



Evaluation on Integrated Method of Fall Army Worm Pest Management in Maize Hybrid in Namakkal District of Tamil Nadu, India

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

Maize (*Zea mays* L.) on farm trials were conducted by Krishi Vigyan Kendra, Namakkal to assess the management modules against Fall Army Worm (FAW) in maize crop in terms of plant height, number of cob/ plant, cob length (cm), number of grain row/cob, 100 grain weight (g), grain yield, stalk yield and net return, first incidence of FAW days after sowing (no.), damage percentage, natural enemies occurrence (no./sq.m), number of adult moth trapped in sex pheromone trap per day per hectare during Kharif 2019 in Namakkal district. The treatment T6 followed is summer ploughing, seed treatment with Fortezaduo (Cyantraniliprole +Thiamethoxam) @ 4ml/kg, Border crop with grain sorghum as trap crop (advance sowing) and legume intercrop (cowpea) to promote natural enemies (few rows at interval), Collection and destruction of egg masses, installation of sex pheromone trap @ 10 numbers per hectare, Azadirachtin 10000 ppm @ 1 per cent spray at 10 to

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15 days after sowing; spraying of Emmamectin Benzoate 5SG @ 0.4g/ litre on 24 days after sowing and *Metarhizium anisopliae*(1x10⁷) @ 2 ml/ litre on 35 days after sowing and farmers practice on application of pesticides four to five times in crop period revealed that maize hybrid (NK 6240) recorded highest plant height of (105.7 and 194 cm) on 60 and 90 DAS, yield attributes viz., number of cobs per plant is 1.7; cob length is 14.4 cm; number of grain row/cob is 10.8; number of adult moth trapped in pheromone trap (1.3 number), natural enemies occurrence 3.2 number per m², and found to be non significant in plant height and growth attributes of Maize followed by Treatment T4 and T5, whereas higher grain yield of 64.25 quintal ha⁻¹ and Stalk yield of 94.8 tonnes ha⁻¹, and first incidence of fall army worm larvae 17 days after sowing, lesser damage of fall army worm percentage (7.2%), were found to be significant as compared to farmers practice. The lesser plant height of 89 cm, 171.3 cm, number of cob/ plant 1.3, cob length 11.4 cm, number of grain row/ con is 8.5, and 100 grain weight is 19.1 gm and grain yield of 56.6 quintal ha⁻¹, stalk yield of 61.5 quintal ha⁻¹ and net return of Rs. 10550 /hand first incidence of FAW days after sowing on 11 days, and damage percentage of 11.4 % was recorded under treatment T7. Treatment T6 plot recorded higher net return of Rs.21,575/ ha, respectively by cultivating maize hybrid (NK 6240) as against the T7 with net return of Rs. 10, 550/- with higher damage of cob, respectively by cultivating Maize hybrid (NK 6240). Farmers were very satisfied with Maize hybrid (NK 6240), as crop find fewer incidences of fall army worm and higher return compared to other practices. Maize hybrid (NK 6240) followed under T6 recommended practices would be a better option for management of Fall Army Worm in kharif season in Namakkal district of Tamil Nadu. The aim of this study was to determine the effect of cultural practices, insecticide application at different plant growth stages between seedling emergence and flowering on yield loss caused by FAW in maize.

Keywords: *Maize; damage severity; fall army worm; pest incidence; IPM practices; insecticide applications; pest management; grain stalk yield; net return; DAS- Days after sowing.*

1. INTRODUCTION

In India, maize (*Zea mays* L. 2n=2x=20) is third important crop after rice and wheat that provides food, feed and fodder and serves as a source of basic raw material for the number of industrial products, viz., starch, oil, protein alcoholic beverages, food, sweeteners, cosmetics bio-fuels etc. Major maize growing states are Tamil Nadu 1.60 lakh hectare (3.96 lakh acres), Maharashtra 1.21 lakh hectare (2.99 lakh acres), Bihar 0.86 lakh hectare (2.13 lakh acres), Telangana 0.82 lakh hectare (2.03 lakh acres), Gujarat 0.50 lakh hectare (1.24 lakh acres) and West Bengal 0.31 lakh hectare.

