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BIORATIONAL MANAGEMENT OF *SPODOPTERA FRUGIPERDA* (J E SMITH) ON MAIZE

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ABSTRACT

The present study on the biorational management of *Spodoptera frugiperda* (J E Smith) on maize was conducted in the farm of Department of Agricultural Entomology, Dr Panjabrao Deshmukh Krishi Vidyapeeth, Akola during kharif 2019-20. The experiment was laid out in randomized block design with eight treatments replicated thrice. The treatments included- *Nomuraea rileyi* 1x10^8 cfu/ g @ 30 g/ 10 l, *Metarhizium anisopliae* 1x10^8 cfu/ g @ 50 g/ 10 l, *Beauveria bassiana* 1x10^9 cfu/ g @ 40 g/ 10 l, NSKE 5%, Bt 85% @ 20 g/ 10 l, SLNPV 1x10^9 POB/ ml (500 LE), azadirachtin 1500 ppm @ 50 ml/ 10 l, and control (untreated). Four sprays were applied at 12 days interval. The results revealed that with fourth spray, Bt 85% @ 20 g/ 10 l was the most effective.

Key words: Maize, *Spodoptera frugiperda*, *Nomuraea rileyi*, SLNPV, Bt, *Metarhizium anisopliae*, *Beauveria bassiana*, azadirachtin.

Maize is a cereal crop grown in > 160 countries in tropical, subtropical and temperate regions, with India having a productivity of 109 kg/ ha, which is much less than the US yield of 863 kg/ ha. This low productivity might be due to several reasons viz*.,* environmental factors, low mechanization, pest and diseases etc. Of these, insect pests are the major constraints as these attacking maize not only directly as borers, sap suckers, stem and root feeders etc. but also indirectly as vectors of diseases. In India, the fall army worm *Spodoptera frugiperda* (J E Smith) was reported in May 2018 on maize for the first time from Karnataka (Sharanabasappa et al., 2018a). Molecular diversity of this from different states of India indicated prevalence of R strain (Mahadevaswamy et al., 2018). The total life of male and female was observed to be 32-43 and 34-46 days, respectively (Sharanabasappa et al. 2018b). The extent of its damage varied from 20 to 80% on maize (Sharanabasappa et al., 2019b). Considering adverse effect of insecticides there is need for environmentally safe and cost-effective management strategy in the form of biopesticides in IPM. The present study evaluates some biorational approaches including biopesticides against *S. frugiperda* on maize.

MATERIALS AND METHODS

The experiment was conducted on the farm of Department of Agricultural Entomology Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during kharif 2019-20. The experiment was laid out in randomized block design (RBD) with eight treatments and three replications, with plot size 5.4x 3 m and spacing of 60x 20 cm . Uday (Mahabeej-1114) cultivar was used and sowing was done on 5th July 2019. All the agronomical practices were carried out as per the recommendations except, plant protection. The treatments include: $T_{1:}$ *Nomuraea rileyi* 1x10^8 cfu/ g - 30 g, $T_{2:}$ *Metarhizium anisopliae* 1x10^8 cfu/g - 50 g, $T_{3:}$ *Beauveria bassiana* 1x10^9 cfu/ g - 40 g, $T_{4:}$ Neem seed kernel extract (NSKE) 5% - 50 g , $T_{5:}$ *Bacillus thuriengiensis* 85% - 20 g, $T_{6:}$ *Sl*NPV 1x10^9 POB/ml - 500 LE, $T_{7:}$ Azadirachtin1500 ppm - 50 ml, $T_{8:}$ Control. (The doses used are in 10 l of water); Source: *N. rileyi, M. anisopliae, B. bassiana*-Plant Pathology department, Dr PDKV, Akola; neem seed kernel extract- neem seeds from area of Dr PDKV, Akola; *Sl*NPV- Department of Agricultural Entomology, Dr PDKV, Akola; *Bacillus thuringiensis* var. *kurstaki*-Margo Company's Delfin WG; azadirachtin 1500 ppm-MBF Company Neem Fighter. The spray solution was freshly prepared with the required quantity of water for spraying each plot estimated by spraying plain water in untreated control plot. The required quantity of biopesticides and botanical was worked out and spray solution was prepared by mixing them in water thoroughly. The following formula was used- $V = \frac{C \, x \, A}{\% \, a \, i}$ where, V= quantity of biopesticides and botanical, C= concentration of spray required, A= quantity of water, % a.i. = active ingredient in commercial product.

