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Efficacy of bio-pesticides and entomopathogenic nematodes against *Helicoverpa armigera (*Hubner)

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Abstract- *Helicoverpa armigera* (Hubner) (Lepidoptera:Noctuidae) is highly polyphagous and destructive pest causing serious damage to various crops. Studies conducted on efficacy of entomopathogenic nematode *Steinernema carpocapsae* and bio-pesticides against *H. armigera*. It was evaluated at five inoculum levels i.e., 100, 200, 300, 400 and 500 IJs against *H. armigera.* Among these IJs, 100 percent mortality occurred at 500IJs within 72 hrs. In comparative efficacy bio-pesticides and entomopathogenic nematodes were tested against pod borer, out of which the Emamectin benzoate 5SG @ 0.4 g/l was found more efficient with highest per cent mortality (100 %) within 72 hours followed by EPNs (500IJs) which caused 100 per cent mortality after 96 hrs of application. In management of lepidopteran insects, failure of chemical insecticides has increased by posing problems due to indiscriminate use of pesticides. This created the momentum saying the urge in shifting to environmental friendly agricultural practices. So we can include the bio-pesticides and entomopathogenic nematode *Steinernema carpocapsae*, in place of chemical pesticides which could give eco-friendly fields to future.

Key Words**:** polyphagus, entomopathogenic, bio-pesticides, momentum, eco-friendly, pesticides, Emamectin benzoate.

1.INTRODUCTION

Helicoverpa armigera (Hubner) (Lepidoptera:Noctuidae) is also called as cotton bollworm, gram pod borer,fruit borer, corn earworm, or old world bollworm. It is highly polyphagous in nature with its charismatic look. The fruit borer, *H. armigera* (Hubner) is a highly destructive pest causing serious damage (Krishnamoorthy and Mani, 1996). It also feeds on host crops like tomato, cotton, pigeon pea, chick pea, cowpea, maize, okra, peas, field beans, soybeans, tobacco etc. It's wide distribution throughout the country has been recorded on 181 cultivated and wild host species (Manjunath et al. 1989). *H. armigera* causes damage to the fruits in developing stage which in turn results in yield loss ranging from 20 to 60 per cent (Tewari and Krishnamoorthy, 1984). The pest has been reported to cause serious crop losses throughout its range, particularly in tomatoes, corn, and cotton ranging from 20 to 80% (Camprag et al, 2013). Taking these losses into consideration present investigation was conducted.

Now a days nematodes also can be used at farm level by producing commercial microbial products throughout the world . Entomopathogenic nemotodes have parasitic associations with insects. Mostly used entomopathogenic nematode families are Steinernematidae and Heterorhabditidae with symbiotic association with bacteria *Xenorhabdus* spp. (Steinernematids) and *Photorhabdus* spp. (Heterorhabditids), respectively (Kaya, 1990). Nematodes are obligate insects and soil inhabitants. It has the ability to kill the insects within 24-48 hours due to its mutualistic behaviour with bacteria. Each nematode has one specific symbiont species though symbionts are associated with more species of nematodes. Nematodes when come across suitable host infective juveniles enters the body of the insect through natural opening like mouth, spiracles and anus or through thin cuticular areas into haemocoel. Third stage infective juvenile or dauer juvenile survives outside the host. It carries bacteria in its intestinal tract. Once nematode releases bacteria into the host bacteria gets propagated rapidly and leads to insect death quickly (Adams and Nguyen, 2002 and Poinar, 1990).

2. Materials and Methods

Mass multiplication of entomopathogenic nematodes Steinernema carpocapsae was done on larvae of *Corcyra cephalonica* and *Helicoverpa armigera. H. armigera* collected from chickpea, tomato, linseed etc were dropped into EPN solution. Initially arrange the filter paper at the base of petri plate. After wetting the filter paper release *H. armigera* larvae collected from field. Then inoculate the petri plate with IJs per larva. After 2-3 days larva gets died. After 7-11 days larval body gets filled with IJs and they would be protruding out from cadaver when observed under microscope. From Dead larvae/cadavers the emerging IJs were collected and used in all experiments.

