Original Research Article

Evaluation of *Beauveria bassiana*, Neem oil and selected insecticides on population of fall armyworm *Spodoptera frugiperda* (J.E.Smith) on Maize (*Zea mays* L.)

Abstract

A field trail was conducted at CRF (Crop Research Farm) SHUATS Naini, Prayagraj, during *kharif* 2021 in Randomized block design with seven treatments *viz*, Imidacloprid 17.8%SL Thiodicarb75%WP,Spinosad 45% SC, Emamectin benzoate 5% SG, Neem oil, *Beauveria bassiana* $1x10^8$ CFU/ml, Thiamethoxam 12.6% + lambda cyhalothrin 9.5 %ZC and untreated control in three replication. Data was taken on fall armyworm population. The larval population of fall armyworm *Spodoptera frugiperda* on three, seven and fourteen days after spraying revealed that the treatment Emamectin benzoate 5% SG (5.15) proved to be the most effective treatment followed by Thiodicarb75%WP (6.44), Thiamethoxam 12.6% + lambda cyhalothrin 9.5 %ZC (7.41), Spinosad 45% SC (8.23), Imidacloprid 17.8%SL (8.79), where as Neem oil 3% (10.24) and *B. bassiana* $1x10^8$ CFU/ml (10.93) was least effective against *Spodoptera frugiperda* pest. The plot treated with Emamectin benzoate 5% SG show highest yield (35.31q/ha), followed by Thiodicarb75%WP (34.21q/ha), Thiamethoxam 12.6% + lambda cyhalothrin 9.5 %ZC (32.58q/ha), Spinosad 45% SC (32.08q/ha), Imidacloprid 17.8%SL (31.21qt/ha), Neem oil 3% (29.63q/ha) and *B.bassiana* $1x10^8$ CFU/ml (28.02), as compared to control plot (22.44q/ha).

Keywords: Benefit-Cost Ratio, Efficacy, Fall of armyworm, Infestation, Maize.

INTRODUCTION

Maize, *Zea mays* L second most cereal crop belongs to Poaceae family. It is one of the most flexible growing crops with greater adaptability to different agro-climatic conditions. Because of higher genetic yield potential among the cereals, this crop is globally known as the "Queen of cereals. Maize kernel is an edible and nutritive part of the crop. The composition of maize kernel contains vitamin C, vitamin E, vitamin K. Potassium is a major nutritional content present which has a good significance because an average human diet is deficient in it **(Kumar and Jhariya, 2013)**.

Recently, the occurrence of a new invasive pest *Spodoptera frugiperda* (J.E. Smith), a lepidopteron pest has been suspected on maize crop in Karnataka **Shylesha *et al*.,(2018**). The pest is native to the tropical and sub-tropical regions of North, and South America, where it has been considered a key pest in maize and several other crops for decades **Smith *et al*.,(1797)**. Fall armyworm was detected for the first time on the African continent in January 2016 in Nigeria, and by 2019 had been reported in almost all of sub-Saharan Africa, as well as Southeast Asia, causing substantial yield. **Divya *et al*.,(2021).** The caterpillar feeds on all stages plant by consuming the foliage and mostly prefers premature corn **Moraes *et al*.,(2015)**. In the event of food depletion and crowding, larvae march out of crop in search of food which gives them name Fall armyworm. The densities of caterpillar reduceds due to their cannibalistic behaviour (**Capinera *et al*., 2008**, **Sisodiya *et al*., 2018)** *S. frugiperda*, is a polyphagous migratory insect pest that is able to cause considerable economic losses in over 80 different crops **Bohnenblust *et al*.,(2014)**. FAW was observed to cause up to 72 %yield loss in maize.

Maize is most vulnerable to fall army worm, *Spodoptera frugiperda*, which causes severe losses to it. Though, application of effective chemicals and botanicals with different mode of action at proper crop stage is significant for its management. The applications of various insecticides with different mode of action strengthen insecticides resistance management strategy. Therefore, keeping in view the above facts the present investigation was carried out with the aim to develop a new management strategy for control of pest at farmer's field economically.