Table 1. Efficacy of biopesticides and botanicals against *S. frugiperda*

Tr. No.	Treatment Dose/ 10 l water	% infestation of *S. frugiperda* 1 DBS	3 DAS	7 DAS	10 DAS	1 DBS	3 DAS	7 DAS	10 DAS	1 DBS	3 DAS	7 DAS	10 DAS	1 DBS	3 DAS	7 DAS	10 DAS	Overall mean
T_1	*Nomuraea rileyi* 1x10^8 cfu/ g 30 g	63.33 (52.91)	33.00 (34.97)	26.67 (31.04)	38.00 (38.03)	39.30 (38.80)	31.33 (34.01)	26.10 (30.69)	33.33 (35.24)	33.91 (35.59)	32.05 (34.46)	31.50 (34.12)	32.90 (34.97)	32.92 (34.98)	32.43 (34.69)	31.83 (34.32)	31.48 (34.10)	31.72 (34.57)
T_2	*Metarhizium anisopliae* 1x10^8 cfu/ g 50 g	78.33 (62.48)	27.67 (31.72)	23.00 (28.64)	32.67 (34.84)	33.33 (35.23)	26.27 (30.77)	23.65 (29.05)	26.47 (30.91)	26.60 (30.99)	25.00 (29.94)	24.01 (29.26)	25.28 (30.10)	25.58 (30.30)	24.80 (29.78)	24.08 (29.29)	23.65 (29.00)	25.54 (30.35)
T_3	*Beauveria bassiana* 1x10^9 cfu/g 40 g	68.33 (56.03)	26.00 (30.64)	16.67 (24.07)	30.00 (33.20)	30.33 (33.40)	22.89 (28.51)	20.92 (27.12)	23.15 (28.69)	23.33 (28.81)	22.19 (28.02)	20.48 (26.80)	21.83 (27.76)	21.96 (27.85)	20.81 (27.04)	19.97 (26.43)	18.65 (25.46)	21.96 (27.93)
T_4	Neem seed extract (NSKE) 5% 50 g	65.00 (54.84)	51.00 (45.57)	44.67 (41.93)	57.67 (49.41)	57.89 (49.54)	48.90 (44.36)	44.24 (41.67)	49.24 (44.56)	49.75 (44.86)	48.68 (44.24)	47.67 (43.66)	48.87 (44.35)	49.20 (44.54)	48.52 (44.15)	48.24 (43.99)	47.81 (43.74)	48.79 (44.31)
T_5	*Bt* 85% 20 g	71.67 (58.26)	23.33 (28.67)	15.33 (22.79)	26.33 (30.77)	26.33 (30.77)	15.33 (22.97)	13.29 (21.33)	15.99 (23.47)	16.03 (23.49)	14.00 (21.87)	12.63 (20.72)	14.33 (22.13)	14.55 (22.31)	13.50 (21.41)	12.33 (20.42)	10.52 (18.79)	15.57 (23.22)
T_6	*Sl*NPV 1x10^9 POB/ml 500 LE	65.00 (54.84)	75.67 (61.12)	79.97 (64.93)	80.00 (63.84)	82.02 (67.27)	82.89 (68.17)	84.13 (69.07)	83.30 (68.46)	83.73 (66.59)	85.96 (70.41)	86.50 (69.77)	86.67 (70.36)	88.12 (71.37)	87.76 (70.40)	87.80 (71.22)	87.77 (71.15)	84.03 (65.70)
T_7	Azadirachtin 1500 ppm 50 ml	70.00 (57.00)	36.33 (37.06)	29.67 (32.96)	39.33 (38.83)	40.33 (39.42)	43.67 (41.36)	38.20 (38.17)	44.26 (41.70)	44.49 (41.83)	43.11 (41.04)	42.04 (40.41)	43.00 (40.97)	43.62 (41.33)	42.76 (40.83)	42.07 (40.43)	41.88 (40.32)	40.52 (39.53)
T_8	Control -	63.33 (53.07)	75.00 (60.78)	79.83 (63.79)	80.22 (65.90)	81.89 (65.04)	82.77 (65.78)	84.00 (66.77)	83.22 (68.71)	84.32 (69.21)	86.00 (68.34)	86.17 (68.56)	86.50 (68.76)	87.67 (69.76)	87.63 (69.69)	87.74 (69.80)	87.63 (69.69)	83.89 (65.53)
‘F’ test		NS	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig
SE(m)±		-	3.27	3.19	3.77	3.56	3.75	3.54	3.70	3.62	3.38	3.18	3.06	2.85	2.29	2.95	2.92	3.25
CD (p= 0.05		-	9.92	9.68	11.44	10.80	11.38	10.75	11.22	10.97	10.25	9.64	9.29	8.63	8.90	8.95	8.86	10.02
CV (%)		-	13.71	14.26	14.73	13.73	15.47	15.17	15.12	14.69	13.84	13.18	12.52	11.52	12.00	12.17	12.18	13.7

* Figures in parentheses arc sin transformed values; DBS- Day before spraying, DAS-Day after spraying

