International Journal of Plant & Soil Science

34(23): 304-308, 2022; Article no.IJPSS.91802
ISSN: 2320-7035

Evaluation of Beauveria Bassiana, Neem Oil and Selected Insecticides on Population of Fall Armyworm *Spodoptera frugiperda* (J. E. Smith) on Maize (*Zea mays* L.)

Rakesh Girishgouda Patil [a#*] and Anoorag R. Tayde [a¥]

[a] Department of Entomology, Faculty of Agriculture, Naini Agriculture Institute Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj-211007, Uttar Pradesh, India.

Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

Article Information

DOI: 10.9734/IJPSS/2022/v34i2331594

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/91802

Original Research Article

Received 18 June 2022
Accepted 22 September 2022
Published 30 September 2022

ABSTRACT

A field trail was conducted at Crop Research Farm (CRF) 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 were taken on fall armyworm population. The larval population of fall armyworm *Spodoptera frugiperda* (J.E.Smith) 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), whereas Neem oil 3% (10.24) and *B. bassiana* 1x10^8 CFU/ml (10.93) were of least effective against *Spodoptera frugiperda*. Plot treated with Emamectin benzoate 5% SG showed 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 (22.44q/ha).

[#] *M.Sc. Scholar;*
[¥] *Assistant Professor;*
**Corresponding author: E-mail: patilrakeshgpatil@gmail.com;*

Keywords: Benefit-cost ratio; efficacy; fall armyworm; infestation; maize.

1. INTRODUCTION

Maize (*Zea mays* L.) is the 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 [1].

Recently, the occurrence of a new invasive pest *Spodoptera frugiperda* (J.E. Smith), a lepidopteron insect has been suspected on maize crop in Karnataka [2]. The insect 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. Fall armyworm was detected for the first time on the African continent during 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 [3]. The caterpillar feeds on all plant stages by consuming the foliage and mostly prefers premature corn [4]. 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 reduceded due to their cannibalistic behaviour [5,6] *S. frugiperda*, is a polyphagous migratory insect that is able to cause considerable economic losses in over 80 different crops [7]. FAW was observed to cause up to 72 %yield loss in maize.

Maize is most vulnerable to fall army worm, *S. 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 a forementioned facts, the present investigation was carried out with the aim to develop a new management strategy for control of *S. frugiperda* at farmer's field economically.

2. 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 maize cultivars. The experiment was sown in Randomized Block Design with three replications consisting of 7 treatments having one absolute control. Five 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), *B.Bassiana.*

$1x10^8$ CFU/ml (T6), Thiamethoxam 12.6%+ Lambdacyhalothrin9.5%ZC (T7). The seed rate of 30kg / ha was utilized to cultivate the crop. Plots of size of (2×2m) was made. Sowing was done with 60 cm × 20 cm spacing and applied dose of farm yard manure was 20t/ha and N, P, K were 90, 60 and 60kg/ha respectively. The population of *Spodoptera frugiperda* (J.E.Smith) was recorded one day before spraying and on 3 rd, 7 th and 14th day after insecticidal application. The obtained data 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 biocides used in these experiments was obtained from nearby 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 were 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.

Table 1. Efficacy of *Beauveria bassiana*, Neem oil and selected insecticides on population of fall armyworm *Spodoptera frugiperda* on maize during Kharif season of 2021

S. No.	Treatments	Population of *S. frugiperda*								Yield (q/ha)	B:C ratio
		First spray				Second spray			Overall mean		
		1DBS	3DAS	7DAS	14DAS	3DAS	7DAS	14DAS			
T1	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
T2	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
T3	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
T4	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
T5	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
T6	*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
T0	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 * B:C = Benefit cost ratio*

3. RESULTS AND DISCUSSION

Effect of different insecticides and biocides on the incidence of *S. frugiperda* (J.E.Smith) 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 treatments were significantly superior over control. Among all the treatments lowest larval population, was recorded in Emamectin benzoate 5%SG (6.62) followed 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 treatment with *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 after first spray and larval population was recorded.The data for second spray showed minimum larval population in Emamectin benzoate 5%SG (3.68) followed 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 treatment with *B.bassiana* $1x10^8$ 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 were 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 treatment with *B. bassiana* $1x10^8$ CFU/ml (10.93) was least effective among all the treatments and control (22.34).

The highest yield and benefit cost ratio due to controlling army worm was recorded by Emamectin benzoate5%SG (35.31q/ha) (1:1.80) these results were supported by Deshmukh *et al*., [8], Thiodicarb 75%WP (34.21 q/ha) (1:1.67) these results were supported by [9], Thiamethoxam 12.6% + lambda cyhalothrin 9.5% ZC (32.58 q/ha) (1:1.57) these results were supported by [10], Spinosad 45% SC (32.08 q/ha) (1:1.56) these results were supported by [11], 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 are in accordance with the obtained data by Kunkel et al.(1999) ; Mallapur et al. [10]; Deshmukh et al. [8]; Sangle et al. [11] and Thumar et al*.* [9]. On the other hand, the treatment with *B. bassiana* $1x10^8$ CFU/ml (28.02 q/ha) (1:1.21) was the lowest efficient one in this regard followed by Neem oil 3% (29.63 q/ha) (1:1.32). These results are supported by the obtained results by Wale et al. [12] and Tulashie et al. [13]. Control treatment yielded poor yield (22.47 q/ha) and (1:0.85).