MATERIALS AND METHODS

The experiment was conducted at Central Research Farm (CRF), Department of Entomology, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj (UP) during 2021during *Kharif* season. The experiment was laid out using GA-85 variety of maize. The experiment was sown in Randomized Block Design with three replications consisting of 7 treatments having one absolute control,5 insecticides, neem oil and one entomopathogenic fungi *Beauveria bassiana* were used.Treatments comprising of Imidacloprid17.8%SL (T1), Thiodicarb75%WP (T2), Spinosad 45%SC (T3), Emamectin benzoate5%SG (T4), Neem oil 3% (T5), *Beaveria Bassiana* $1x10^8$ CFU/ml (T6), Thiamethoxam12.6%+Lambdacyhalothrin9.5%ZC (T7). The seed rate of 20 kg / ha was utilized to raise the crop. Plots of size of 2m×2m was made. Sowing was done with 30 cm × 10 cm spacing and applied dose of farm yard manure was 20t/ha and N, P, K is 50 kg, 25kg and 25kg/ha respectively. The population of *Spodoptera frugiperda* was recorded one day before spraying and on 3 rd day, 7 th day and 14th day after insecticidal application and were subjected to statistical analysis. The populations of *S. frugiperda* was recorded on 5 randomly selected and tagged plants from each plot for investigating larval population and cost benefit ratio.

The cost of insecticides and biopesticides used in this experiments was obtained from near by market. The total cost of plant protection consisted of plant protection consisted of cost of treatement,sprayer,rent and labour charges for the spray.There are two sprays throughout the research period and the overall plant protection expenses was calculated.total income was realised by multiplying the total yield per hectare by prevailing market price,while the net benefit is obtained by subtracting the total cost of plant protection from the total income.Benefit over the control for each sprayed treatement was obtained by substracting the income of the control treatment from that of each sprayed treatement.

RESULT AND DISCUSSION

Effect of different insecticides and biopesticides on the incidence of *S.frugiperda* showed that all the treatements were significantly superior in reducing the infestation of fall of armyworm resulting in increasing the yield, significantly as compared to control.The first spray was given after 40 days of planting. The larval population of fall of armyworm on maize after first spray revealed that all the chemical treatements were significantly superior over control. Among all the treatements lowest larval population, was recoreded in Emamectin benzoate 5%SG(6.62) follwed by Thiodicarb 75%WP (7.93), Thiamethoxam 12.6% + lambda cyhalothrin 9.5 %ZC (8.99), Spinosad 45% SC (9.77), Imidacloprid

17.8%SL (10.223). Neem oil 3% (11.15). The treatement *Beaveria Bassiana* 1x10^8 CFU/ml (11.92) was found to be least effective but comparatively superior over the control.

The second spray was applied after 15 days of first spray and larval population was recorded.The data for second spray shows minimum larval population in Emamectin benzoate 5%SG (3.68) follwed by Thiodicarb 75%WP (4.95), Thiamethoxam 12.6% + lambda cyhalothrin 9.5 %ZC (5.84), Spinosad 45% SC (6.706), Imidacloprid 17.8%SL (7.376) and Neem oil 3% (8.95). The treatement *Beaveria Bassiana* 1x108 CFU/ml (9.95) was found to be least effective among all the treatments but comparatively superior over the control.

All the insecticides were found very effective and significantly over control. The data for overall mean larval population was recorded of which least larval population was recorded in Emamectin benzoate 5%SG (5.15), Thiodicarb 75%WP (6.4), Thiamethoxam 12.6% + lambda cyhalothrin 9.5 %ZC (7.41), Spinosad 45% SC(8.23), Imidcloprid17.8%SC (8.7), Neem oil 3% (10.24).The treatement *Beaveria Bassiana* 1x10^8 CFU/ml (10.93) was least effective among all the treatements and control (22.34).