Experiment was conducted using a statistical technique completely randomized design (CRD) with seven treatments and three replications. Six treatments included different biopesticides, *Beauveria bassiana* (green heal company, green basivert) , *Metarhizium anisopliae* (Alkarty) and Emamectin benzoate (agrosis company, jupiter) along with most effective EPN dose. Each treatment was replicated thrice. For control treatment distilled water was used. Bio-pesticides were applied against *H. armigera* larvae using detached- leaf bio assay method. Terminal branches of chick pea along with four to five leaflets were taken from field. Collected leaves were thoroughly washed under distilled water to avoid any leaf exudates that would contaminate the experiment. Leaves were dipped into diluted biopesticide solution for 5 min, after that they were allowed to settle for sometime and transferred to petri plates with whatsman paper no.1 at the base. Larvae were released into each petriplate and covered with parafilm. Leaves were changed for every two days. There are 7 treatments each with 3 replications.

Treatment details

Treatments	Biopesticide & EPN dose / Petri plate
T_1	*Beauveria bassiana* 2.5ml/l
T_2	*Beauveria bassiana* 5ml/l
T_3	*Metarhizium anisopliae* 2.5g/l
T_4	*Metarhizium anisopliae* 5g/l
T_5	Most effective EPN dose
T_6	Emamectin benzoate 5SG @ 0.4g/l
T_7	Control

Per cent mortality calculated by using the following formula 1 (Karthi et.al. 2019) and per cent control calculated by using Abbott's (1925) formula (2)

$$\text{Percentage of mortality} = \frac{Numbers\ of\ dead\ larvae}{Numbers\ of\ larvae\ introduced} \times 100 \qquad (1)$$

$$\text{Per cent control} = 100 \times \left(\frac{X-Y}{X}\right) \qquad (2)$$

Where as X = the per cent living in the check.

Y = the per cent living in the treated.

X-Y = the per cent killed by the treatment.

3. RESULTS AND DISCUSSION

24 hrs after treatment application:

The experimental results tabulated in the Table 1 regarding per cent mortality of pod borer larvae disclosed that mortality of larvae ranging from 26.67% to 73.33% after exposing them to different treatments within 24 hrs. Highest mortality was recorded in the treatment Emamectin benzoate 5SG@0.4g/l (73.33) which was at par with treatment entomopathogenic nematodes. The treatment *Beauveria bassiana* @ 5ml/lt showed 40 per cent mortality followed by *Metarhizium anisopliae* @ 2.5 g/l, *Beauveria bassiana* @ 2.5ml/l with 31.67 and 26.67 percent mortality respectively. While *Metarhizium anisopliae* @ 5g/l caused 66.67 per cent mortality.

48 hrs after treatment application:

It is clear from the Table 1 regarding per cent mortality of pod borer larvae varied from 40.00 to 90% after 48 hrs of exposure for different treatments. The least mortality was recorded in the treatment *Beauveria bassiana* @ 2.5ml/lt (40% mortality). Highest mortality was recorded with treatment Emamectin benzoate @ 0.4 g/lt (90%) which was at par with treatment EPNs 500IJs observed with 80% mortality. Next effective treatment was *Metarhizium anisopliae* @ 5g/lt with 73.33% mortality. And treatment *Beauveria bassiana* @ 5ml/lt with 50 per cent mortality followed by *Metarhizium anisopliae* @ 2.5 g/l and *Beauveria bassiana* @ 2.5ml/lt with 46.67 and 40 percent mortality, respectively.

72 hrs after treatment application:

It is apparent from the Table 1 that the mortality percentage differed from 60 to 100 within 72 hrs after treatment application. The maximum mortality (100%) was captured at treatment *Emamectin benzoate* 5 SG @ 0.4 g/l which was followed by the treatment EPN dose (500IJs) with 86.67% mortality. The treatment EPN dose (500IJs) *Metarhizium anisopliae @5ml/l* showed 83.33 per cent mortality followed by *Beauveria bassiana* @5ml with 80.00 percent mortality. However the least mortalities were recorded in the treatments *Metarhizium anisopliae* @2.5ml/l and *Beauveria bassiana* 2.5ml with 76.67 and 60 percent mortality respectively.

96 hrs after treatment application:

It is quite clear from the Table 1 that per cent mortality varied from 76.67 to 100 after treatment application within 96 hrs. Maximum mortality per cent (100) was recorded from the treatment Emamectin benzoate 5SG @ 0.4 g/l and minimum mortality per cent (76.67) was recorded from the treatment *Beauveria bassiana* @ 2.5ml/l. Second best treatment was noticed in EPN dose (500IJs) which attained 100 per cent mortality within 96 hrs followed by *Metarhizium anisopliae* @5ml/l with 93.33 percent mortality. While the treatments *Beauveria bassiana* @ 5ml/l and *Metarhizium anisopliae* @2.5ml/l were with 90.00 and 83.33 percent mortality respectively. However it is evident that mortality percent has found to be increased from 24hrs to 96hrs.

