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Field efficacy of biopesticides against *Helicoverpa armigera* in pearl millet

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ABSTRACT

Investigations on evaluation of different bio pesticides against pearl millet ear head worm, *Helicoverpa armigera* in pearl millet crop were made at Instructional Farm, College of Agriculture, Junagadh Agricultural University, Junagadh during *Kharif* 2015. Insecticides used in experiment were spinosad @ 0.014 per cent, indoxacarb @ 0.0079 per cent, *Beauveria bassiana* @ 2.5 kg/ha, *Lecanicillium lecanii* @ 2.0 kg/ha, *Ha*NPV @ 500 LE/ha, azadirechtin @ 0.000375 per cent and *Bacillus thuringiensis* @ 1.5 kg/ha. Among the eight treatments, spinosad @ 0.014 per cent and indoxacarb @ 0.0079 per cent was found to be most effective in reducing the larval population of *H. armigera*. The treatments *Ha*NPV @ 500 LE/ha, *B. thuringiensis* @ 1.5 kg/ha and azadirechtin @ 0.000375 per cent found moderately effective for the control of this pest. *L. lecanii* @ 2.0 kg/ha and *B. bassiana* @ 2.5 kg/ha proved to be least effective against pearl millet earhead worm. Spinosad @ 0.014 per cent recorded the highest grain yield of pearl millet (2685 kg/ha) and it was at par with indoxacarb @ 0.0079 per cent (2477 kg/ha). As far as economics of various insecticides are concerned, the treatments of *Ha*NPV @ 500 LE/ha or spinosad @ 0.014 per cent or azadirechtin @ 0.000375 per cent were found as effective and economical as recommended synthetic insecticides and are recommended for eco-friendly management of *H. armigera* in pearl millet ecosystem.

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INTRODUCTION

Pearl millet [*Pennisetum glaucum* (L.) R.Br.], commonly known as pearl, cat tail, spiked or bulrush millet in English is world's sixth important and widely grown potential food cereal crop in subsistence in India and Africa. Pearl millet is a staple food common in Gujarat State. The climatic condition of North Middle Gujarat and of Saurashtra region are most suitable for this crop. In India pearl millet occupies an area of 7.3 million hectare and production of 8.74 million tonnes with productivity of 1198 kg/ha (Anonymous, 2012). Gujarat has an area

of 371100 ha under *Kharif* pearl millet cultivation and production of 502891 tonnes with productivity of 1355.15 kg/ha. (Anonymous, 2013). Pearl millet grain are used for human consumption and it was found to be 5.8 to 20.9 per cent protein, 63.1 to 78.5 per cent starch, 1.1 to 1.8 per cent crude fibres, 4.1 to 6.4 per cent fat and 1.4 to 2.6 per cent soluble sugar. Besides that, seed also constituent of minerals like calcium, potassium, iron, zink, magnesium (Khairwal *et al*., 2007).

This crop is attacked by a number of insect pests, *viz.*, ear head worm, *Helicoverpa armigera*; Gujarat hairy caterpillar, *Amsacta moorei*, army worm, *Cirphis unipuncta*; stem borer, *Chilo zonellus*; blister beetle, *Cylindrothorax ruficolis*, shoot fly, *Atherigona varia socata*, surface grasshopper, *Chrotogonus brachypterous* and white grub, *Holotrichia consanguinea* (Patel *et al*., 1970). Among the various pests, the *H. armigera* is more common and destructive polyphagous pest (Juneja and Raghvani, 2000). In recent years, due to adoption of *Bt*. cotton in large areas, the pest is diverted towards pearl millet crop for its existence. Larval stage of this pest is observed at earhead stage and starts damaging on floral parts, milky grains, mature grain which ultimately reduce the grain yield and quality also. Juneja and Raghvani (2000) recorded 10-15 per cent reduction in yield by this pest in pearl millet. In the recent years, this pest has created a serious threat to agricultural industry due to development of resistance toward commonly used insecticides. It has drawn the attention of entomologists to develop eco-friendly and sustainable management practices. Among eco-friendly approaches, bio-pesticide is one of the most important components, which are being employed to control of pests in pearl millet ecosystem. *Lecanicillium lecanii*, *Beauveria bassiana* and *Neem* based products are the most important component for its control as well as in reducing the chances for development of resistance against them. Very limited work is found in the literature for the management of *H. armigera*. Hence the research work for the management of this pest was under taken.

MATERIAL AND METHODS

In order to study the field efficacy of bio pesticides against *H.armigera* in pearl millet, the variety GHB-558 was sown at Instructional Farm, College of Agriculture, JAU, Junagadh, in Randomized Block Design with three replications. Pearl millet (GHB-558) was sown at spacing of 45 cm between two rows and 10 cm within the rows in a gross and net plot area of 5.0 x 2.7 m and 4.0 x 1.8 m, respectively. All the recommended agronomical practices were followed. The spray solution of insecticides was applied with the help of knapsack sprayer. The care was taken to obtain uniform coverage of insecticides in each plot. The first spray was done at the time of substantial population of *Helicoverpa*, followed by second spray at 15 days after first spray. The *Helicoverpa* population was recorded from 20 earhead/net plot randomly 24 hours before spraying. Subsequently the observations were recorded at 3, 5, 7 and 10 days after spraying. The data were converted to per cent mortality by using a modified given by Henderson and Tilton (1955). Grain yield per plot was recorded at harvested from net plot area. Grain yield of pearl millet was converted to kilograms per hectare. Economics of all the treatments were worked out by considering the price of products, cost of insecticides and labour charges. Cost benefit ratio was worked out to compare the economics of different insecticidal treatments.

