Journal of Experimental Agriculture International

Volume 46, Issue 6, Page 7-12, 2024; Article no.JEAI.115712
ISSN: 2457-0591
(Past name: American Journal of Experimental Agriculture, Past ISSN: 2231-0606)

Evaluation of Integrated Pest Management Technologies against Fall Armyworm in Maize

M. Swathi [a*], K. Lakshmana [a] and K. Tejeswara Rao [a]

[a] ANGRAU - District Agricultural Advisory and Transfer of Technology Centre, Vizianagaram, Andhra Pradesh, 535001, India.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/JEAI/2024/v46i62451

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/115712

Original Research Article

Received: 10/02/2024
Accepted: 16/04/2024
Published: 20/04/2024

ABSTRACT

The evaluation of integrated pest management technologies against fall armyworm in maize was conducted by District Agricultural Advisory and Transfer of Technology Centre (DAATTC), Vizianagaram in five farmer's field during 2019-20, 2020-21 and 2021-22. The results revealed that the pest incidence was lower in IPM module compared to the historically adopted farmer's practices, featuring here as a control. The increase in yield of 6.78% was observed in IPM demonstration (8503 kg/ha) compared to the control (7963 kg/ha). The net returns of Rs. 10,3214.00/ha and Rs. 91,145.00/ha were obtained in the IPM and control, respectively. The extension gap, technology gap and technology index were 747 kg/ha, 540 kg/ha and 8.07%, respectively. The lower technology index indicates that the technology implementation is feasible providing better education and popularization of the new programs thus reducing the gap between extension programs and new technologies.

**Corresponding author: E-mail: mogallapuswathi@gmail.com;*

Keywords: Fall armyworm; maize; technology gap; extension gap; technology index.

1. INTRODUCTION

Maize (*Zea mays* L.) is one of the most versatile crops having wider adaptability under varied agro-climatic conditions and cultivated throughout the year. It is the third most important staple food crop after rice and wheat. The productivity of maize is challenged by various biotic and abiotic factors. It acts as host for approximately 141 insect pests [1]. Recently, the invasive pest Fall armyworm (FAW) [*Spodoptera frugiperda* (J. E. Smith)] has become a great threat to cereal production in the world [2].

The pest is native to tropical and subtropical regions of the United States of America and it was spread to 47 African countries and 13 Asian countries because of its high migratory capacity *i.e.,* up to 100 km per night [3,4]. In India, it was first noticed on maize in Karnataka during May, 2018 [5] later, it was spread to Andhra Pradesh, Madhya Pradesh, Maharashtra, Tamil Nadu and Telangana [6]. It is a polyphagous pest and has a wide host range of 186 plant species including many economically important crops such as maize, sorghum, sugarcane, rice, wheat, cowpea, groundnut, potato, soybean, cotton, *etc.* belonging to 42 different families [7].

In the case of maize, FAW damages the crop from seedling to physiological maturity stage. The young larvae consume leaf tissue from one side initially by leaving the opposite epidermal layer intact giving a peculiar 'windowpane display' [8]. It causes skeletonization of leaves and heavily windowed whorls loaded with larval frass. It could also bore into the maize stem and cobs [9]. Reported yield losses are up to 34% [10], 57.6 to 58% p [11,12] and. in some tropical areas yield losses can reach up to 100 % [13].

As the FAW has recently been introduced into India the management of this pest is difficult due to the lack of awareness for the management practices and its natural enemies. The pest has caused severe losses to the maize in Vizianagaram district of Andhra Pradesh. Hence, the present study was conducted to determine the efficacy of IPM technologies for the FAW management.