In Tamil Nadu, Perambalur district stands first in Maize and Cotton cultivation in Tamil Nadu. Being a rainfed district, Perambalur district produces in an average of 4.0 lakh metric tons of food grains per year. The fall army worm (FAW), *Spodoptera frugiperda*, an invasive pest has become a threat to farmers and Indian Agriculture and first detected on the Indian subcontinent in May 2018 in Maize fields at the College of Agriculture, Shivamogga, Karnataka [1].

Maize is the main staple food for more than 500 million people in SSA. It is mainly cultivated by small-scale farmers using low input production systems [2]. Most farming systems in SSA are prone to major crop production constraints including biotic stressors (diseases and insect pests), abiotic stressors (drought stress and low soil fertility) and various socio-economic constraints such as inadequate extension services and poor access to credit opportunities [3,4]. To overcome these constraints, the study was taken for assessing of fall army worm management in Maize crop.

The fall armyworm (FAW) (*Spodoptera frugiperda* J.E.Smith (Lepidoptera: Noctuidae)) is a relatively new, polyphagous pest infest maize during all plant growth stages, with infestation during vegetative stages leading to serious leaf-feeding injury, while late infestation leads to ear damage [5-7]. Insecticide application has been the main method of FAW control in South America [8]. The combination of FAW together with existing production constraints have threatened the stability and sustainability of food systems, livelihoods, ecosystems biodiversity, local, regional, and global trade in Sub-Saharan Africa (SSA) since its arrival in 2016, [9].

2. MATERIALS AND METHODS

The field trials were conducted in different farmers' field in an area of 0.6 ha at Thattaiyengaripatty village, Pudhuchattiram block, Namakkal District during Kharif season 2019 - 20. Thattaiyengaripatty village is situated at 11.380 N latitude and 78.160 E longitude with mean sea level of 142 MSL. The annual rainfall of Pudhuchattiram block was 509.3 mm with 57 rainy days. Of which, experimental season was September 2019 to December 2019, received average rainfall of 363.6 mm with 31 rainy days. Maximum monthly mean temperature was 31.6°C and minimum was 21.8°C. The experimental soil type was black in colour, sandy clay loam and sandy loam in texture and calcareous to non calcareous. The soil was neutral in soil reaction (7.84), non saline (0.052dS m⁻¹), low in organic carbon (0.52%), low in available nitrogen (212 kg ha⁻¹), medium in available phosphorus (16.42 kg ha⁻¹), and medium in available potassium (144 kg ha⁻¹).

The plot size was 5 m x 4 m with plant spacing of 60 cm x 25 cm. Sowing of maize hybrid was carried out under drip irrigation system to irrigate maize crop. The germination percentage of seed was more than 94 per cent and required plant population was maintained with gap filling done within one week after sowing. Farm yard manure @ 12.5 ton ha⁻¹ was applied to all the treatments. A fertilizer schedule of 135:62.5:50 kg of NPK ha⁻¹ is recommended constant for all the treatments and apply quarter dose of N, full dose of P₂O₅ and K₂O as basal before sowing and remaining N top dressing after 20th and 45 days after sowing (DAS). Application of the pre-emergence herbicide, Atrazine 50WP @ 500 g ha⁻¹ at 3 days after sowing as spray on the soil surface followed by one hand weeding on 42 days after sowing.

Treatment plot plant protection measures viz., T1 to T7 is presented in Table 1. Spraying of insecticide was done by using Battery operated hand sprayer on the growth of terminal shoots of every plant. Sex pheromone trap was placed randomly in different places of maize field with *Spodoptera frugiperda* lure placed above the plant height on 5 DAS and lure replaced on 60 DAS. The data on first incidence of Fall Army Worm larvae (Days after sowing), damage percentage, number of adult moth captured in pheromone trap, Natural enemies occurrence, growth attributes, yield attributes, Plot were

harvested to calculate the yield of Grain and stalk yield and expressed in quintal per hectare, Gross return in Rs./ ha; Net return Rs./ ha and Benefit Cost ratio were recorded.

3. RESULTS AND DISCUSSION

The observation of plant height (cm), number of cob per plant, cob length (cm), number of grain row per cob, 100 grain yield (gram), grain yield (Quintal/hectare), stalk yield (Quintal/hectare), Net return (Rs.), first incidence of fall Army worm days after sowing (number), damage percentage (%), Natural enemies occurrence(no./sq.m), number of adult moth trapped in pheromone trap was taken to assess the fall worm incidence and grain yield of maize crop.

