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FRONTLINE DEMONSTRATIONS: EMPOWERING MAIZE FARMERS WITH INTEGRATED PEST MANAGEMENT FOR COMBATING FALL ARMYWORM

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ABSTRACT

The fall armyworm, scientifically known as *Spodoptera frugiperda* (J. E. Smith) (Lepidoptera: Noctuidae), originates from the Americas then it was reported for the first time causing severe damage on maize in Karnataka, India, during May 2018. Subsequently spread to different parts of India which is caused huge loss to maize cultivators. In this view ICAR- Krishi Vigyan Kendra, Dharwad conducted 30 Front Line Demonstrations in the farmer's fields on Integrated Pest management (IPM) of fall army worm in Maize crop during 2018-2022. The results showed that average net return per hectare Rs. 39704 was recorded in demonstrated plot, while it was Rs. 30460 under farmer's practice. The cost benefit ratio was 2.23 and 1.91 for demonstration and farmer's practices respectively. The average additional benefit of Rs. 9244 was recorded in demonstration plot. The integrated pest management practices gave 11.43 and 8.44 percent increase in yield in comparison with the control. Chlorantraniliprole, emamectin benzoate, and *Nomuraea rileyi* are promising components for the integrated pest management of fall armyworm in India.

***Keywords*:** Fall armyworm, Karnataka, Front Line Demonstrations, Maize

Introduction

The fall armyworm, scientifically known as *Spodoptera frugiperda* (J. E. Smith) (Lepidoptera: Noctuidae), originates from the Americas and has been documented in various nations, including Mexico, Brazil, Argentina, and the USA (Prowell *et al.,* 2004; Clark *et al.,* 2007). It inflicts significant economic damage across multiple crops such as maize, soybean, cotton (Pogue, 2002; Nagoshi *et al.,* 2007; Bueno *et al.,* 2010), rice, as well as various grasses, and thrives on several weed species (Nabity *et al.,* 2011). Notable outbreaks of fall armyworm have been recorded in African countries like Nigeria, Bénin, and Togo in 2016 (Goergen *et al.,* 2016). Its invasive presence in Asia was first documented in India on maize in May 2018 (Sharanabasappa *et al.,* 2018a), subsequently spreading to different Indian states (Mahadevaswamy *et al.,* 2018; Sharanabasappa *et al.,* 2018b). The rapid expansion of this pest to other Asian nations, including Thailand, Sri Lanka, Bangladesh, Myanmar, Vietnam, Laos, and China (Guo *et al.,* 2018; Wu *et al.,* 2019), has been noted.

Maize, a vital crop in India, covers an extensive area of 10.04 million hectares in 2021-22 with an annual production of 33.62 million tons. Karnataka, among the second leading maize-producing state, holds the foremost position an area of 1.47 million ha with production of 4.55 million tons (Anonymous 2022). The invasive fall armyworm populations showed genetic similarity to the fall armyworm from South Africa, and the area of origin is consistent with the Western Hemisphere (Nagoshi *et al*., 2019). Insecticides are used widely as a tool in fall armyworm management both in the Americas (Tomquelski & Martins 2007; Hardke *et al*., 2011; Gutierrez-Moreno *et al.,* 2019) and in Africa (Prasanna *et al*., 2018; Sisay *et al*., 2019). Therefore, it is necessary to investigate the field efficacy of insecticides on fall armyworm to integrate with Integrated Pest Management practices. At present, the Central Insecticide Board and Registration Committee recommends the use of

chlorantraniliprole 18.5 SC, thiamethoxam 12.6% + lambda cyhalothrin 9.5 % ZC, and spinetoram 11.7 SC (DPPQS 2019) for fall armyworm management. In the year of fall armyworm introduction, farmers have resorted to 2 to 3 sprays of different insecticides without the knowledge of their efficacy. The fall armyworm larva feeds by remaining most of its life in the whorl of maize, thus reducing its contact with insecticides (FAO 2018). Multiple sprays of insecticides may lead to the quick development of resistance as has occurred in other areas (Gutierrez-Moreno *et al.,* 2019).