2. MATERIALS AND METHODS

The present study was conducted by the District Agricultural Advisory and Transfer of Technology Centre, Vizianagaram in five farmer's field during *rabi,* 2019-20, 2020-21 and 2021-22.The treatments within IPM practices were seed treatment with cyantraniliprole 19.8 + thiamethoxam 19.8 FS @ 6 ml/kg, spraying with azadirachtin 1500 ppm (Neem 1500) @ 5ml/L at 20 DAS, spraying with *Metarhizium anisopliae* @ 5g/L at 30-35 DAS, and spraying emamectin benzoate 5SG (Proclaim) @ 0.4g/L at 45-50 DAS whereas treatment in control fields consisted of following insecticide applications: chlorpyriphos 20 EC@2.5ml/L, profenophos 50EC @ 2ml/L etc. The treatment efficacy data were collected from 20 plants in both, the IPM demonstration fields and control blocks by registering the number of FAW indicating the level of infestation from seedling to crop maturity at 15-days interval. The yield data was collected in both the IPM and control fields. The extension gap, technology gap and technology index were worked out by using the following formula [14,15].

Technology gap (kg ha^{-1}) = Potential yield (kg ha^{-1}) – Demonstration yield (kg ha^{-1})

Extension gap (Kg ha^{-1}) = Demonstration yield (Kg ha^{-1}) – Control (Farmer's) yield (Kg ha^{-1})

Technology index (%) = (Potential yield (Kg ha^{-1})–Demonstration yield (Kg ha^{1})) X 100 / Potential yield (Kg ha^{-1})

3. RESULTS AND DISCUSSION

Our findings indicate that it is essential to have an improved set of recommendations for effective FAW management in maize. The incidence of pest was low in the IPM plots compared to the control. (Table 1). The plant infestation caused by fall armyworm was 9.92% in the IPM plot, and 20.95% in the control block. The low incidence of pest in the IPM plot could be attributed to regular monitoring and prophylactic applications of azadiractin at the rate of 1500ppm which acted as a strong oviposition deterrent & repellent against FAW adults and antifeedant for larvae of FAW. The prophylactic spraying of entomopathogenic fungicide like *Metarhizium anisopliae* @ 5g/L and chemical insecticide like emamectin benzoate 5SG @ 0.4g/L were effective in the management of larvae. Similar findings were observed by Geetha [16], Reddy et al., [17], and Narayanamma et al. [18].

Table 1. Incidence of fall armyworm on maize during *rabi*, 2019-20, 2020-21 and 2021-22

S. No.	Year	Plant infestation (%)	
		IPM	Farmers' practice
1	2019-20	11.5	23.75
2	2020-21	8.75	18.50
3	2021-22	9.50	20.60
Mean		9.92	20.95

Table 2. Effect of IPM of fall armyworm on yield and economics of maize during *rabi*, 2019-20, 2020-21 and 2021-22

S. No.	Year	Yield (kg/ha)			Gross returns (Rs./ha)		Cost of cultivation (Rs./ha)		Net returns (Rs./ha)		Benefit cost ratio	
		IPM	Farmers' practice	Increase in yield (%)	IPM	Farmers' practice	IPM	Farmers' practice	IPM	Farmers' practice	IPM	Farmers' practice
1	2019-20	8513	7965	6.88	149836	140191	47752	48995	102084	91196	3.14:1	2.86:1
2	2020-21	8481	7882	7.60	149262	138716	49753	52150	99509	86566	3.00:1	2.66:1
3	2021-22	8516	8043	5.88	159255	150398	51206	54724	108049	95674	3.11:1	2.75:1
Mean		8503	7963	6.78	152784	143102	49570	51956	103214	91145	3.08:1	2.75:1

Table 3. Technology gap, extension gap and technology index of IPM of fall armyworm in maize during *rabi*, 2019-20, 2020-21 and 2021-22

S. No.	Year	Yield (kg/ha)			Technology gap (kg/ha)	Extension gap (kg/ha)	Technology index (%)
		Potential	IPM	Farmers' practice			
1	2019-20	9250	8513	7965	737	548	7.97
2	2020-21	9250	8481	7882	769	599	8.31
3	2021-22	9250	8516	8043	734	473	7.94
Mean		9250	8503	7963	747	540	8.07