RESULTS AND DISCUSSION

Per cent mortality of *H. armigera* at ten days after first spray (Table 1) of bio pesticides indicated that spinosad @ 0.014 per cent was found the most effective which showed 73.86 per cent larval mortality and it was statistically at par with indoxacarb @ 0.0079 per cent (65.92 %) larval mortality of this pest. The treatment of *Ha*NPV @ 500 LE/ha showed 52.26 per cent larval mortality and it was at par with *B. thuringiensis* @ 1.5 kg/ha which showed 49.21 per cent mortality of this pest. Whereas, *L. lecanii* @ 2.0 kg/ha showed the lowest mortality (25.93 %) of this pest and it was at par with azadirechtin @ 0.000375 per cent and *B. bassiana* @ 2.5 kg/ha *i.e.* 39.92 and 32.69 per cent, respectively.

Upto ten days after second spraying (Table 1), there was gradually increasing in per cent larval mortality of *H. armigera*. The data on mortality recorded at ten days after application of bio pesticides indicated that spinosad @ 0.014 per cent was found the most effective and showed 76.17 per cent mortality. However, it was at statistically at par with indoxacarb @ 0.0079 per cent, which showed 65.99 per cent mortality. The treatment *Ha*NPV @ 500 LE/ha, *B. thuringiensis* @ 1.5 kg/ha and azadirechtin @ 0.000375 per cent found moderately effective as they showed 61.80, 55.30 and 53.48 per

cent mortality, respectively and were at par with each other. The treatment *L. lecanii* 2.0 kg/ha found least effective as they exhibited 41.37 per cent mortality followed by *B. bassiana* @ 2.5 kg/ha.

Critical examination of the data on larval per cent mortality of *H. armigera* at different interval of both sprays indicate that bio pesticides were found least effective against pest as compare to synthetic insecticides.However, these bio pesticides showed increasing trend in per cent mortality of this pest with duration. Earlier, the effectiveness of spinosad against the *H. armigera* has been reported by Deshmukh *et al*. (2010) on chickpea, Gandhi *et al*. (2013) on sorghum and Suneel Kumar and Sarada (2015) on chickpea; indoxacarb by Singh *et al*. (2014) on chickpea and Sukumar *et al*. (2014) on tomato; *Ha*NPV by Mane *et al*. (2013) on sunflower; *B. thuringiensis* by Tyagi *et al*. (2010) on tomato; azadirechtin by Walikar and Deshapande (2011) on sorghum and *B. bassiana* by Bajya *et al*. (2015) on chickpea. Thus, results obtained

Table 1 : Field efficacy of bio-pesticides against *H. armigera* in pearl millet during *Kharif*-2015

Sr. No.	Treatments	Mean per cent larval mortality at different intervals								Mean grain yield (kg/ha)	Yield increase over control (%)
		First spray				Second spray					
		3 DAS	5 DAS	7 DAS	10 DAS	3 DAS	5 DAS	7 DAS	10 DAS		
1.	Spinosad @ 0.014 %	55.33* (67.64)	60.60 (75.90)	61.02 (76.53)	59.25 73.86)	57.14 (70.56)	58.53 (72.74)	59.63 74.43)	60.78 (76.17)	2685	66.46
2.	Indoxacarb @ 0.0079 %	50.93 (60.28)	55.12 (67.29)	56.76 (69.96)	54.29 65.92)	51.61 (61.44)	53.16 (64.04)	54.33 (65.99)	55.34 (67.65)	2477	53.56
3.	*Beauveria bassiana* @ 2.5 kg/ha	36.44 (35.28)	37.28 (36.69)	38.30 (38.41)	34.87 32.69)	38.32 (38.44)	39.72 40.84)	40.73 42.58)	41.43 (43.78)	1736	7.62
4.	*Lecanicillium lecanii* @ 2.0 kg/ha	30.61 (25.93)	33.51 (30.48)	34.52 32.11)	33.52 30.50)	32.40 (28.72)	36.72 35.75)	39.72 40.84)	40.03 (41.37)	1674	3.16
5.	*Ha*NPV @ 500 LE/ha	45.78 (51.37)	47.80 (54.87)	49.34 (57.54)	46.29 52.26)	46.91 (53.33)	49.21 (57.33)	50.71 (59.91)	51.82 (61.80)	2211	37.07
6.	*Bacillus thuringiensis* @ 1.5 kg/ha	43.08 (46.65)	45.38 (50.67)	47.94 (55.12)	44.55 (49.21)	44.06 (48.37)	46.88 (53.29)	47.51 (54.38)	48.04 (55.30)	2118	30.93
7.	Azadirechtin @ 0.000375 %	42.01 (44.80)	43.63 47.61)	45.27 (50.48)	39.18 39.92)	42.44 (45.54)	44.75 (49.56)	46.45 52.52)	46.99 (53.48)	2012	24.73
8.	Control	-	-	-	-	-	-	-	-	1613	-
	S.E. ±	2.45	2.48	2.88	2.56	2.56	2.60	2.76	2.74	150	-
	C.D. (P=0.05)	7.55	7.65	8.87	7.9	7.89	8.00	8.52	8.43	457	-
	C.V. %	9.76	9.31	10.48	9.96	9.93	9.57	9.88	9.63	13	-

