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Management of major insect pests of pearl millet under organic cultivation

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ABSTRACT

A field experiment was conducted at Pearl millet Research Station, Junagadh Agricultural University, Jamnagar during *Kharif* 2016 to 2018 to find out the effective and economical control measures against the major insect pests in pearl millet for organic cultivation. The bio-efficacy of different bio-pesticides *viz.*, HaNPV (6×10^9 POB/ml) @ 250 LE/ha, *Bacillus thuringinensis var kurstaki* @ 5% WP @ 0.01 %, *Beauveria bassiana* 1.15 WP (2×10^6 cfu/g) @ 5g/lit, *Lecanicillium lecanii* 1.15 WP (2×10^6 cfu/g) 5g/lit and NSKE 5 per cent were evaluated agaisnt the major insect pests in pearl millet crop. The treatment of *B. bassiana* 1.15 WP (2×10^6 cfu/g) @ 5g/l recorded the least incidence of shoot fly (7.2%) and stem borer (5.36%) at earhead stage of the crop. Whereas, in case of ear head worm *Helicoverpa armigera*, treatment of HaNPV (6×10^9 POB/ml) @ 250 LE/ha recorded the lowest larval population (5.78 larvae /20 ear heads) and it was at par with *B. thuringiensis* @ 1.0 kg/ha (8.36 larvae /20 ear heads) and *B. bassiana* @ 5g/l (9.87 larvae /20 ear heads). The treatment of *B. bassiana* @ 5g/l also recorded the highest grain yield (1727 kg/ha) followed by HaNPV @ 250 LE/ha (1490 kg/ha).

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INTRODUCTION

Pearl millet, *Pennisetum glaucum* is the staple nutritious food of the poor and small land holders, as well as feed and fodder for livestock in rainfed regions of the country. Pearl millet excels all the cereals due its unique features-C_4 plant with high photosynthetic efficiency, high dry matter production capacity and is grown under the most adverse agro-climatic condition with less inputs where other crops like sorghum and maize fail to produce economic yields. In India, pearl millet is the fourth most widely cultivated food crop after rice, wheat and maize. During 2017-18, pearl millet was grown on 7.4 million ha with an average production of 9.13 million tones and productivity of 1237 kg/ha (Anonymous, 2019). The major pearl millet growing states are Rajasthan, Maharashtra, Gujarat, Uttar pradesh and Haryana which account for more than 90 per cent of

pearl millet acreage in the country and commonly grown in rainfed season. It is also grown in summer season in parts of Gujarat, Rajasthan and Uttar Pradesh.

Pearl millet is rich source energy, carbohydrate, fat, ash, dietary fibres, iron and zinc. It is a rich source of vitamins like thiamine, riboflavin and niacin and minerals like potassium, phosphorus, magnesium, iron, zinc, copper and manganese. Even though, it was part of the traditional diet pattern, but, now a day, due to changing cropping pattern and consumption pattern, such crop is disappearing from the field and diet as well. Recently, minimum support price of pearl millet is increased to Rs. 1950 per quintal (raised Rs. 525 which is 36.84 %) compared to the previous year's MSP at Rs. 1425 resulting in highest returns of 96.97 per cent over the cost incurred when compared to other all other crops. To bring millets into mainstream for exploiting the nutritional rich properties and promoting their cultivation, Gov. of India has also declared year 2018 as the "Year of Millets".

Pearl millet, being a C_4 plant, has agreater yield potential as compared to other cereals, but attack of insect pests infesting this crop at various crop growth stages from sowing to maturity poses serious limitation in full manifestation of yield potential of pearl millet crop. More than 100 insect pest species have been reported to be associated with pearl millet based cropping system (Prem Kishore and Solomon, 1989). Out of these, shoot fly, *Atherigona varia socata* and stem borer, *Chilo partellus* Swinhoe are comparatively more serious pests attacking at vegetative as well as at ear head stages of the crop. Incidence of stem borer was noticed 15 days of germination of the crop and gradually increased to its peak at 77 days after germination of the crop (Raghvani *et al*., 2008). Losses in yield of *Bajra* crop due to shoot fly estimated to the tune of 23.3 to 36.5 per cent in grain and 37.55 per cent in fodder, while the estimated losses in *Bajra* yield due to stem borer is 20 to 60 per cent (Kishore, 1996). Ear head worm, *Helicoverpa armigera* is more common and destructive polyphagous pest. Juneja and Raghvani (2000) recorded 10-15 per cent reduction in yield by this pest in pearl millet.