Frontline demonstration stands as one of the most pivotal and effective tools in agricultural extension due to the prevailing notion among farmers that 'learning by doing' and 'seeing is believing'. The aim of this frontline demonstrations Study is to showcase the integrated management technology for controlling fall armyworm in the fields of farmers across various villages in Dharwad district of Karnataka state, India it was deemed necessary to evaluate the impact of frontline demonstrations conducted by ICAR-KVK, Dharwad. Hence, the current study was initiated with the following specific objective of integrated management of fall armyworm in Maize.

Materials and Methods

The frontline demonstrations on Maize were conducted by ICAR-Krishi Vigyan Kendra, Dharwad. For the purpose of investigation, Tabakad Honnihalli, Asthakatti, Ugginakeri and Nelliharavi villeges of Kalaghatagi taluk of Dharwad district, where FLDs were conducted during preceding three years were selected. A sample of 60 respondents was taken comprising 30 beneficiary and 30 non- beneficiary farmers. FLDs on Integrated management of Fall armyworm on Maize were conducted during 2019-20, 2022-21 and 2021-2022. From each selected village 10 beneficiary farmers were selected randomly for demonstration of technology (Table 1). The demonstrated technology was inclusive of first application of *Nomuraea rileyi* (2g/l) at 25 days after sowing, which is very promising bio pesticide against FAW. Then installation of 5 pheromone traps per acre followed by whorl application of Emamectin benzoate 5 SG (0.2 g/l) and Chlorantraniliprole 18.5 SC (0.2 ml/l) were taken. The observations were recorded on number of caterpillars per plant and per cent dead heart. The consistent visits to demonstration fields by KVK scientists ensured farmers received proper guidance. Additionally, training sessions, field days, and group meetings were organized to educate farmers about scientific Integrated Pest Management (IPM) methods for pest control technologies. Detailed guidance was offered to Frontline Demonstration (FLD) beneficiaries regarding optimal sowing dates, planting distances, fertilizer application rates, irrigation schedules, plant protection measures, and harvesting techniques. Production data were collected from both demonstration (FLD) plots and control plots. Subsequently, the costs of cultivation, net income, and benefit-cost ratios were calculated accordingly.

$$\text{Percent infestation} = \frac{\text{Number of plants damaged}}{\text{Total number of plants observed}} \text{ X } 100$$

Table 1: Year wise Details of Front-Line Demonstrations conducted in different villages by ICAR-KVK, Dharwad

Sr. No.	Year	Village	Taluka	District	No. of FLD
1	2019-20	Tabakad Honnihalli	Kalaghatagi	Dharwad	5.0
		Asthakatti	Kalaghatagi	Dharwad	5.0
2	2020-21	Ugginakeri	Kalaghatagi	Dharwad	10.0
3	2021-22	Nelliharavi	Kalaghatagi	Dharwad	10.0

(Source: Annual Report 2019-20, 2022-21 and 2021-2022 of KVK, Dharwad)

Results and Discussion

The average three years of demonstration results shows that highest yield was recorded in demonstration plot 48.20 q/ha than local check plot 43.35 q/ha. The per cent reduction of fall armyworm (FAW) infestation was recorded 89.86, 87.46, 88.86 and 89.60 respectively in demonstration plots of Tabakad Honnohalli, Asthakatti,Ugginakeri and Nelliharavi villages. The per cent larval reduction was recorded 89.48, 89.51, 89.82 and 89.37 in respective demonstrated villages (Table 2). While in the year 2019-20 and 2021-22 the Integrated Pest management (IPM) practices gave 11.43 and 8.44 percent increase in yield over local pest management practices respectively.