* Arcsine transformed values Figures in parenthesis are retransformed values DAS - Day after spraying

Table 2 : Economics of different treatments for the control of *H. armigera* in pearl millet during *Kharif*-2015

Sr. No.	Treatments	Total cost of insecticides including labour charges (Rs./ha)	Yield of bajra grains (kg/ha)	Net grain yield over control (kg/ha)	Gross realization (Rs./ha)	Realization over control (Rs./ha)	CBR
1.	Spinosad @ 0.014 %	4224	2685	1072	40275	16080	1: 3.80
2.	Indoxacarb @ 0.0079 %	2150	2477	864	37155	12960	1: 6.02
3.	*Beauveria bassiana* @ 2.5 kg/ha	1250	1736	123	26040	1845	1: 1.47
4.	*Lecanicillium lecanii* @ 2.0 kg/ha	1180	1674	61	25110	915	1: 0.77
5.	*Ha*NPV @ 500 LE/ha	1160	2211	598	33165	8970	1: 7.73
6.	*Bacillus thuringiensis* @1.5 kg/ha	4460	2118	505	31770	7575	1: 1.69
7.	Azadirechtin @ 0.000375 %	1895	2012	399	30180	5985	1: 3.15
8.	Control	-	1613	-	-	-	-

in present investigation are in close agreement with the work carried out by earlier workers.

The data on grain yield of pearl millet in different treatments (Table 1) varied from 1613 to 2685 kg/ha. The highest grain yield (2685 kg/ha) was recorded in the treatment of spinosad @ 0.014 per cent. However, it was found statistically at par with indoxacarb @ 0.0079 per cent (2477 kg/ha). The treatments *Ha*NPV @ 500 LE/ha (2211 kg/ha), *B. thuringiensis* @ 1.5 kg/ha (2118 kg/ha) and azadirechtin @ 0.000375 per cent (2012 kg/ha) were found moderately effective in grain yield over control and found at par with each other. The treatments *L. lecanii* @ 2.0 kg/ha and *B. bassiana* @ 2.5 kg/ha were found least effective in grain yield over control. Considering the per cent increase in the yield of pearl millet over control, it was the highest in spinosad @ 0.014 per cent (66.46 %). The treatments of indoxacarb 15.8 @ 0.0079 per cent (53.56 %), *Ha*NPV @ 500 LE/ha (37.07 %) and *B. thuringiensis* @ 1.5 kg/ha (30.93 %) were found next in order with respect of per cent increase in grain yield over control. The remaining treatments viz., *L. lecanii*, *B. bassiana* and azadirechtin recorded less than 30 per cent increase in yield over control.

It is evident from the data presented in Table 2 that the net realization of different treatments varied from 915 to 16080 Rs./ha. The treatment of spinosad @ 0.014 per cent recorded maximum net realization *i.e.*16080 Rs./ha, followed indoxacarb @ 0.0079 per cent (12960 Rs./ha), *Ha*NPV @ 500 LE/ha (8970 Rs./ha),*B. thuringiensis* @ 1.5 kg/ha (7575 Rs./ha) and azadirechtin @ 0.000375 per cent (5985 Rs./ha) whereas, minimum net realization was observed in the treatment of *L. lecanii* @ 2.0 kg/ha (915 Rs./ha). Cost benefit ratio is a very important criterion, which indicates the efficacy and suitability of a recommendation for wide scale adoption. The result indicated that *Ha*NPV @ 500 LE/ha gave the highest cost benefit ratio of 1: 7.73. The next in order being indoxacarb @ 0.0079 per cent (1: 6.02), spinosad @ 0.014 per cent (1: 3.80) and azadirechtin @ 0.000375 per cent (1: 3.15). The remaining treatments showed comparative low cost benefit ratio (1: 0.77 to 1: 1.69). Considering the efficacy, yield and economics of insecticides, *Ha*NPV @ 500 LE/ha and spinosad @ 0.014 per cent emerged to be the most effective insecticides followed by azadirechtin @ 0.000375 per cent (1: 3.15). Thus, on the basis of effectiveness and economics of the insecticides, treatments of *Ha*NPV @ 500 LE/ha or spinosad @ 0.014 per cent or azadirechtin @ 0.000375 per cent were found as effective and economical as recommended synthetic insecticides and are recommended for ecofriendly management of *H. armigera* in pearl millet ecosystem.

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