Since the pearl millet is grown under low input conditions, the use of costly chemical insecticides that are effective against the insect pests does not find flavour with cultivars. Morever, the use of synthetic insecticides against the insect pests is not safe due to their persistence and high mammalian toxicity. 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. Hence, the research work for the management of this pest was under taken.

MATERIAL AND METHODS

The experiment was conducted in Randomized Block Design with seven treatments including control in four replication at Pearl Millet Research Station, Junagadh Agricultural University, Jamnagar during *Kharif* 2016 to 2018. The pearl millet variety GHB-905 was sown at 60 × 10 cm spacing for this purpose. The gross plot size was 5.0 × 3.6 m and net plot size was 4.0 × 2.4 m. Two foliar applications of bio-pesticides were given at 30 and 60 days after sowing. At vegetative stage, observations were recorded from 20 plants randomly selected plants by counting dead hearts and thus, per cent dead heart was worked out for shoot fly. For stem borer, plants showing parallel holes due to stem borer larvae in the leaves were considered as damaged plants and per cent damaged plants were calculated by observing 20 randomly selected plants. At ear head stage, numbers of ear heads showing shoot fly and stem borer damage were recorded separately from randomly selected 20 ear heads in each treatment from net plot and thus per cent ear head damage was worked out. For ear head worm, observations of larval population before 24 hours and after 7 days of application recorded from 20 randomly selected ear heads from net plot area. Grain and fodder yield was recorded from net plot area at harvest and data thus, obtained was analyzed statistically (Panse and Sukhatme, 1989).

RESULTS AND DISCUSSION

The findings of the present study as well as relevant discussion have been presented under the following heads:

Shoot fly incidence:

Year wise as well as pooled results of shoot fly infestation at vegetative and at ear head stage are presented in Table 1 indicated that during *Kharif* 2016 results were found significant. While during *Kharif* 2017,

Table 1 : Statement showing year wise and pooled shoot fly per cent incidence in pearl millet

Sr. No	Treatments	Per cent shoot fly incidence at vegetative stage				Per cent shoot fly incidence at ear head stage			
		2016	2017	2018	Pooled	2016	2017	2018	Pooled
1.	HaNPV 250 LE/ha	19.45*	20.29	16.52	18.37	22.71	22.54	17.90	20.55
		(11.20)	(12.12)	(8.08)	(10.47)	(14.98)	(14.76)	(9.45)	(13.06)
2.	*B. thuringinensis* @	18.83	19.89	13.02	17.45	22.49	22.62	16.78	20.77
	0.01%	(10.56)	(11.60)	(5.08)	(9.08)	(14.67)	(14.81)	(8.34)	(12.61)
3.	*B. bassiana* @ 5 g/lit	18.64	19.68	14.82	17.63	16.50	17.21	12.39	15.15
		(10.26)	(11.39)	(6.55)	(9.40)	(8.15)	(8.85)	(4.61)	(7.20)
4.	*L. lecanii* @ 5 g/lit	18.89	19.70	15.98	18.27	20.79	20.26	19.18	20.13
		(10.56)	(11.42)	(7.57)	(9.85)	(12.69)	(12.03)	(10.79)	(11.84)
5.	NSKE 5 %	19.26	19.56	14.09	17.88	22.24	21.03	14.00	19.34
		(10.92)	(11.26)	(5.92)	(9.37)	(14.33)	(12.91)	(5.85)	(11.03)
6.	Control	23.68	21.48	17.43	20.94	27.78	26.08	22.56	25.44
		(16.14)	(13.42)	(8.97)	(12.84)	(21.73)	(19.33)	(14.72)	(18.59)
T	S.E.±	0.91	0.79	1.48	0.64	0.93	0.74	1.62	0.67
	C.D. (P=0.05)	2.73	NS	NS	NS	2.80	2.24	4.87	1.91
Y	S.E.±	-	-	-	0.45	-	-	-	0.47
	C.D. (P=0.05)	-	-	-	1.28	-	-	-	1.35
Y×T	S.E.±	-	-	-	1.10	-	-	-	1.16
	C.D. (P=0.05)	-	-	-	NS	-	-	-	NS
	C.V.%	9.15	7.91	19.27	11.97	8.41	6.87	19.05	11.46

* indicate significance of value at P=0.05 Figures in parenthesis are retransformed values NS= Non-significant

Table 2: Statement showing year wise and pooled shoot fly per cent incidence in pearl millet

