Bioefficacy of different Biopesticides against Larval Instars of Fruit Piercing Moth, *Eudocima materna* L.

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Abstract—*The three fungal pathogens Beauveria bassiana (Bals.) Vuill., Metarhizium anisopliae (Metchnikoff) Sorokin and Nomuraea rileyi and two bacterial pathogens Photorhabdus luminescens and Bacillus thuringiensis were evaluated as potential biological control agents against larvae of fruit piercing moth, Eudocima materna (Lepidoptera : Noctuidae). Early instars of E. materna were found to be the most susceptible stage with maximum reduction by different tested biopesticides. P. luminescenes was found to be most effective treatment against 1st, 2nd, 3rd and 4th instars larvae tested. The descending order of effectiveness was P. luminescens < B. thuringiensis < M. anisopliae < N. rileyi <B. bassiana. Alongwith Bacteria, entomo- pathogenic fungi could provide avenues in the management of fruit piercing moth at its immature stages as these fungi can develop epizootic during the rainy season due to high humidity.*

Keywords*: Bioefficacy, biopesticides, larval instars, fruit piercing moth.*

1. INTRODUCTION

The fruit piercing moth, *Eudocima* sp. is polyphagous pest of fruit crops in many subtropical and tropical countries, including parts of Africa, Southeast Asia and western Pacific countries (Waterhouse and Norris 1987). These moths are difficult to control as unlike most other moths and butterflies, as the immature stages survive only on twining vines of the family Menispermaceae in scrub and forest areas, often remote from orchards (Fay, 1996 and Denton *et al.,* 1991). The larval host plants belonging to family Menispermaceae found in Karnataka are *Anamirta cocculus*, *Cissampelos pareira*, *Cyclia peltata*, *Diploclisia glaucescens* and *Stephania japonica* (Bhumannavar, 2000). These vines are located mostly in inaccessible places and near water sources. All these vines are hard to kill.

Even though these moths cause serious damage to tropical and subtropical fruits, very little research has been done in India especially on their management at larval stage. Chemical control has not been an option to control this pest because of the insufficient contact of the moth with the fruit denies knockdown and in any event, an adequate with holding period is not achievable as ripe fruits are normally attacked. Effective inhibition of fruit piercing moth damage is only possible by bagging of fruits or netting of trees or orchards. Night watching, hand collection of moths, moth destruction using light traps and bonfires has limited impact. The management of fruit piercing moth is rather difficult. Hence, considering the seriousness of the problem and scanty information, for the first instance at present efforts were made to evaluate the efficacy of different biopesticides against the larval stage *of E. materna* and the results were summarized.

2. MATERIAL AND METHODS

Toxicity studies of different bio-pesticides were carried out in Laboratory of Entomology department, Post Graduate Institute, Mahatma Phule Krishi Vidyapeeth, Rahuri during 2012-13. In this investigation, *Bacillus thuringiensis* var. *kurstaki* 1 % WG (2 gm/L, 1 gm/L), *Photorhabdus luminescens* sp. *akhurstii* 5% SL (5 ml/L and 2.5 ml/L), *Beauveria bassiana* 1.15% WP (5 gm/L and 2.5 g/L), *Metarrizium anisopliae* 1.15% WP (5.0 g/L and 2.5 g) *Nomuraea rileyi* 1.15% WP (5.0 g, and 2.5 g) and untreated control were tested under laboratory conditions using Completely Randomized Design (CRD) with three replications of each on first, second, third and fourth instars larvae of fruit piercing moth, *Eudocima materna* (Linnaeaus) were used for bioefficacy studies.

To find out the toxicity of bio-pesticides against the larvae *E. materna*, the stock solutions of above said bio-pesticides were prepared in distilled water and directly sprayed in each Petri dish of the respective treatment. The Petri dishes were allowed to dry for 15 minutes so as to form a thin film of the toxicant. Thereafter, ten larvae were released in each Petri dish for 30 minutes. Thereafter, larvae were removed from each Petri dish and released further to the gulvel leaves for feeding. In all 30 larvae per concentration were used for bioassay. Each experiment was replicated three times.