The highest yield and Benefit cost ratio was recorded in Emamectin benzoate5%SG (35.31q/ha) (1:1.80) these results were supported by **Deshmukh *et al*., (2020),** Thiodicarb 75%WP (34.21 q/ha) (1:1.67) these results were supported by **(Thumar *et al*.,2020),** Thiamethoxam 12.6% + lambda cyhalothrin 9.5 %ZC (32.58 q/ha) (1:1.57) these results were supported by **(Mallapur *et al*.,2019),** Spinosad 45% SC (32.08 q/ha) (1:1.56) these results were supported by (**Sangle *et al*.,2020),** Imidacloprid17.8%SC (31.21 q/ha) (1:1.43) these results were supported by **(Kunkel *et al*.,1999),** Neem oil 3% (29.63 q/ha) (1:1.32) these results were supported by **(Tulashie *et al*.,2021).** The treatements *Beaveria Bassiana* 1x10^8 CFU/ml (28.02 q/ha) (1:1.21) these results were supported by**(Wale *et al*.,2022)** and the lowest yield was recorded in control (22.47) (1:0.85).

TABLE 1. Efficacy of *Beauveria bassiana*, Neem oil and selected insecticides on population of fall armyworm *Spodoptera frugiperda* (J.E.Smith) on Maize during *kharif* season of 2021

S.No.	Treatments	Population of *Spodoptera frugiperda*								Yield (q/ha)	B:C ratio
			First spray			Second spray			Overall mean		
		1DBS	3DAS	7DAS	14DAS	3DAS	7DAS	14DAS			
T_1	Imidacloprid 17.8% SL	16.80	11.4^{bcd}	9.20 ^{cd}	10.4^{cd}	9.2 ^{d}	5.6 ^{c}	7.33 ^{bc}	8.79	31.21	1: 1.43
T_2	Thiodicarb 75% WP	17.10	9.33 ^{E}	6.47^{F}	8.0 ^{F}	6.73 ^{F}	3.6 ^{Ef}	4.53 ^{Ef}	6.44	34.21	1: 1.67
T_3	Spinosad 45% SC	16.10	10.8 ^{cd}	8.6 ^{de}	9.6 ^{de}	8.26^{dc}	5.46 ^{cd}	6.4 ^{cd}	8.23	32.08	1 :1.56
T_4	Emamectin benzoate 5%SG	16.60	7.73 ^{f}	5.53 ^{f}	6.6 ^{g}	4.93 ^{g}	2.73 ^{f}	3.4 ^{f}	5.15	35.31	1: 1.80
T_5	Neem oil 3%	17.30	11.9^{bc}	10.2^{bc}	11.33^{bc}	10.5 ^{c}	8.8 ^{b}	7.53^{bc}	10.24	29.63	1: 1.32
T_6	*Beauveria bassiana* 1x10^{8} CFU/ml	13.80	12.46^{b}	10.9 ^{b}	12.46 ^{b}	11.6 ^{b}	9.8 ^{b}	8.4 ^{b}	10.93	28.02	1: 1.21
T_7	Thiamethoxam 12.6%+lambda cyhalothrin 9.5%ZC	19.70	10.30^{de}	7.80 ^{e}	8.86 ^{ef}	7.46 ^{ef}	4.46^{de}	5.6^{de}	7.40	32.58	1:1.57
T_0	Control	21.3	21.6 ^{a}	21.8 ^{a}	22.13 ^{a}	22.53 ^{a}	22.7 ^{a}	23.38 ^{a}	22.34	22.47	1: 0.85
	F-test	NS	S	S	S	S	S	S	S	------	------
	S. Ed (±)	N/A	0.66	0.52	0.59	0.59	0.44	0.53	0.44	------	------
	C.D. (P = 0.5)	-	1.412	1.114	1.256	1.256	0.95	1.13	0.94	------	------

*DBS=Day befors spray ** DAS= Day after spray

CONCLUSION

It may be stated that the synthetic insecticides and botanicals Emamectin benzoate 5%SG .suggested for the management of spodoptera frugiperda on maize crop proved to be most effective and economical. Similarly, the use of Thiodicarb 75%WP ,Thiamethoxam 12.6% + lambda cyhalothrin 9.5 %ZC, Spinosad 45% SC, Imidacloprid 17.8%SL, can also be thought for the management of fall of armyworm .However, the application of Neem oil 3% and *Beauveria bassiana* $1x10^8$ CFU/ml could not exert much encouraging role for fall of armyworm management. These products helps in reducing pollution in the the environment.hence it can be suitably incorporated as treatment from an IPM perspective

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