120 hrs after treatment application:

Results obtained from the experiment recorded in table 1 declared that Emamectin benzoate 5SG @ 0.4 g/l, *Metarhizium anisopliae* @5ml/l and EPN dose (500IJs) attained 100 percent mortality within 120 hrs. However treatments *Beauveria bassiana* @ 5ml/l, *Metarhizium anisopliae* @2.5ml/l and *Beauveria bassiana* @ 2.5ml/l showed 95%, 90% and 80% mortality respectively.

Table 1 : Comparative bio-efficacy of *Steinernema carpocapsae* against *H. armigera.*

Treatment (dose)	Mortality percentage of *H. armigera*				
	24 hrs	**48 hrs**	**72 hrs**	**96 hrs**	**120 hrs**
T1 ***Beauveria bassiana* @ 2.5ml/lt**	26.67 (31.00)	40.00 (39.15)	60.00 (50.85)	76.67 (61.22)	80.00 (63.43)
T2 ***Beauveria bassiana* @ 5ml/lt**	40.00 (37.22)	50.00 (45.00)	80.00 (63.93)	90.00 (71.57)	95.00 (79.55)
T3 ***Metarhizium anisopliae*@2.5g/l**	31.67 (34.23)	46.67 (43.08)	76.67 (61.22)	83.33 (65.95)	90.00 (71.57)
T4 ***Metarhizium anisopliae* @ 5g/l**	66.67 (54.78)	73.33 (59.00)	83.33 (66.14)	93.33 (77.71)	100.00 (90.00)
T5 **EPNs 500IJs**	70.00 (57.00)	80.00 (63..93)	86.67 (68.86)	100.00 (90.00)	100.00 (90.00)
T6 **Emamectin benzoate @ 0.4 g/l**	73.33 (59.00)	90.00 (71.57)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)
T7 **Control**	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
SEm (±)	1.28	1.32	1.78	1.12	1.55
CD(p=0.05)	3.83	3.9	4.4	3.48	5.42

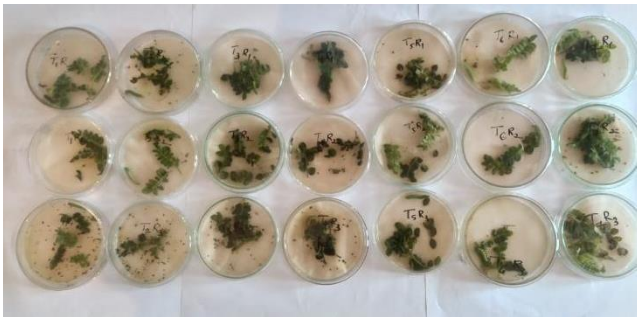

Fig -1: Figure

3. CONCLUSIONS

Highest performance was observed with treatment Emamectin benzoate 5SG @ 0.4g/l larval mortality 73.33 %, 90.00 % and 100 % at 24 hrs, 48 hrs and 72 hrs, respectively. Next best performer EPNs (500IJs) with maximum 100% mortality within 96hrs and minimum 70% mortality within 24hrs. When treated with *Metarhizium anisopliae* @5ml/l 66.67, 73.33, 83.33, 93.33, 100 percent mortality percentage at 24hrs, 48hrs, 72hrs, 96hrs and 120 hrs respectively. Other treaments like *Metarhizium anisopliae @ 2.5*ml/l , *Beauveria bassiana* @ 5g/l and 2.5g/l increased there mortality percent with increase in exposure duration.There was no any mortality observed in control. It was concluded that increase in doses increased the larval mortality. The larval mortality was recorded highest in all the treatments at 120 hrs after imposition of treatments. Fungi produces endotoxins which leads to death of the larvae. Infected body becomes mummified, dried and hard in case of *Metarhizium anisopliae.* Insect cadaver becomes soft, breakable and gets milky fluid from its body due to *Baeuveria bassiana*. Larvae treated with Emamectin benzoate stops feeding and gets irreversibly paralyzed due to blocking of (GABA) gamma aminobutyric acid at neuromuscular junction in insects.

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