Preparation of bio-pesticides solution for treatment

The required concentrations of each bio-pesticides were taken for investigation made by following formula.

$$V = \frac{C \times A}{\%\ a.i.}$$

Where,

V = Volume of bio-pesticides

C = Concentration required

A = Quantity of water required

% a.i.= Percent active ingredients in commercial bio-pesticides.

The required quantity of chemicals and *Photorhabdus luminescens* was taken with the help of micropipette and transferred into beaker containing distilled water. However, the required quantity of mycoinsecticides and *Bacillus thuringiensis var. kurstaki* was taken by using weighing balance. The solution was mixed and stirred well with the help of glass rod.

Observation recorded : In each treatment, observation on mortality of the larvae were recorded at 1, 3, 5 and 7 days after treatment and per cent mortality were worked out. In control, only distilled water spray was given. The moribund larvae were counted as dead. The mortality on 7th day was considered as final mortality.

Analysis of data : The per cent mortality data in each treatment was recorded and this data was statistically analyzed under ANOVA for Completely Randomized Design (CRD) in basic programme at Department of Statistics, Post Graduate Institute, MPKV, Rahuri.

3. RESULTS AND DISCUSSION

The efficacy of different bio-pesticides against 1st, 2nd, 3rd and 4th instar larvae of fruit piercing moth was evaluated and presented in Table 1.

Table 1: Bioefficacy of bio-pesticides against different instar larvae of *E. maternal*

Tr. No.	*Treatment*	Dose (Per litre)	Test insects used	Per cent larval mortality											
				1st instar			2nd instar			3rd instar			4th instar		
				3DAT	5DAT	7DAT	3DAT	5DAT	7DAT	3DAT	5DAT	7DAT	3DAT	5DAT	7DAT
T_1	*B. thuringiensis* 1% WG	2.0 g	30	56.67 (48.85)*	86.67 (68.86)	90.0 (75.0)	40.0 (39.15)	83.33 (66.64)	86.67 (68.86)	33.33 (35.22)	66.67 (54.78)	76.67 (61.22)	23.33 (28.78)	53.33 (46.92)	63.33 (52.78)
T_2	*B. thuringiensis* 1% WG	1.0 g	30	33.33 (35.22)	63.33 (52.78)	66.67 (54.99)	26.67 (30.79)	50.0 (45.0)	60.0 (50.77)	20.0 (26.57)	43.33 (41.15)	53.33 (46.92)	13.33 (21.14)	33.33 (35.22)	40.0 (39.23)
T_3	*P. luminescens* 5% SL (2×10^9 CFU/ml)	5.0 ml	30	100.0 (90.0)	100.0 (90.0)	100.0 (90.0)	100.0 (90.0)	100.0 (90.0)	100.0 (90.0)	96.67 (83.86)	100.0 (90.0)	100.0 (90.0)	93.33 (77.71)	100.0 (90.0)	100.0 (90.0)
T_4	*P. luminescens* 5% SL (2×10^9 CFU/ml)	2.5 ml	30	76.67 (61.22)	83.33 (66.14)	90.0 (75.0)	66.67 (54.78)	76.67 (61.22)	83.33 (66.14)	53.33 (46.92)	63.33 (52.78)	73.33 (59.0)	50.0 (45.0)	66.67 (54.78)	66.67 (54.78)
T_5	*B. bassiana* 1.15% WP (1×10^8 CFU/g)	5.0 g	30	23.33 (28.29)	63.33 (53.07)	83.33 (66.14)	10.0 (15.0)	56.67 (48.93)	73.33 (59.0)	3.33 (6.14)	43.33 (41.07)	56.67 (48.93)	0.0 (0.0)	36.67 (36.93)	46.67 (43.08)
T_6	*B. bassiana* 1.15% WP (1×10^8 CFU/g)	2.5 g	30	13.33 (17.71)	43.33 (41.15)	50.0 (45.0)	6.67 (12.29)	36.67 (37.22)	46.67 (43.08)	0.0 (0.0)	26.67 (31.0)	36.67 (37.22)	0.0 (0.0)	23.33 (28.78)	30.0 (33.0)
T_7	*M. anisoplae* 1.15% WP (1×10^8 CFU/g)	5.0 g	30	30.0 (33.0)	70.0 (57.0)	86.67 (68.86)	16.67 (23.86)	63.33 (52.78)	83.33 (66.14)	6.67 (12.29)	50.0 (45.0)	70.0 (56.79)	3.33 (6.14)	43.33 (41.15)	56.67 (48.85)