Sr. No.	Treatments	Per cent stem bore incidence at vegetative stage				Per cent stem borer incidence at ear head stage			
		2016	2017	2018	Pooled	2016	2017	2018	Pooled
1.	HaNPV 250 LE/ha	6.94*	16.54	19.60	14.15	9.34	26.07	18.34	18.85
		(1.58)	(8.20)	(11.26)	(7.01)	(4.25)	(19.32)	(9.90)	(11.16)
2.	*B. thuringinensis* @	8.08	16.72	18.91	14.41	4.55	22.62	15.98	14.98
	0.01%	(1.99)	(8.28)	(10.50)	(6.92)	(1.01)	(14.84)	(7.57)	(7.81)
3.	*B. bassiana* @ 5 g/lit	7.62	16.48	19.60	14.58	7.25	17.50	12.07	12.85
		(1.94)	(8.05)	(11.26)	(7.08)	(2.56)	(9.16)	(4.37)	(5.36)
4.	*L. lecanii* @ 5 g/lit	7.34	17.11	17.43	14.26	8.94	24.59	19.14	18.35
		(1.83)	(8.67)	(8.97)	(6.49)	(3.88)	(17.34)	(10.75)	(10.66)
5.	NSKE 5 %	7.53	17.46	18.60	14.51	8.71	19.98	17.13	16.04
		(1.76)	(9.04)	(10.17)	(6.99)	(3.68)	(11.83)	(8.68)	(8.07)
6.	Control	9.17	18.13	19.74	15.68	11.32	28.03	23.34	22.40
		(2.54)	(9.69)	(11.40)	(7.88)	(6.20)	(22.12)	(15.70)	(14.67)
T	S.E.±	0.64	0.46	1.41	0.54	0.65	0.87	1.55	1.10
	C.D. (P=0.05)	NS	NS	NS	NS	1.95	2.63	4.68	3.48
Y	S.E.±	-	-	-	0.38	-	-	-	0.78
	C.D. (P=0.05)	-	-	-	1.09	-	-	-	2.46
Y×T	S.E.±	-	-	-	0.94	-	-	-	1.09
	C.D. (P=0.05)	-	-	-	NS	-	-	-	3.12
	C.V.%	16.45	5.40	14.93	12.81	12.19	7.56	17.24	12.69

* indicate significance of value at P=0.05 Figures in parenthesis are retransformed values NS= Non-signficanct

Kharif 2018 as well as in pooled difference was found non significant. In pooled data, the treatment of *B. bassiana* @ 5g/lit recorded significantly the least incidence of shoot fly (7.2%) at ear head stage. However, remaining all the insecticides were found statistically at par each other in their effectiveness except control. According to Abebe *et al.* (2014) entomopathogenic fungi, *B. bassiana* was found effective in reducing the shoot flies populations after application of 10 days under field condition.

Stem borer incidence:

Data presented in Table 2 indicated that difference in per cent plant damage due to stem borer at vegetative stage was found non-significant during all the three years and in pooled. Whereas, at ear head stage in the pooled, the treatment of *B. bassiana* @ 5g/lit recorded the least per cent plant damage (5.36%). However, it was at par with the treatments of *B. thuringinensis var kurstaki* 5% WP @ 1.0 kg/ha (12.85%) and NSKE 5% (8.07%) in their effectiveness. Dhalival (2016) reported that the

Table 3: Statement showing year wise and pooled population of *Helicoverpa* in pearl millet

Sr. No.	Treatments	Population of Helicoverpa larvae /20 ear heads (24 hrs before spray)				Population of Helicoverpa larvae /20 ear heads (7 days after spray)			
		2016	2017	2018	Pooled	2016	2017	2018	Pooled
1.	HaNPV 250 LE/ha	3.26#	6.27	4.84	4.92	1.00	2.87	2.89	2.20
		(10.63)	(39.35)	(23.41)	(24.46)	(1.00)	(8.00)	(8.33)	(5.78)
2.	*B. thuringinensis* @	3.30	6.63	4.69	4.86	1.28	3.88	2.90	2.71
	0.01%	(10.90)	(43.93)	(22.00)	(25.61)	(1.63)	(15.00)	(8.44)	(8.36)
3.	*B. bassiana* @ 5g/lit	3.14	6.91	4.57	4.73	2.69	3.92	2.98	3.04
		(9.89)	(47.78)	(20.86)	(26.17)	(7.23)	(15.00)	(8.88)	(9.87)
4.	*L. lecanii* @ 5 g/lit	3.15	6.67	4.69	4.95	3.21	4.16	3.98	3.68
		(9.95)	(44.47)	(21.98)	(25.47)	(10.30)	(17.00)	(15.83)	(14.38)
5.	NSKE 5 %	3.28	6.37	4.61	4.71	3.10	4.48	3.78	3.68
		(10.75)	(40.63)	(21.28)	(24.22)	(9.63)	(20.00)	(14.31)	(14.65)
6.	Control	3.40	6.62	5.27	4.91	3.35	7.36	4.94	5.25
		(11.57)	(43.81)	(27.82)	(27.74)	(11.19)	(54.00)	(24.41)	(29.87)
T	S.E. ±	0.19	0.49	0.31	0.20	0.16	0.34	0.29	0.36
	C.D. (P=0.05)	NS	NS	NS	NS	0.47	1.03	0.87	1.13
Y	S.E. ±	-	-	-	0.15	-	-	-	0.25
	C.D. (P=0.05)	-	-	-	0.41	-	-	-	0.80
Y×T	S.E. ±	-	-	-	0.35	-	-	-	0.28
	C.D. (P=0.05)	-	-	-	NS	-	-	-	0.79
	C.V.%	12.07	14.86	13.31	14.62	12.94	15.35	16.46	16.19