3.1 Yield and Gap Analysis

The IPM technology had an impact on the incidence of FAW and yield of maize (Table 2). The yield obtained in the IPM managed field (8,503 kg/ha) was 6.78% higher than in the control field (7,963 kg/ha). The net returns of Rs. 103,214.00/ha were obtained from the IPM managed fields, versus Rs. 91,145.00/ha from the control. The highest benefit cost ratio of 3.08:1 was recorded in the IPM managed fields compared to the 2.75:1 obtained from the control. The increased yield and net returns in the IPM module demonstration plot is due to the timely implementation of protection measures against FAW.The results are in concurrence with the findings of Rajashekhar et al. [19] and Kavyashree et al. [20].

The extension gap, technology gap and technology index observed in the present study were 747 kg/ha, 540 kg/ha and 8.07 respectively, (Table 3). The extension gap and technology gap were higher. This study indicates that more efforts are needed to convince farmers to adopt IPM practices as more efficient production management approach resulting in reduction in pest damage, cost of production, and improved produce quality. The technology index of 8.07% showed the feasibility of technology adaptation and implementation at farmer's fields. The findings are in line with Ramadevi et al. [21] and Reddy et al. [17].

4. CONCLUSION

The fall armyworm is one of the devastating pests in maize. It infests the crop from seedling to cob maturity and causes significant yield loss. The results obtained in the present trial on evaluation of IPM management approaches against fall armyworm in maize revealed that this technology provides superior results in the FAW population managemnt and as such, it is feasible for adaptation and implementation in farmer's fields. The FAW pest incidence was low in the IPM managed fields resulting in the 6.78% higher yield compared to the yield obtained in the control field managed in a traditional manner. However, the extension gap and technology gap were higher. There is an urgent need to create awareness among farmers about the effectiveness of the IPM program and benefits of the program implementation for better FAW management in maize. That could be achieved through the services of extension personnel to improve the maize yield and quality, and to reduce the extension and technology gap in the Vizianagaram district of Andhra Pradesh.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Reddy YVR, Trivedi S. Maize production technology. Academic Press. 2008;190-192.
2. Day R, Abrahams P, Bateman M, Beale T, Clottey V, Cock M, Yelitza C, Natalia C, Early R, Godwin J, Gomez J, Moreno PG, Murphy ST, Mensah BO, Phiri N, Pratt C, Silvestri S, Witt A. Fall armyworm: Impacts and implications for Africa. Outlook on Pest Management. 2017;28(5): 196-201.
3. Nagoshi RN, Fleischer S, Meagher RL, Hay-Roe M, Khan A, Murua MG, Silvie P, Vergara C, Westbrook J. Fall armyworm migration across the lesser antilles and the potential for genetic exchanges between North and South American populations. Plos One. 2017;12:1-18.