T_8	*M. anisoplae* 1.15% WP (1 x 10^8 CFU/g)	2.5 g	30	23.33 (28.78)	53.33 (47.01)	60.0 (50.85)	10.0 (15.0)	43.33 (41.15)	56.67 (48.85)	0.0 (0.0)	33.33 (35.22)	40.0 (39.15)	0.0 (0.0)	26.67 (31.0)	33.33 (35.22)
T_9	*N. rileyi* 1.15% WP (1 x 10^8 CFU/g)	5.0 g	30	26.67 (31.0)	63.33 (52.86)	83.33 (66.14)	13.33 (21.14)	56.67 (48.85)	80.0 (63.43)	3.33 (6.14)	46.67 (43.08)	63.33 (52.78)	0.0 (0.0)	40.0 (39.15)	53.33 (46.92)
T_{10}	*N. rileyi* 1.15% WP (1 x 10^8 CFU/g)	2.5 g	30	16.67 (23.86)	46.67 (43.08)	56.67 (48.85)	6.67 (12.29)	36.67 (37.22)	50.0 (45.0)	0.0 (0.0)	26.67 (31.0)	40.0 (39.23)	0.0 (0.0)	23.33 (28.78)	30.0 (33.0)
T_{11}	Untreated control	-	30	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
	SE (m) ±			3.64	3.18	4.15	4.74	2.80	2.03	3.80	2.47	2.10	3.0	2.55	2.13
	CD at 1%			14.52	12.68	16.56	18.90	11.16	8.10	15.14	9.83	8.38	11.95	10.16	8.49

Bioefficacy of different biopesticides against first instar larvae of fruit piercing moth, *Eudocima materna* L.

The most effective treatment was *P. luminescens* @ 5.0 ml/L recorded maximum larval mortality ranged from 36.67 to 100.0 % at 1 to 7 DAT followed by *B. thuringiensis (Btk)* @ 2.0 g/L and *P. luminescens* @ 2.5 ml/L recorded (20.0 to 90.0%) and *M. anisopliae* @ 5.0 g/L (0.0 to 86.67%). The next better treatment was *B. bassiana* @ 5.0 g/L and *N. rileyi* @ 5.0 g/L recorded 0.0 to 83.33% larval moratlity. The next best treatment was *B. thuringiensis (Btk)* @ 1.0 g/L (0.0 to 66.67%) followed by *M. anisopliae* @ 2.5 g/L (0.0 to 60.0%) and *N. rileyi* @ 2.5 g/L (0.0 to 56.67%). The treatment *B. bassiana* @ 2.5 g/L (0.0 to 50.0% larval mortality) was comparatively less effective.

Bioefficacy of different biopesticides against second instar larvae of fruit piercing moth, *Eudocima materna* L.

