulted females progressively decreased with the increase in the concentration of B. bassiana (Table 3).

An obvious malformation was observed among the emerged moths after treating the prepupae with concentrations varied from $16.5x10^8$ to $2.06x10^8$.

Data in Table 4 show the effect of B. bassiana on the adults of P. operculella at different concentrations. The longevity of adult males was shortened to 9.3±0.4 days at $16.5x10^8$ conidia/ml as compared with 12.9±0.11 days in the control. At the lowest concentration of $0.26x10^8$ conidia/ml, the male longevity was 12.2±0.57 days. At concentration of $16.5x10^8$ conidia/ml, the longevity of adult females was 11.4±0.24 days.

Treated adult females of P. operculella showed delayed effect on the egg production. The produced egg was 103.3±15.8 at the concentration of $16.5x10^8$ conidia/ml, increased to 138.9±3.35 eggs/female at $0.26x10^8$ conidia/ml. In the control, the egg production averaged 146.33±11.43 eggs female.

Fungi reach the heamocoel through the cuticle or the mouth parts. Infection, therefore resulted from contact between a virulent infection inoculum and a susceptible insect cuticle, germination, penetration of the germ tubes through the integument and finally spread of the pathogen through the host tissues. Entomopathogenic fungi produce mycotoxine, which kill the host by inducing progressive degeneration of host tissues, due to loss of structural integrity of membranes followed by dehydration of cells as a result of fluid loss (4).

During the present study, the treatment of prepupae and pupae with different concentrations of B. bassiana preparation, resulted in decreasing the numbers of emerged adults of P. operculella which showed a high percent of malformation. Resulted adult males and females lived shorter time and laid low numbers of eggs.

The 1st and 2nd larval instars were more susceptible than the 3rd or 4th instars. Also, feeding adult females of Phthorimaea with contaminated diet, resulted in a marked decrease in the deposited eggs. B. bassiana provide a great amount of Ostrinia nubilalis and Chilo partellus suppression (9).

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