

# Eco-Friendly Pest Management in Maize

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**M**aize (*Zea mays*), also known as corn, is the third most important cereal crop in India, after rice and wheat. It serves as a staple food, livestock feed, and an essential raw material for industries producing starch, ethanol, and biofuels. Maize is highly versatile, grown across diverse agro-climatic zones, and cultivated round the year. Maize cultivation in India faces significant challenges from various insect pests and diseases, which can substantially impact crop yield and quality. Among the major insect pests, the fall armyworm (FAW) (*Spodoptera frugiperda*), first reported in India in 2018, has emerged as a devastating threat, capable of causing 20-80% yield losses by feeding aggressively on leaves, tassels, and cobs. The stem borer (*Chilo partellus*) is another serious pest, particularly in the *Kharif* season, boring into stems and leading to plant wilting and deadheart formation, with potential yield reductions of 26-80%. Other insect threats include the oriental armyworm (*Mythimna separata*), which feeds on leaves and ears, and the cob borer (*Helicoverpa armigera*), which damages kernels, reducing grain quality. In addition to insects, maize crops suffer from severe fungal, bacterial, and viral diseases. Turcicum Leaf Blight, caused by *Exserohilum turcicum*, can cause 50% or more yield loss under favorable conditions. Maydis Leaf Blight (MLB), caused by *Bipolaris maydis*, is another significant foliar disease, with yield losses reaching 40-70%. Banded Leaf and Sheath Blight (BLSB), caused by *Rhizoctonia solani*, is a major concern in humid regions, leading to losses up to 60%. The increasing frequency of these insect pests and diseases, coupled with changing climatic conditions, necessitates the adoption of integrated pest management (IPM) strategy. Therefore, an Integrated Pest Management (IPM) module was synthesized, validated, and promoted under farmers' field conditions to safeguard maize yields and promote sustainable maize production.

The study was conducted *Kharif* 2022–25 in farmers participatory approach at Turgarh village (24°28'40.4" N 73°35'80.02" E) of district Udaipur, Rajasthan. The trial initially covered 8.0 hectares with 30 progressive farming families in 2022-23 and was expanded to 50 hectares with 100 families in 2024-25. Population and incidence of major pests were compared with FP and untreated control plots.



### IPM Strategy:

- Seed treatment with *Trichoderma asperellum* @ 10g/kg of seeds,
- Installation of pheromone trap @10/ha for FAW monitoring,
- Spray of azadirachtin 1500ppm @ 5m/lit at 10 days after planting,
- Spray of biopesticide *Metarhizium anisopliae* ( $1 \times 10^8$ cfu/g @ 10g/litre),
- Release of *Trichogramma chilonis* @ 1 card/acre (16000-20,000 eggs).
- Need based application of chemical pesticides

The neem pesticides were used early in when one moth/ trap was trapped, since they act as oviposition deterrent against egg-laying female moths, and feeding deterrent against the larvae. The chemical pesticide was the last component in the IPM package. Application of bio-pesticide or pesticide treatments started after one week of emergence of seedling, when the *S. frugiperda* infestation built-up and exceeded the economic threshold level (about 1 larvae/plant). The IPM package was compared with the Farmers' practice, and with the untreated control. Farmers' practice (FP) mainly involved calendar-based spraying of chemical pesticides for management of FAW as per the advice of pesticides dealers.

Baseline information about the villages Turgarh was collected, which indicated that the total cultivated area in the village is about 300 ha out of which maize occupies an area of about 150 ha and other crops grown in the area are soybean, mung, ginger and few vegetables. Farmers do not faced any significant pest problem in maize except FAW, which appeared since 2020, and they never required to spray any insecticides or fungicides. The average yield of maize 24q/ha which ranges between 18 to 30 q/ha. Pesticide applications were solely based on recommendations from pesticide dealers. Farmers had limited knowledge of the effects of high nitrogen doses, timely sowing, and an ETL-based approach to plant protection. Key pest problems in the area are fall





armyworm (FAW), stem borer (SB), maydis leaf blight (MLB), post flowering stalk rot (PFSR) and banded leaf and sheath blight (BLSB).

### Impact of IPM

IPM interventions significantly reduced FAW infestation which was 17% in IPM, 32% in Farmer Practice (FP) and 55% in control plots. Maydis Leaf Blight was significantly lower in IPM fields, with an average severity of 10%, compared to 28% in FP and 37% in untreated control plots. IPM fields maintained the lowest average severity in the case of BLSB at 7.3%, compared to 11.5% in FP and 18.6% in control plots. Similar is the case of PFSR caused by *Fusarium verticillioides*, with lowest incidence in IPM (7.3%) followed by FP (12.3%) and control (15.4%). The overall average population of natural enemies was highest in control (11.9/50 plants), followed by IPM (7.2/50 plants), and lowest in FP (3.6 /50 plants), indicating that IPM supports a higher population of beneficial predators compared to FP. In all three years, the highest population of natural enemies was observed in the control treatment, with the peak recorded in 2023 (13.5/50 plants), followed by 2022 (12.2/50 plants) and 2024 (10/50 plants). The IPM treatment had a moderate predator population, with its highest in 2023 (8.4/50 plants), followed by 2022 (7/50 plants) and a decline in 2024 (6.2/50 plants). The FP consistently showed the lowest population, remaining below 4 in all years, with a slight increase in 2023 (3.9/50 plants) compared to 2022 (3.5/50 plants) and a minor change in 2024 (3.4/50 plants) (Table 1).