# indicates square root $\sqrt{x+0.5}$ values, figures in parenthesis are retransformed values NS= Non-significant

Table 4 : Economics of various treatments for the management of major insect pests inesting pearl

Sr. No.	Treatments	Yield (kg/ha)		Yield increase over control		Additional income over control (Rs./ha)	Total expenditure (Rs./ha)	Net return (Rs./ha)	ICBR
		Grain	Fodder	Grain	Fodder				
1.	HaNPV 250 LE/ha	1490	3696	266	402	7454	1560	5894	1:4.78
2.	*B. thuringinensis* @ 0.01%	1438	3630	214	336	6022	3600	2422	1:1.67
3.	*B. bassiana* @ 5 g/lit	1727	3958	289	664	8553	1710	6843	1:5.00
4.	*L. lecanii* @ 5 g/lit	1438	3656	214	362	6074	1710	4364	1:3.55
5.	NSKE 5 %	1468	3586	244	292	6684	2320	4364	1:2.88
6.	Control	1224	3294	-	-	-	-	-	-

fungal concentrations at 10^6 and 10^7 conidia/ml of *B. bassiana* isolates had affected the laval development, movement and mobility on corn borer larvae, *Chilo patellus* during the seedling and vegetative stages of maize plant under laboratory and field condition.

Ear head worm infestation:

Data presented in Table 3 indicates that during all the three years and in pooled the population of *H. armigera* larva was found non significant before spray. This shows that there was an even population in all the treatments. Pooled analysis showed that the treatment of HaNPV@250 LE/ha recorded lowest population (5.78 larvae /20 ear heads) and it was at par with *B. thuringiensis* @ 1.0 kg/ha (8.36 larvae /20 ear heads) and *B. bassiana* @ 5g/l (9.87 larvae /20 ear heads). Whereas remaining bio-pesticides, *L. lecanii* @ 5g/lit and NSKE 5 per cent were found equally effective in reducing the larval population of *Helicoverpa* in pearl millet. The present investigation are match with the results of Makwana *et al*. (2017) who reported that the treatments of HaNPV@ 500 LE/ha and *B. thuringiensis* @ 1.5 kg/ha found effective for the control of *Helicoverpa* in pearl millet. Spray of HaNPV @ 450 LE/ha or *B. thuringiensis* @ 1.0 kg/ha or *B. bassiana* @ 4 g/lit was also found effective against larval population of *Helicoverpa* in pearl millet (Anonymos, 2018).

Data presented in Table 4 indicated that difference in yield of bajra grain was found significant during all the three seasons as well as in pooled. In pooled data, results showed that the treatment of *B. bassiana* @ 5g/lit recorded the highest grain yield (1727 kg/ha) followed by HaNPV @ 250 LE/ha (1490 kg/ha). Treatment of *B. bassiana* @ 5g/lit recorded the highest net realization *i.e*. Rs. 6843/- with highest ICBR (1:5.0) which was followed by HaNPV 250 LE/ha (1:4.78).

Conclusion:

Base on yield and economics of various insecticidal treatments, it was noticed that *B. bassiana* @ 5g/lit recorded not only the highest grain yield but also registered highest ICBR value (1:5.0). However, the treatment of HaNPV 250 LE/ha also recorded comparatively higher ICBR values (1:4.78). The farmers who are interested in growing organic farming are advised to apply two sprays of *B. bassiana* @ 5g/lit at 30 and 60 days after sowing for the effective and economical management of shoot fly and stem borer in pearl millet crop. Whereas, for effective and economical management of ear head worm, *H. armigera*, one spray of HaNPV 250 LE/ha at anthesis stage should be done.

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