**Evaluation of integrated pest management against fall armyworm in maize**

**Abstract:** The evaluation of integrated pest management 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 low in IPM module than farmers’ practice. The increase in yield of 6.78% was observed in IPM demonstration (8503 kg/ha) than farmers’ practice (7963 kg/ha). The net returns of Rs. 103214.00/ha and Rs. 91145.00/ha were obtained in the IPM and farmer’s practice, respectively. The extension gap, technology gap and technology index were 747 kg/ha, 540 kg/ha and 8.07%, respectively. The lower technology index indicated that the technology is feasible at farmers’ fields and the technology need to be popularized to reduce the extension gap and technology gap.

**Keywords:** Fall armyworm,maize, technology gap, extension gap, technology index

**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 (**Reddy and Trivedi, 2008**). Recently, the invasive pest fall armyworm (FAW) [*Spodoptera frugiperda* (J. E. Smith)] has become a great threat to cereal production in the world (**Day *et al.,* 2017**).

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 (**Nagoshi *et al.,* 2017 and Prasanna *et al.,* 2018**). In India, it was first noticed on maize in Karnataka during May, 2018 (**Sharanabasappa *et al.,* 2018**) later, it was spread to Andhra Pradesh, Madhya Pradesh, Maharashtra, Tamil Nadu and Telangana (**Swamy *et al.,* 2018**). 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 (**Casmuz *et al.,* 2010**).

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’ (**Sonali Deole and Nandita Paul, 2018**). It causes skeletonization of leaves and heavily windowed whorls that loaded with larval frass. It could also bore into the maize stem and cobs (**Dhar *et al.,* 2019**). It causes yield loss up to 34% **(Williams and Davis, 1990)** and 57.6 to 58% **(Cruz *et al.,* 1999** and **Chimweta *et al.,* 2019)** in maize. However, in some tropical areas yield losses can reach up to 100 % **(Blanco *et al.,* 2016**).

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

**Material 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 in IPM package were seed treatment with cyantraniliprole 19.8 + thiamethoxam 19.8 FS @ 6 ml/kg, spraying of azadirachtin 1500 ppm @ 5ml/L at 20 DAS, spraying of *Metarhizium anisopliae* @ 5g/L at 30-35 DAS, spraying of emamectin benzoate 5SG @ 0.4g/L at 45-50 DAS while in farmers’ practice, they have used insecticides like chlorpyriphos 20 EC@2.5ml/L, profenophos 50EC @ 2ml/L etc. The data on incidence of fall armyworm in terms of plant infestation was recorded on 20 plants in demonstration and farmers’ practice fields from seedling to crop maturity at 15 days interval. The yield data was collected in both the IPM and farmers’ field. The extension gap, technology gap and technology index were worked out by using the following formula **(Samui *et al.,* 2000 and Swathi *et al.,* 2020)**.

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) – Farmer’s yield (Kg ha-1)

Technology index (%) = (Potential yield (Kgha-1)–Demonstration yield (Kgha-1)) X100/ Potential yield (Kg ha-1)

**Results and discussion:** The data on incidence of fall armyworm indicated that the improved package of practices is important for effective management of fall armyworm in maize. The incidence of pest was low in IPM plots than farmer’s practice (Table1). The plant infestation caused by fall armyworm was 9.92% and 20.95% in IPM plot and farmers’ practice plot, respectively. The low incidence of pest in IPM plot is may be due to the regular monitoring and prophylactic spraying of azadiractin 1500ppm which act 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 are effective in the management of larvae. Similar, findings were observed by **Geetha (2021), Reddy *et al*., 2023 and Narayanamma *et al*., 2023.**

**Yield and gap analysis:**

The IPM technology had impact on the incidence of pest and yield of maize (Table 2). The yield obtained in IPM module (8503 kg/ha) was higher than farmer’s practice (7963 kg/ha). The increase in yield over farmers’ practice of 6.78% was observed in IPM module. The net returns of Rs. 103214.00/ha and Rs. 91145.00/ha were obtained in the IPM and farmer’s practice, respectively. The highest benefit cost ratio of 3.08:1 was recorded in the IPM than farmer’s practice (2.75:1). The increased yield and net returns in the IPM module demonstration plot is due to the timely adoption of protection measures against FAW in maize. The results are in concurrence with the findings of **Rajashekhar *et al*. (2022)** and **Kavyasree *et al*. (2023)**

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 more. However, some more efforts have to be done to convince the farmers for adoption of IPM to reduce pest damage, cost of cultivation and to get good quality produce. The technology index of 8.07% showed the feasibility of technology at farmer’s fields. The findings are in line with **Ramadevi *et al*. (2020)** and **Reddy *et al*. (2023)**.

**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 against fall armyworm in maize revealed that the technology is feasible at farmer’s field for the management of fall armyworm. The incidence of pest was low in IPM and the increased yield of 6.78% was in IPM than farmer’s practice was obtained However, the extension gap and technology gap were more so, there is an urgent need to create awareness among farmers on implementation of IPM against FAW in maize through the services of extension personnel to improve the maize yield and to reduce the extension and technology gap in the Vizianagaram district of Andhra Pradesh.

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**Table 1: Incidence of fall armyworm on maize**

|  |  |  |
| --- | --- | --- |
| **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**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **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**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **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 |