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Impact of Integrated Pest Management Practices on fall armyworm (*Spodoptera frugiperda*) in maize through Extension approaches

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ABSTRACT

The present demonstrations were conducted to convince maize growers on the integrated approaches for management of fall armyworm in maize and its economic impact. It was implemented successively in the operational area of ICAR- Krishi Vigyan Kendra, Adilabad (Telangana state) for three consecutive years during 2019-20 to 2021-2022 *rabi* seasons starting from early vegetative stage. By adopting the timely management practices for fall army worm provided average additional yield of 6.88 q ha^{-1} over non-IPM practices. IPM technologies demonstrated reflected an improved benefit cost ratio of 2.85:1 with 40 Percent reduction in sprays over farmers practice with B:C ratio of 2.22:1. Hence, demonstrations in the farmer fields play a vital role in dissemination of technology on community basis and to be popularized to minimize the extension gap.

Key words: *Fall armyworm, Demonstrations, IPM, B:C, Management.*

Introduction

Maize is the third most important cereal crop grown in India after rice and wheat. Various biotic and abiotic factors effect production and productivity in the maize growing areas in India. The fall armyworm (FAW), *Spodoptera frugiperda* (J.E. Smith) (Lepidoptera: Noctuidae) is a pest native to the Americas (FAO, 2017). In 2016, it was reported in Africa causing economic losses in maize crop (Goergen *et al*., 2016). In 2018, it was first reported in India on maize in Shivamogga district of Karnataka (Ganiger *et al*., 2018). In Adilabad district, it has become major problem. Fall armyworm (*Spodoptera frugiperda*), is a voracious pest and its life cycle ranges from 32 to 46 days (Sharanabasappa *et al*., 2018). Its female moth lays eggs on leaves and after hatching early instars scrape the young leaves causing papery patches and white elongated patches. Later instars feed on leaves and cause irregular holes and cutting down leaves because of voracious feeding and leaves faecal pellets in whorls during vegetative, tasseling and cob formation stages causing yield losses (Navik *et al*., 2021). The damage to maize crops during July 2018 to February 2019 varied between 20% and 80% (Sharanabasappa *et al.*, 2018). It is highly migratory in nature, high fecundity and voracious feeding behaviour without diapauses, make it as destructive insect-pests of crops.

Lack of awareness on fall armyworm identification and integrated approaches for its management leading maize growers to increase the number of

pesticide sprays resulting in increased cost on plant protection sprays. Keeping this in view, Krishi Vigyan Kendra, Adilabad (Telangana state) initiated on farm assessment of fall armyworm management in maize and other extension activities were planned and implemented successively in the operational area of KVK covering the district to provide knowledge on various management practices against pest with easily available critical inputs which will be helpful in minimizing cost on chemical sprays.

Materials and Methods

To combat the problem of fall armyworm in maize, KVK, Adilabad scientists demonstrated the maize farmers to follow key IPM practices in farmers field for three consecutive years during 2019-20 to 2021-2022 starting from early vegetative stage and created awareness on stage wise pest control by cultural, biological, mechanical and chemical control methods as they are very much essential for curbing fall armyworm infestation.

All the 15 practicing farmers were trained on various aspects of maize production and protection technologies and provided with all the critical inputs *viz*. pheromone traps, lures, neem oil. The proper method, time of traps installation, height adjust as per crop height and change of lures in the traps was demonstrated to the farmers at their fields and right time of application of plant protection chemicals based on ETL level of pest, larval stage and severity of incidence.

In IPM plots, erected Pheromone traps (FAW) @ 4 /ac within one week after sowing followed by spraying Azadirachtin 10000ppm @ 1ml/l at 8 to 10 days after crop emergence. First spray with Emamectin benzoate 5%SG @ 0.4g/l or Spinosad 45%SC 0.4 ml/l at 15-30 DAE when 10-20% plant damage noticed. Second spray with Chlorantraniliprole 18.5 SC @ 0.3 ml/l or Spinetoram 11.7 SC@ 0.3 ml/l one week after previous spray. Recommended application of *Bt* @ 2ml/l or *Metarhizium anisopliae* @ 5 ml/l at > 60 DAE and advised applications against tassels / cobs during this stage. The pest population, infestation levels and stage of crop was considered to intervene the pest management components in the IPM field. Farmers, on the other hand, were allowed to continue with their conventional techniques in the other field.

In the present study, observations on the infestation level of pest, trap catches, data on gaps between the potential yield, demonstration yield, extension gap, technology index, quantity of insecticides used, and reduction in cost of plant protection were collected from IPM technology demonstrated plots and check plots of maize for analysis and interpretation.

Results and Discussion

Early vegetative stage is very feasible to FAW infestation, from this period suggested the farmer to collect and destroy the FAW egg masses as it is one of the best cultural approach to reduce pest incidence before larvae hatches out. To monitor the early incidence of FAW in the field advised erection of pheromone traps within one week after sowing @ 4 /acre to trap the male moths in early stages followed by increasing pheromone traps number to 8/ac for mass trapping of adult moths. Suggested Spray application of azadirachtin 10000 ppm @ 1ml/l water at 10 days after seedlings emergence as it acts as feeding and oviposition deterrent, and growth regulator by preventing larvae from developing into adults. Conducted field visit when crop is at 30 days and suggested to spray emamectin benzoate 0.4g/l water directing towards maize whorl as the larva resides inside for feeding. At late whorl stage, spraying of chlorantraniliprole 0.4 ml/l water in the maize whorls managed the pest incidence below ETL. Regularly monitored the presence of fall armyworm through the installed pheromone traps and noticed adult catches in the range of 12-15 number/trap.