4. Prasanna BM, Huesing JE, Eddy R, Peschke VM. Fall armyworm in Africa: A guide for integrated pest management. International maize and wheat improvement center (CIMMYT), Mexico. 2018;2.
5. Sharanabasappa, Kalleshwaraswamy CM, Asokan R, Swamy MHM, Maruthi MS, Pavithra HB, Hedge K, Navi S, Prabhu ST, Goergen G. First report of the fall armyworm, *Spodoptera frugiperda* (J. E. Smith) (Lepidoptera: Noctuidae), an alien invasive pest on maize in India. Pest Management in Horticultural Ecosystems. 2018;24(1):23-29.
6. Swamy HM, Asokan R, Kalleshwaraswamy CM, Sharanabasappa, Prasad YG, Maruthi MS, Shashank PR. Prevalence of "r" strain and molecular diversity of fall armyworm *Spodoptera frugiperda* (J.E. Smith) (Lepidoptera: Noctuidae) in India. Indian Journal of Entomology. 2018;80(3):544-553.
7. Casmuz A, Juarez ML, Socias MG, Murua MG, Prieto S, Medina S. Review of the host plants of fall armyworm, *Spodoptera frugiperda* (Lepidoptera: Noctuidae). Revista de la Sociedade Entomologica Argentina. 2010;69(3&4): 209-231.
8. Sonali Deole, Nandita Paul. First report of fall army worm, *Spodoptera frugiperda* (J.E. Smith), their nature of damage and biology on maize crop at Raipur, Chhattisgarh. Journal of Entomology and Zoology Studies. 2018;6(6):219-221.
9. Dhar T, Bhattacharya S, Chatterjee H, Senapati SK, Bhattacharya PM, Poddar P. Occurrence of fall armyworm, *Spodoptera frugiperda* (J.E. Smith) (*Lepidoptera: noctuidae*) on maize in West Bengal, India and its field life table studies. Journal of Entomology and Zoology Studies. 2019; 7(4):869-875.
10. Williams WP, Davis FM. Response of corn to artificial infestation with fall armyworm and South Western corn borer larvae. South Western Entomology. 1990;15:163-166.
11. Cruz I. Impact of fall armyworm, *Spodoptera frugiperda* (Smith and Abott, 1797) on grain yield in field corn. *MS Thesis*. Purdue University, West Lafayette, Indiana, US. 1996; 162.
12. Chimweta M, Nyakudya IW, Jimu L, Mashingaidze AB. Fall armyworm, *Spodoptera frugiperda* (J.E. Smith) damage in maize: Management options for flood-recession cropping small holder farmers. International Journal of Pest Management. 2019;66(2):142-154.
13. Blanco CA, Chiaravalle W, Dalla-Rizza M, Farias JR, García- Degano MF, Gastaminza G, Mota-Sánchez D, Murúa MG, Omoto C, Pieralisi BK. Current situation of pests targeted by *Bt*crops in Latin America. Current Opinion in Insect Science. 2016;15:131-138.
14. Samui SK, Maitra S, Roy DK, Mondal AK, Saha D. Evaluation of front line demonstration on groundnut (*Arachis hypoggaea*L.) in Sundarbans. Journal of the Indian Society of Coastal Agricultural Research. 2000;18(2):180-183.
15. Swathi M, Lakshmana K, Rao KT. Evaluation of integrated pest management module for pink bollworm in cotton. Progressive Research – An International Journal. 2020;15:522-523.
16. Geetha B. Evaluation of IPM technologies for the management of fall armyworm, *Spodoptera frugiperda* J E Smith on maize in Tamil Nadu. Indian Journal of Plant Protection. 2021;49(1):05-08.
17. Reddy BKK, Jyothi VJ, Sadhineni M, Johnson M, Swamy GN. Evaluation of IPM Modules against Fall Armyworm in Maize through Frontline Demonstration and Its Economic Impact. International Journal of Environment and Climate Change. 2023; 13(1):24-29.
18. Narayanamma VL, Ratnakar V, Prasad MR, Shiva B, Vishwatej R, Veeranna G, Reddy RU. Assessment of integrated pest management modules against fall army worm and its economic impact in maize. International Journal of Environment and Climate Change. 2023;163(10):2842-2848.
19. Rajashekhar M, Prabhakar Reddy T, Chandrashekara KM, Rajashekar B, Jagan Mohan Reddy M, Ramakrishna K. Evaluation of integrated pest management module for pink bollworm, *Pectinophoragossypiella* (Saunders) and its economic analysis under farmer's field conditions. Int. J. Pest Manag. 2022; 68(3): 1-9.
20. Kavyashree BA, Basappa S, Deshmukh S, Kalleshwaraswamy CM. Sridhar S. Evaluation of ipm modules against the fall army worm*Spodoptera frugiperda* (J E

Smith) on maize. Indian Journal of Entomology. 2023;1-4. DOI:10.55446/IJE.2023.506

21. Ramadevi A, Kumar YP, Charan GS, Raghuveer M, Kumar MS, Poshadri A, Reddy RU. Impact of extension activities on pink bollworm management in Bt cotton in tribal areas of Adilabad district. Journal of Entomology and Zoology Studies. 2020; 8(3):16836-1687.

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/115712