4. CONCLUSION

It may be stated that the synthetic insecticides and the botanical Emamectin benzoate 5%SG could be suggested for the management of *Spodoptera frugiperda* [14] on maize plants, which 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 armyworm .However, the application of Neem oil 3% and *B. bassiana* $1x10^8$ CFU/ml could not exert much encouraging role for fall armyworm management. These products help in reducing pollution in the environment, hence they can be suitably incorporated as treatment from an IPM perspective.

ACKNOWLEDGEMENT

The authors are grateful to Prof. (Dr.) Rajendra B. Lal Hon'ble Vice Chancellor SHUATS, Prof. Dr. Shailesh Marker, Director of research, Dr. Deepak Lal, Dean of PG studies, Dr. Gautam Gosh, Dean, Naini Agricultural Institute and Dr. Ashwani kumar, Head, Department of Entomology, Sam Higginbottom University of Agriculture Technology And Sciences, for taking their keen interest and encouragement to carry out this research work.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Kumar D, Jhariya AN. Nutritional, medicinal and economical importance of corn: A mini review. Research Journal of Pharmaceutical Sciences. 2013;2(7):1-6.

2. Shylesha AN, Jalali SK, Gupta, Ankita, Varshney, Richa, Venkatesan T, Shetty P, Raghavendra A. Studies on new invasive pest *Spodoptera frugiperda* (JE Smith)(Lepidoptera: Noctuidae) and its natural enemies. Journal of Biological Control. 2018;32(3):1-7.
3. Divya J, Kalleshwaraswamy CM, Deshmukh S, Ambarish S, Sunil C. Evaluation of whorl application of insecticides mixed with sand against fall army worm *Spodoptera frugiperda* in maize. Indian Journal of Entomology. 2021;1-5.
4. Moraes AR, Lourencao AL, Paterniani Meag Z. Resistance of conventional and isogenic transgenic maize hybrids to *Spodoptera frugiperda* (Lepidoptera: Noctuidae). Bragantia. 2015;74:50-57.
5. Capinera J. Fall armyworm, *Spodoptera frugiperda* (J.E.Smith) (lepidoptera: noctuidae). Encyclopedia of Entomology. 2008;1409-1412.
6. Sisodiya DB, Raghunandan BL, Bhatt NA, Verma HS, Shewale CP, Timbadiya BG, Borad PK. The fall armyworm, *Spodoptera frugiperda* (JE Smith)(Lepidoptera: Noctuidae); first report of new invasive pest in maize fields of Gujarat, India. Journal of Entomology and Zoology Studies. 2018;6(5):2089-2091.
7. Bohnenblust EW, Breining JA, Shaffer JA, Fleischer SJ, Roth GW, Tooker JF. Current European corn borer, *Ostrinia nubilalis*, injury levels in the Northeastern United States and the value of Bt field corn. Pest Management Science. 2014;70(11):1711-1719.
8. Deshmukh S, Pavithra HB, Kalleshwaraswamy CM, Shivanna BK, Maruthi MS, Mota-Sanchez D. Field efficacy of insecticides for management of invasive fall armyworm, *Spodoptera frugiperda* (JE Smith) (Lepidoptera: Noctuidae) on maize in India. Florida Entomologist. 2020;103(2):221-227.
9. Thumar RK, Zala MB, Varma HS, Dhobi CB, Patel BN, Patel MB, Borad PK. Evaluation of insecticides against fall armyworm, *Spodoptera frugiperda* (JE Smith) infesting maize. International Journal of Chemical Studies. 2020;8(4):100-104.
10. Mallapur CP, Naik AK, Hagari S, Praveen T, Naik M. Laboratory and field evaluation of new insecticide molecules against fall armyworm, *Spodoptera frugiperda* (JE Smith) on maize. Journal of Entomology and Zoology Studies. 2019;7(4):869-875.
11. Sangle SV, Jayewar NE, Kadam DR. Efficacy of insecticides on larval population of fall armyworm, *Spodoptera frugiperda* on maize. Journal of Entomology and Zoology Studies. 2020;8(6):1831-1834.
12. Wale SD, Mahadik SS, Hole UB. Biointensive management of fall armyworm, *Spodoptera frugiperda* infesting maize. Annals of Plant Protection Sciences. 2022;30(1):73-77.
13. Tulashie SK, Adjei F, Abraham J, Addo E. Potential of neem extracts as natural insecticide against fall armyworm (*Spodoptera frugiperda* (J.E Smith) (Lepidoptera: Noctuidae). Case Studies in Chemical and Environmental Engineering. 2021;4:1-7.
14. Smith JE. First record of the fall armyworm, *Spodoptera frugiperda* (Lepidoptera: Noctuidae). African Entomology. 1797;26(1):244-246.

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/91802