Original Research Article

Evaluation of *Beauveriabassiana*, Neem oil and selected insecticides on population of fall armyworm *Spodopterafrugiperda* (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,*Beauveriabassiana*1x10^{8} CFU/ml,Thiamethoxam 12.6% + lambda cyhalothrin 9.5 %ZCand untreated control in three replication. Data was taken on fall armywormpopulation. The larval population of fall armyworm*Spodopterafrugiperda* 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 byThiodicarb75%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~~whereasNeem oil 3% (10.24) and *B. bassiana*1x10^{8} CFU/ml(10.93) was least effective against *Spodopterafrugiperda* 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 (31.21q~~t~~/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~~ 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 (reference?). Because of

Comment [CM1]: I think you also evaluatedyield and Benefit cost ratio. The title needs to be revised

Comment [CM2]: The components of an abstract are introduction/background, methods, results, and conclusion. Results followed by methods should be the main emphasis of the abstract.
Objective
Methods
Results
Conclusion

Comment [CM3]: Population or abundance?

Comment [CM4]: The method on how you determined the yield (q/ha) is not defined?

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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 nutritionalcontentpresent 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 *Spodopterafrugiperda* (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 (reference?), 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 **Morales*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 reducedsdue 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, *Spodopterafrugiperda*, 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.

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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~~, 5insecticides, neem oil and oneentomopathogenic fungi *Beauveriabassiana* were used.Treatments comprising ofImidacloprid17.8%SL (T1), Thiodicarb75%WP(T2), Spinosad 45%SC(T3), Emamectin benzoate5%SG(T4), Neem oil3% (T5), *BeaveriaBassiana*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~~ were 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 *Spodopterafrugiperda*was recorded one day before spraying and on 3 rd day, 7 th day and 14th day after insecticidal applicationand 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~~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

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Comment [CM10]: Is it population or abundance?

Comment [CM11]: Does the harvest take place after the 14th day?
How can you explain that the highest yields are related to low abundance of caterpillars when you have stopped at day 14?
In the cycle of the corn, other infestations of Spodoptera can occur and cause damage?

Comment [CM12]: What kind of analysis?

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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*BeaveriaBassiana*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 inEmamectin 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*BeaveriaBassiana* 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*BeaveriaBassiana* 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 (32.58q/ha) (1:1.57) these results were supported by (**Mallapur *et al.*,(2019),**Spinosad 45% SC (32.08q/ha) (1:1.56) these results were supported by (**Sangle*et al.*,(2020),**Imidacloprid17.8%SC (31.21q/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*BeaveriaBassiana* 1x10^8 CFU/ml (28.02q/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).

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TABLE1.Efficacyof*Beauveriabassiana*, Neem oil and selected insecticides on population of fall armyworm *Spodopterafrugiperda* (J.E.Smith) on Maize during *kharif*season of2021

S.No.	Treatments	~~Population~~Abundance of *Spodopterafrugiperda larvae*							Overall mean	Yield(q/ha)	B:C ratio
			Firstspray			Secondspray					
		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	*Beauveriabassiana*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 beforsspray ** DAS= Day after spray S.No?B:C?

Comment [CM14]: 1. I see that there are 03 results depending on the treatments.
-One result on Spodoptera infestations
-A result on the yields
-The cost of insecticides and biopesticides
2. So you should have 03 objectives
-a comparison of the level of Spodoptera infestation according to the treatments
-a comparison of the yield (t/ha)
- a comparison of the cost of insecticides and biopesticides
3. For each objective you need to define the methodology adopted as well as the statistical analyses performed (I believe an Analysis of Variance (ANOVA) should be done
4. Discussion: the two results should be discussed

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Comment [CM16]: When observing the T0 treatment (Control) we notice that the infestation is low, less than 25 larvae. In this case, even if we do not use insecticides, the damage will not be so serious. With such a low number of larvae, can we conclude that the other treatments have an effect?

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CONCLUSION

It may be stated that the synthetic insecticides and botanicals Emamectin benzoate 5%SG .suggested for the management of ~~*spodoptera*~~ *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 *Beauveriabassiana* $1x10^8$ CFU/ml could not exert much encouraging role for fall of armyworm management. These products helps in reducing pollution in the theenvironment.hence it can be suitably incorporated as treatment from an IPM perspective

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