The economics and cost benefit ratio of local check and demonstrated plot was also calculated (Vinaya *et al.,* 2015). An average net return per hectare Rs. 39704 was recorded in demonstrated plot, while it was Rs. 30460 under farmer's practice. The cost

benefit ratio was 2.23 and 1.91 for demonstration and farmer's practices respectively. The average additional benefit of Rs. 9244 (Table 3) was recorded in demonstration plot.

The demonstration clearly indicated that integrated pest management technology was potential tool to mitigate the damage caused by fall armyworm. The foliar spray of *N. rileyi* at the rate of 2 X10^8 cfu/ml conidial formulation were equally effective against the mortality of the larvae of *S. frugiperda* (Mallapur *et al.*, 2018). This entomopathegenic fungus has the ability to perpetuate and cause natural epizootics on fall armyworm if congenial environmental conditions particularly normal temperature and high humidity prevail in the field. Providing frequent irrigation will aid the farmers to create congenial environmental conditions by bringing down the temperature and increasing the relative humidity. Whorl application of emamectin benzoate 5 SG (0.2 g/l) and Chlorantraniliprole 18.5 SC (0.2 ml/l) was promising against management of FAW very effectively in field condition. Thus, FLDs play vital role to prove the potentiality of new technology against fall armyworm in Maize and increase the productivity with net return.

Conclusion

The findings infer that the yield of demonstration plot of integrated Fall armyworm management (IPM) in Maize produced 12.23 per cent higher yield over the check with higher net return. It means that demonstration plot had better production than local plot of IPM in maize crop. From the above findings an interference could be drawn that Front Line demonstrations (FLDs) conducted by KVK, Jamnagar played an important role in increasing the production of cotton through adopting integrated pest management technology in the crop. The results also depict that demonstration plot had significantly higher yield of Maize crop as compared to local plot. From the results it may be assumed that FLD on IPM in Maize had played significant role in busting up Maize production with more net return. Thus, the Front-Line Demonstrations (FLDs) will certainly be boon for convincing the farmers of Dharwad districts to adopt new integrated pest management technology of Maize crop against fall armyworm.

Table 2: Reduction of fall armyworm infestation in frontline demonstration fields at different places

Location	Year	Pest infestation (%)		Reduction of infestation (%)	No. of larvae per 20 plants		Larval reduction (%)
		1 DBS	15 DAS		1 DBS	15DAS	
Tabakad Honnihalli	2019-20	14.89	1.51	89.86	13.5	1.42	89.48
Asthakatti	2019-20	15.23	1.91	87.46	14.87	1.56	89.51
Ugginakeri	2020-21	16.34	1.82	88.86	14.93	1.52	89.82
Nelliharavi	2021-22	15.87	1.65	89.60	13.45	1.43	89.37

Table 3: Average yield and cost parameters of Demonstration and local plots

Particulars	Demo (Technology introduction)				Check (Farmers Practice)			
	2019-20	2020-21	2021-22	Mean	2019-20	2020-21	2021-22	Mean
Yield (q/ha)	55	43.32	46.27	48.20	52	36.5	41.56	43.35
Increase in yield (%)	11.43	13.81	11.44	12.23	-	-	-	-
Gross Cost (Rs/ha)	31867	31700	32948	32172	33849	34231	33849	33976
Gross Return (Rs/ha)	92193	50543	72893	71876	83166	44425	65720	64436
Net Return (Rs/ha)	60325	18843	39945	39704	49317	10193	31871	30460
BC ratio	2.9	1.59	2.21	2.23	2.5	1.3	1.94	1.91
Additional returns (Rs/ha)	11008	8650	8074	9244	-	-	-	-

(Source: Annual Report 2019-20, 2022-21 and 2021-2022 of KVK, Dharwad)

Plate 1: Initial observation of Fall armyworm in maize

Plate 2: FAW larvae infested with *Nomuraea rileyi*

Plate 3: Field monitoring by scientist of ICAR-KVK, Dharwad at Asthakatti village

Plate 4: Field monitoring by scientist of ICAR-KVK, Dharwad at Nelliharavi village

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