The field trials revealed that maize hybrid (NK 6240) in treatment T6 was found to recorded highest plant height on 60 and 90 DAS (105.7 and 194 cm), yield attributes viz., number of cobs per plant is 1.7; cob length is 14.4 cm; number of grain row/cob is 10.8; and 100 grain weight of 21.7 gram were found to be non significant in plant height and growth attributes of Maize crop and it was followed by Treatment T4 and T5, respectively. Whereas treatment T7 recorded lesser plant height of 89 cm, 171.3 cm, number of cob/ plant 1.3, cob length 11.4 cm, number of grain row/ cob is 8.5, and 100 grain weight is 19.1 gram (Table 2).

The treatment T6 was found to be recorded higher grain yield of 64.25 quintal ha⁻¹ and stalk yield of 94.8 tonnes ha⁻¹ and found to be significant to other treatments, whereas it was followed by treatment T4 and T5, respectively. The lower grain and stalk yield was recorded in treatment T7 of 56.6 q/ha and 61.5 quintal/ha. Treatment T6 plot recorded higher net return of Rs.21,575/ ha, respectively by cultivating maize hybrid (NK 6240) as against to the treatment T7 of Rs. 10, 550/- with higher damage of cob (Table 2).

First incidence of fall army worm larvae was noticed on 17 days after sowing, lesser damage of fall army worm percentage (7.2%), in treatment T6 and were found to be significant to T4, whereas in treatment T7 found to be first incidence of fall army worm at earlier on 11 DAS, FAW damage 11.4 per cent and natural enemies occurrence @ 2.6 number per square meter

Table 1. Treatment details (T1 to T7) for controlling fall army worm in maize crop

T 1	<ul style="list-style-type: none"> ➤ Summer ploughing ➤ Seed treatment with <i>Beauveria bassiana</i>@ 4 g/ kg. ➤ <i>S. frugiperda</i> pheromone traps @ 10 no./ha., ➤ Azadiractin10000 ppm spray @ 2ml/ litre on 15 DAS, ➤ Second spray of Bt @2g/litre on 30DAS, ➤ <i>Mettarhizium anisophilae</i> spray (1×10^7) @2 ml/ litre on45DAS.
T 2	<ul style="list-style-type: none"> ➤ Summer ploughing ➤ <i>S. frugiperda</i> pheromone traps @ 4 no./ acre. ➤ Azadiractin10000 ppm @ 2ml/ litre on 15 DAS, ➤ <i>Mettarhizium anisophilae</i> spray (1×10^7) @2 ml/ litre on 30 DAS,
T 3	<ul style="list-style-type: none"> ➤ Summer ploughing ➤ Border crop with grain sorghum+ intercrop with cowpea (few rows). ➤ Azadiractin10000 ppm @ 2ml/ litre on 15 DAS, ➤ First Insecticide spray of Emmamectin benzoate5SG @0.4g/ litre on 30 DAS, ➤ <i>Mettarhizium anisophilae</i> spray (1×10^7) @2 ml/ litre on 45 DAS.
T 4	<p>Spraying of insecticide – after noticing the FAW incidence</p> <ul style="list-style-type: none"> ➤ Emmamectin Benzoate 5SG @ 0.6 g/ litre on 15 DAS, ➤ Spinosad 480 SC @ 0.6 ml/ litre on 30 DAS, ➤ Chlorantraniliprole @ 1ml/ litre and Delicate @ 2 ml / litre on 45 DAS,
T 5	<ul style="list-style-type: none"> ➤ Summer ploughing, ➤ Seed treatment with Fortenza duo (Cyantraniliprole + Thiamethoxam) @ 4 ml/ kg, ➤ Emmamectin Benzoate 5SG @ 0.6 g/ litre on 15 DAS, ➤ Spinosad 480 SC @ 0.6 ml/ litre on 30DAS, ➤ Chlorantraniliprole @ 1ml/ litre on 45DAS.
T 6	<ul style="list-style-type: none"> ➤ Summer ploughing ➤ Seed treatment with Fortenza duo (Cyantraniliprole + Thiamethoxam) @ 4 ml/ kg. ➤ Collection and destruction of egg masses, ➤ <i>S. frugiperda</i> pheromone traps @ 10 no./ha., ➤ Border crop with grain sorghum+ intercrop with cowpea (few rows), Azadiractin10000 ppm @ 2ml/ litre on 15 DAS, ➤ First insecticide sprays -Emmamectin benzoate 5SG @0.4g/ litre on 25 DAS, ➤ <i>Mettarhizium anisophilae</i> spray (1×10^7) @2 ml/ litre on 35 DAS, ➤ Second insecticide sprays -Chlorantraniliprole 18.5 SC @0.3 ml/ litre on 48 DAS.
T 7	<ul style="list-style-type: none"> ➤ Summer ploughing ➤ Blue bendamide @ 1.5 ml/ litre on 20 DAS, ➤ Lamda cylothrine @ 3 ml / litre on 40 DAS.