IPM-treated fields recorded the highest average yield of 36 q/ha and a net return of Rs. 48,780/ha, outperforming both FP fields, which yielded 29.8 q/ha with Rs. 32,334 net return, and control fields, which lagged with 18 q/ha yield and Rs. 14,942 net return. Benefit-Cost (B:C) ratio was highest under IPM, 2.39, while FP (1.87) and control plots (1.27) showed lower BC ratios. In IPM fields, only one chemical pesticide spray was applied in 2023, whereas FP fields increased pesticide use each year, reaching three sprays with 83.25 g/ha of active ingredients in 2024 that was 27.75 g/ha of active ingredients in 2022 (Table 2). Farmers' meetings, Farmers' Field Schools, and IPM Field Days were organized at regular intervals in the village, which helped in strengthening linkages among farmers, scientists, and extension workers. These activities enabled 100% of the IPM farmers to identify major pests and natural enemies (such as spiders and coccinellids), understand the role of pheromone traps in pest monitoring, appreciate the importance of seed treatment, field sanitation, and weed removal in pest management, and gain clarity on the concepts of ETL and the need-based application of safer pesticides.

**Table 1: Pest and natural enemy in maize under IPM, FP, and control fields at Turgarh, Udaipur (kharif 2022–2024)**

Years	Treatments variables	FAW (%)	MLB (%)	BLSB (%)	PFSR (%)	Predators (No./50 plants)
2022	IPM	17.2±2.08	10.4±2.43	9.18±2.01	8.7±1.61	7.0±1.01
	FP	35.9±4.24	18.6±2.61	12.8±2.42	14.3±2.25	3.5±1.25
	Control	52.4±4.05	22.8±3.69	12.8±2.78	18.5±3.66	12.2±0.95
2023	IPM	18.2± 2.69	15.5± 1.07	4.53± 1.03	5.63±0.70	8.46± 2.53
	FP	30.0± 4.61	22.4±1.06	8.62± 1.48	10.1±0.99	3.96± 0.94
	Control	58.3± 3.98	30.0±1.71	21.6± 1.73	12.3±1.31	13.5± 1.25
2024	IPM	17.1±1.07	18.0± 1.90	8.4± 1.26	7.6± 0.84	6.2± 1.15
	FP	32.8±1.42	28.7± 2.10	13.2± 1.60	12.5± 1.21	3.4± 0.84
	Control	55.0±2.35	37.7± 2.84	21.3± 2.30	15.3± 1.40	10.0± 1.01
Pooled	IPM	17.5±0.61	14.6±3.87	7.4±2.49	7.3±1.56	7.2±1.15
	FP	32.9±2.95	23.2±5.10	11.5±2.54	12.3±2.11	3.6±0.30
	Control	55.2±2.96	30.2±7.45	18.6±5.00	15.4±3.10	11.9±1.77

#Values are the mean of 10 weeks ±standard deviation; FAW: fall armyworm, MLB: Maydis leaf blight, BLSB: Banded Leaf and sheath Blight, PFSR: Post flowering stalk rot; IPM- Integrated pest management, FP-farmers' practice

Table 2: Economic analysis of IPM, FP and control fields at Udaipur during 2022 to 2024

Variables	2022			2023			2024			Pooled Mean			% I/D*
	IPM	FP	Control	IPM	FP	Control	IPM	FP	Control	IPM	FP	Control	
Chemical pesticide sprays (no.)	0	1	0	1	2	0	0	3	0	0.33	2.00	0.00	-83.5
Pesticide active ingredient (kg/ ha)	0.0	27.75	0	27.75	55.50	0	0	83.25	0	9.25	55.50	0.00	-83.3
Yield (q/ ha)	36	30	16	40	32	15	32	27.5	21	36.00	29.83	17.33	20.7
Gross Income (Rs./ ha)*	66600	55500	29600	78480	62784	29430	62784	53955	41202	69288	57413	33410	20.7
Cost of cultivation (Rs./ ha)	28800	29200	26200	29700	30450	26200	28450	32900	26260	28983	30850	26220	-6.1
Net income (Rs./ ha)	37800	26300	3400	48780	32334	3230	34334	21055	14942	40304	26563	7190	51.7
BC Ratio	2.31	1.90	1.12	2.64	2.06	1.12	2.20	1.63	1.56	2.39	1.86	1.27	

Market price of maize Rs 1962/q, IPM- Integrated Pest Management, FP-farmers' practice, % Increase or decrease in IPM over FP