Per cent larval mortality increased significantly over time. The most effective treatment was *P. luminescens* @ 5.0 g/L ranged from 33.33 to 100.0% larval mortality at 1 to 7 DAT. The next superior treatment was *B. thuringiensis (Btk)* @ 2.0 g/L (0.0 to 86.67%), *P. luminescens* @ 2.5 ml/L and *M. anisopliae* @ 5.0 g/L (16.67 to 83.33%), *N. rileyi* @ 5.0 g/L (0.0 to 80.0%). The next effective treatment was *B. bassiana* @ 5.0 g/L (0.0 to 73.33%) followed by *B. thuringinesis (Btk)* @ 1.0 g/L recorded 0.0 to 60.0% larval mortality and *M. anisopliae* 2.5 g/L (0.0 to 56.67%). However, *N. rileyi* @ 2.5 g/L recorded 0.0 to 50.0% larval mortality. The least effective treatment was *B. bassiana* @ 2.5 g/L recorded 0.0 to 46.67% larval mortality.

Bioefficacy of different biopesticides against third instar larvae of fruit piercing moth, *Eudocima materna* L.

The most effective treatment was *P. luminescens* @ 5.0 g/L recorded larval mortality ranged from 20.0 to 100%. The next effective treatment was *B. thuringiensis (Btk)* @ 2.0 g/L (0.0 % to 76.66%), *P. luminescens* @ 2.5 ml/L (6.67 to 73.33%) and *M. anisopliae* @ 5.0 g/L (0.0 to 70.0%). The next better treatment was *N. rileyi* @ 5.0 g/L (0.0 to 63.33%) followed by *B. bassiana* @ 5.0 g/L (0.0 to 56.67%). However, *B. thuringiensis (Btk)* @ 1.0 g/L recorded 0.0 to 53.33% larval mortality. The least effective treatments were *B. bassiana* @ 2.5 g/L (0.0 to 36.67%) followed by *M. anisopliae* @ 2.5 g/L and *N. rileyi* @ 2.5 g/L (0.0 to 40.0%).

Bioefficacy of different biopesticides against fourth instar larvae of fruit piercing moth, *Eudocima materna* L.

Per cent larval mortality increased significantly over time. The most superior treatment was *P. luminescens* @ 5.0 g/L recorded larval mortality ranged from 6.67 to 100% followed by *P. luminescens* @ 2.5 ml/L (0.0 to 66.67%), *B. thuringiensis (Btk)* @ 2.0 g/L (0.0 to 63.33%), *M. anisopliae* @ 5.0 g/L (0.0 to 56.67%) and *N. rileyi* @ 5.0 g/L (0.0 to 53.33%). The next better treatments were *B. bassiana* @ 5.0 g/L (46.67%) followed by *B. thuringiensis (Btk)* @ 1.0 g/L (0.0 to 40.0%) and *M. anisopliae* 2.5 g/L (0.0 to 53.67%). The least effective treatments were *B. bassiana* @ 2.5 g/L and *N. rileyi* @ 2.5 g/L (0.0 to 30.0%).

Similar type of results are reported by Vastard *et al.* (2002) recorded larval mortality of 29.76 to 50 per cent due to *B. bassiana* (Basina) @ 5 g/Lit. Mohan *et al*. (2003) recorded 100% mortality of 4th instar larvae of cabbage white butterfly, *Piries brassicae* within 24 hours when treated with *Photorhabdus* bacteria. Tefera *et al.* (2003) who selected *B. bassianna* and *M. anisopilae* fungi based on their pathogenicity, causing 95–100% mortality to second instar *C. partellus* 6 days after treatment. Vijayavani *et al.* (2009) studied the bio-efficacy of *B. bassiana* on *S. litura* larvae which caused 100% mortality. Rahoo *et. al*. (2011) reported that *P. Luminescens* caused the maximum mortality 99 % at a concentration of 4x10^7 cells/ml. Shahina *et al.* (2011) recorded 95 and 98% mortality of *G. mellonella* and *Macrotermis spp*. due to *P. luminescens*. The present findings are in agreement with the reports of these workers.

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Beauveria bassiana

Metarhizium anisopliae

Nomuraea rileyi

Bacillus thuringiensis

Photorhabdus luminescens

Fig. 1 Effect of biopesticides on larvae of *E. materna*