As noticed in Table 1, the average yield noticed was 80.25, 69.1 and 78.45 q ha^{-1} in demonstration plots which reflected an increased yield in the range of 7.76% - 11.67 % while in farmer's practices it was 72.5, 64.4 and 70.25 q ha^{-1} during the years 2019-20, 2020-21 and 2021-22, respectively. Data indicated that by adopting the timely management practices

Table 1. Year wise yield details and performance of IPM and farmer Practices

Year	Yield (q ha^{-1})		Additional yield over FP (q ha^{-1})	Increased yield Over FP (%)
	IPM	FP		
2019-20	80.25	72.5	7.75	9.65%
2020-21	69.1	64.4	4.7	7.76%
2021-22	78.45	70.25	8.2	11.67%
Average	75.93	69.05	6.88	9.69

for fall armyworm from early stage of sowing provided average additional yield of 6.88 q ha^{-1} over non-IPM practices.

Data from the Table 2 revealed that, the adoption of right technology in demonstrations decreased the cost of cultivation and increased net returns over the farmer's practice during three years. The cost of production of maize under demonstration from 2019-20 to 2021-22 varied from Rs. 38,739 – 46,250 ha^{-1} with an average of Rs. 43,465 ha^{-1} as against farmers practice cost incurred for production ranged from 45,484 -53,817 ha^{-1} with an average 50,767 (Table 2). The additional cost increased in the demonstration was mainly due to more cost involved in pesticide sprays. These results are following the findings of Reddy *et al.* (2023). Integrated approaches gave good net returns of Rs. 45555, 89682 and 101296 ha^{-1} during 2019-20, 2020-21 and 2021-22, respectively with an average net return of 78844 ha^{-1} which was lower in farmer's practices (60979 ha^{-1}). IPM technologies demonstrated reflected an improved benefit cost ratio of 2.85:1 whereas in farmers practice it was 2.22:1. Raju *et al.* (2015) also showed an increase in productivity in pigeonpea due to the adoption of improved technology by the farmers through front line demonstrations in the farmer's field.

To know the effectiveness of technology, economics of IPM components were worked out (Table 3) and noticed that the additional income due to increased yield was Rs. 13640, 8695 and 15334 ha^{-1}, respectively with cost saving on plant protection inputs of Rs. 6750, 6745 and 8411 ha^{-1} during 2019-20, 2020-21 and 2021-22, respectively. Thus, net income gained due pest management measures on an average for three years was Rs. 19876 $ha^{-1.}$

The data (Table 4) on number of sprays for management of fall armyworm showed 40 Percent reduction in sprays over farmers practice and hence the results enabled to conclude that the IPM technology reduced chemical load in environment considerably and was found as feasible technology.

In demonstrated field, plant infestation was 36.7% before application of treatments and later after adoption of IPM strategies reduced plant infestation to 15.6 % with 46.94% reduction over control (Table 5). while, in conventional fields 38.9% plant infestation before insecticidal sprays and after 5 number sprayings reduced to 29.4% infestation. This might be due to Pheromone traps were not in-

Table 4. Details of insecticidal sprays in IPM and farmers practice

Practice	Number of sprays (No.)	Percent reduction in sprays over FP (%)	Extension gap
IPM	3	40	-2
FP	5		

Table 2. Economic Analysis of Demonstrations on fall Armyworm Management in Maize

Year	Cost of cultivation (Rs ha^{-1})		Gross Return (Rs ha^{-1})		Net Return (Rs ha^{-1})		B:C Ratio	
	IPM	FP	IPM	FP	IPM	FP	IPM	FP
2019-20	46250	53000	91805	84700	45555	31700	1.98:1	1.60:1
2020-21	38739	45484	128421	119171	89682	73687	3.32:1	2.63:1
2021-22	45406	53817	146702	131368	101296	77551	3.24:1	2.44:1
Average	43465	50767	122309	111746	78844	60979	2.85:1	2.22:1

Table 3. Economics of IPM practices for management of fall armyworm in maize

Year	Increased yield (Extn.Gap) over FP (q ha^{-1})	Average price (Rs. q^{-1})	Additional income due to increased yield (Rs. ha^{-1})	Amount saved on plant protection chemicals over FP (Rs. ha^{-1})	Net income gained (Rs. ha^{-1})
2019-20	7.75	1760	13640	6750	20390
2020-21	4.7	1850	8695	6745	15440
2021-22	8.2	1870	15334	8411	23745
Average	6.88	1827	12574	7302	19876

Table 5. Effect of treatments in IPM and farmers practice

Practice	Before Application of treatments	After application of all treatments	
	Plant Infestation (%)	Plant Infestation (%)	% ROC
IPM	36.7	15.6	46.94
FP	38.9	29.4	

Per cent plant infestation = (Total No. of plants infested/ 20 plants) X 100
Per cent reduction over control =(C-T)/C X 100
C= Per cent damage in control plots (FP); T= Per cent damage in treated plots (IPM**)**

stalled due to lack of knowledge on traps availability and sprayings done without knowledge on economic threshold level (ETL) level of pest.

Negative digits of extension gap can be read as reduction in number of plant protection chemical sprayed in one acre area.

Conclusion

Demonstration on management practices of fall armyworm has motivated other farmers to adopt IPM practices in the coming seasons and has proved that, if followed in right direction of management with the latest knowledge can get good net returns with the technology. The general impacts of the IPM noticed are reduction in the number of insecticide sprays, environmental safety and conservation of natural enemies, Good yields and higher net returns. Therefore, target-oriented training programs and multiple demonstrations were required to enhance the knowledge and skills of growers for adoption of the IPM module.

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