Table 2. Effect of IPM on fall army worm incidence and management on growth and yield of maize crop

Treatments	Plant height on 60 DAS (cm)	Plant height on 90 DAS (cm)	No. of cob/plant. (No.)	Cob length (cm)	No. of grain row/ cob (No.)	100 grain weight (g.)	Grain yield (Q./ha).	Stalk yield (Q./ha.)	Net return (Rs.)
T1	93.0	180.3	1.3	12.5	8.7	19.5	58.5	75.5	17117
T2	91.0	179.7	1.3	12.3	8.6	19.3	57.5	72.5	16975
T3	98.7	184.0	1.3	12.9	8.9	20.3	58.7	82.0	19403
T4	101.0	188.0	1.7	13.4	10.5	21.5	59.0	86.0	21492
T5	99.7	187.7	1.7	13.2	9.9	20.5	58.9	82.5	20583
T6	105.7	194.0	1.7	14.4	10.8	21.7	65.4	94.8	21575
T7	89.0	171.3	1.3	11.4	8.5	19.1	56.6	61.5	10550
Total	678.0	1285.0	10.3	90.1	65.8	141.9	414.6	554.8	127695
Mean	96.9	183.6	1.5	12.9	9.4	20.3	59.2	79.3	18242
S Ed	5.92	5.99	0.50	0.99	0.84	1.39	2.1	5.8	1183
C.D.	12.91	13.06	1.59	2.17	1.82	3.03	4.5	12.7	2578
F test	NS	NS	NS	NS	NS	NS	*	*	*

Table 3. Effect of IPM on fall army worm incidence and its management in Maize crop

Treatments	First incidence of FAW days after sowing (No.)	Damage percentage (%)	Natural Enemies occurrence (no/ sq.m)	No. of adult moth trapped
T1	14	9.97	2.8	1.4
T2	13	10.9	2.7	2.3
T3	14	9.50	3.0	-
T4	15	8.80	3.0	-
T5	15	9.20	3.0	-
T6	17	7.20	3.2	1.3
T7	11	11.4	2.6	-
Total	99	66.97	20.4	-
Mean	14	9.57	2.9	-
S Ed	1	0.77	0.3	-
C.D.	2	1.67	0.6	-
F test	*	*	NS	-

(Table 3). The number of adult FAW moth trapped in pheromone trap in treatments T1, T2 and T6 are 1.4, 1.3 and 1.3 numbers per day, respectively, Treatment T6 Maize hybrid (NK 6240), as crop increase in plant height, yield attributes, grain and stalk yield and higher return, compared to other treatments might be due to integration of organic and inorganic fertilizer application, integrated pest and disease management practices. The treatment T6 was found efficient in controlling the fall worm incidence of Maize in time which increases the crop yield and net return. The late incidence of fall army worm incidence in maize and lesser damage percentage and more natural enemies in treatment T6 was due to seed treatment with timely application of bio-products, installation of sex pheromone trap and number of natural enemies which increases the yield and FAW management. The result of the present study is in comparable with those of investigation [10].

The probable reason for lesser incidence of Fall Army Worm in maize on treatment T6 was due to seed treatment with Fortenza duo, followed by raising border crop with grain sorghum and cow pea inter crop, installation of *Spodoptera frugiperda* trap, need based application of pesticide, neem oil, bio-pesticide in time effectively controlled the pest and resulted in higher seed weight, grain yield influenced by genotype, environmental and management factor [1].

4. CONCLUSION

It is concluded that installation of sex pheromone trap followed by bio-pesticide application in time starting from 15 DAS after sowing once in 10 days interval (three times) effectively management of fall army worm and increase the yield and income of the maize crop.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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