Table 2. Efficacy of biopesticides and botanicals against *S. frugiperda*

Tr. No.	Treatment	% infestation of fall armyworm			
		3 DAS	7 DAS	10 DAS	Overall mean
T_1	*Nomuraea rileyi* 1x10^8 cfu /g 30 g	32.20 (34.57)	29.02 (32.60)	33.93 (35.62)	31.72 (34.57)
T_2	*Metarhizium anisopliae* 1x10^8 cfu /g 50 g	25.93 (30.61)	23.68 (29.11)	27.02 (31.32)	25.54 (30.35)
T_3	*Beauveria bassiana* 1x10^9 cfu /g 40 g	22.97 (28.64)	19.51 (26.21)	23.40 (28.93)	21.96 (27.93)
T_4	Neem seed extract (NSE) 5% 5 g	49.27 (44.58)	46.20 (42.82)	50.90 (45.52)	48.79 (44.31)
T_5	*Bt* 85% 20 g	16.54 (23.99)	13.39 (21.46)	16.79 (24.19)	15.57 (23.22)
T_6	*Sl*NPV 1x10^9 POB/ ml 500 LE	83.07 (65.70)	84.6 (66.89)	84.43 (66.76)	84.03 (65.70)
T_7	Azadirachtin1500 PPM 50 ml	41.46 (40.08)	37.99 (38.05)	42.12 (40.47)	40.52 (39.53)
T_8	Control	82.85 (65.54)	84.44 (66.77)	84.39 (66.72)	83.89 (65.53)
	'F' test	Sig	Sig	Sig	Sig
	SE(m)$\pm$	3.17	3.22	3.36	3.25
	CD at 5%	10.11	9.76	10.20	10.02
	CV (%)	13.76	13.70	13.64	13.7

*Figures in parentheses corresponding arc sin transformation values; DBS- Day Before Spraying; DAS-Day after spraying.

Neem seed extract was prepared following standard methodology. Pretreatment observations were made one day before spray, with further observations made on 3rd, 7th, and 10th days after spray (DAS) taking 10 plants/ plot selected randomly and % worked out. The data were subjected to statistical analysis as per Gomez and Gomez (1984).

RESULTS AND DISCUSSION

The pretreatment observations of *S. frugiperda* were found statistically non-significant – ranging from from 63.33 to 78.33/ 10 plants. Three DAS, the treatments were found to significantly superior over control; minimum incidence of 23.33% was observed with $T_{5:}$ *Bacillus thuriengiensis* 85%- 20 g; and $T_{6:}$ *Sl*NPV 1x10^9 POB/ml - 500 LE was inferior to control (75.67%). Seven DAS, again T_5 was found superior (15.33%), statistically at par with T_3, T_2 and *N. rileyi* @ 30 g/ 10 l and T_6 was found inferior to control (79.97%). Ten DAS too T_5 was superior (26.33%), and T_6 was inferior. Thus, after first spray, six treatments were significantly effective. With second spray after 3 DAS, the least incidence was observed plots treated with T_5, statistically at par with T_3, T_2 and T_1 and T_6 was inferior to control. At 7 and 10 DAS, similar trend was observed. Thus, with mean % incidence after second spray six treatments were significantly effective, with T_5 resulting in minimum infestation (14.87%), found at par with T_3, T_2 and T_1. After third spray, at 3 DAS the least incidence was observed with T_5, statistically at par with T_3 and T_2; T_6 showed 85.96% infestation as against 86% in control. Seven DAS (after third spray) the incidence reduced to 12.63% with T_5, found statistically at par with T_3 and T_2. Ten days after third spray again similar trend was observed. Thus, after third spray T_5 resulted in minimum infestation of 13.65%, found statistically at par with T_3 and T_2. Similar results were obtained with fourth spray leading to 13.50% incidence with T_5 (Table 1).

The cumulative effect of treatments given in Table 2 reveal that at three days after spray, T_5 proved effective by recording minimum infestation of *S. frugiperda* (16.54%), However, this treatment was found statistically at par with T_3 and T_2 recorded 22.97% and 25.93% infestation respectively. Whereas the treatments T_1, T_7 and T_4 concentration with 32.20%, 41.46% and 49.27%, infestation respectively. The control plot recorded 82.85% infestation. T_6 treatment was inferior to control and recorded maximum (83.07) % infestation. The data on cumulative effect of different treatments at seven days after spray revealed similar trend. T_{5-} *Bacillus thuriengiensis* 85%- 20 g led to minimum incidence (13.39%), and found statistically at par with, T_3 and T_2, and T_6 treatment was inferior to control. Polanczyk et al. (1999) evaluated in vivo activities of *Bt* strains on *S. frugiperda*, and observed that suspensions of *Bt aizawai* HD 68 and *Bt thuringiensis* 4412, containing 3x 10^8 cells/ ml, induced effective mortality. Similar results were obtained by Hernandez (1988). Ramanujam et al. (2020) with field trials observed efficacy of three sprays of *M. anisopliae* ICAR-NBAIR Ma-35 and *B. bassiana* ICAR-NBAIR Bb-45. Ahirwar et al. (2013) in soybean reported that *B. thuringiensis* var. *kurstaki* was the most effective. Ramos et al. (2020) with biological control assays revealed that, both *B. bassiana* and *M. anisopliae* caused (100%) mortality. Gutierrez et al. (1996) evaluated entomopathogenic fungi and observed that isolates of *Metarhizium anisopliae*, *Paecilomyces fumosoroseus*, and *Paecilomyces javanicus* were highly pathogenic. Mallapur et al. (2018) in studies on *N. rileyi* revealed effective reduction of incidence of *S. frugiperda.*

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