Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

E-ISSN: 2320-7078
P-ISSN: 2349-6800
JEZS 2019; 7(5): 388-390

Received: 01-07-2019
Accepted: 03-08-2019

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Integrated approach for the management of major insect pest in maize agro-ecosystem in Perambalur district

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Abstract
Studies on the efficacy on IPM technology against the important insect pests of maize were carried out at the farmers field of Perambalur district of Tamil Nadu during the Kharif seasons of 2017-18. The efficacy of Integrated Pest Management technologies against the white grub *Holotrichia serrata* (Coleoptera: Scarabaeidae) and stem borer in the maize (*Chilo partellus*) fields was evaluated. The findings revealed that the per cent white grub infestation after two months was recorded as 35.5 percent in the farmers practices and minimum infestation of 0.3 percent was noticed in IPM fields. Minimum stem borer infestation of 4 percent was recorded in IPM fields and maximum infestation was recorded 15.4 percent in farmers practices. The maize yields harvested from the plots treated with IPM technologies were at least 35.33% higher than that from farmers practices. The cost-benefit of using IPM technologies for white grub and stem borer control was estimated to be 2.08 whereas it was 1.27 in farmers practices of using only chemicals. IPM technologies showed promise for white grub and stem borer control in maize fields. It is concluded that IPM is the most effective control methods against white grub and stem borer and obtaining the highest maize yield of 54.34 q/ha whereas 33.00 q/ha in farmers practices.

Keywords: Maize, stem borer, *Chilo partellus*, white grub, *Holotrichia serrata*, IPM, yield

Introduction
In India Maize is the third most important food cash crops after wheat and rice. In Tamil Nadu Perambalur, Ariyalur, Cuddalore, Dindigul and Tirupur are the major maize growing districts. The State's contribution to the national yield is roughly around 7.25 per cent. Perambalur district stands first in Maize and Cotton cultivation in Tamil Nadu. Maize was cultivated approximately 61, 000 ha during 2018-19 in Perambalur district. Maize Stem borer *Chilo partellus* Swinhoe) (Lepidoptera: Pyralidae) is widespread and serious pest of maize in Perambalur. Maize stem borer is most common destructive insect pests of maize crop [1, 2]. It also infests sorghum, millets, rice, sugarcane, bajra and some other grasses [3, 4]. It causes dead hearts, reduced translocation, ear damage, lodging, initial leaf senescence and in severe cases complete crop failure [5, 6]. Singh and Sajjan have reported 57.70 to 79.40 per cent maize grain yield losses due to *C. partellus* in Punjab [7].

Recently in Perambalur district during 2017-18 monsoon seasons was characterised by long dry spells, followed by short spells of heavy rains leads to white grub outbreak. White grub infestation has been reported majority of the maize growing areas of Perambalur district and the magnitude of the problem has been wide spread over the past two years. Outbreak occurs due to monoculture of maize and minimal varietal diversity and climatic change. The affected plant shows varying degrees of yellowing, wilting and death of plants and if untreated entire field may be devastated. Apart from maize the damage caused by this pest is observed in patches in majority of crops in Perambalur district *i.e.*, sugarcane, turmeric, brinjal, onion and yam and the entire crop was wiped out in untreated farmers fields. This white grub has become a challenging pest for the farmers because of lack of resistant variety and wider host range. Being the soil insect the farmers may not be easily identify the pest at early stage of damage and only noticed this pest when damage crossed the ETL. They are going for synthetic pyrithroid group of insecticides spray for white grub management at heavy infestation this leads to environmental pollution and chance of development of resistant in insects. Therefore, there is a need to evolve suitable management strategy to tackle this pest by reducing the chemical spray. Hence, the Krishi Vigyan Kendra aims to help farmers to recognize these pests

at early stages and thereby take effective protection of the crop against them by adopting Integrated Pest Management technologies with this back ground the front line demonstration was conducted

Materials and Methods

Experimental layout

Frontline demonstrations on integrated pest management (IPM) on maize were conducted in white grub and Stem borer endemic areas in Nochiyam village of Perambalur district of Tamil Nadu involving 10 farmers. Altogether totally ten demonstrations were laid out over an area of 2 hectares during the seasons *Rabi* 2016/17(November 2016 to April 2017).

T1. IPM module components

The basal application of Neem cake @ 100/ acre and Talc based formulations of *Metarhizium anisopliae* and Entomopathogenic nematode (*Heterorhabdites indica*) commercially available in the market were applied at the rate of @ 1 kg acre-^{1} each with FYM. The field was irrigated immediately after application against white grub. Manual whorl application granular insecticide carbofuran 3G @8 kg/acre was used at their recommended dose in each replication was carried out at ETL (four weeks after sowing). Second application of Chlorpyriphos 20 EC @ 3 lit/ ha insecticide was performed when maize stem borer infestation regained ETL (two weeks after first granular insecticide application) was done in the treatment field. The Popular maize hybrid of area 'NK 6240' was used as test hybrid.

1. Basal application of Neem cake @ 100/ acre plus *Metarhizium anisopliae* and Entomopathogenic nematode *(Heterorhabdites indica)* commercially available in the market were applied at the rate of @ 1 kg acre-^{1} each with FYM.
2. Manual whorl application granular insecticide carbofuran 3G @8 kg/acre at ETL (four weeks after sowing).
3. Application of Chlorpyriphos 20 EC @ 3 lit/ ha insecticide was performed when maize stem borer infestation regained ETL (two weeks after first granular insecticide application)
4. The Popular maize hybrid of area 'NK 6240' was used as test hybrid.

T2. Farmers practice component

Applied synthetic pyrethroid insecticides at least three times in a cropping period

Observations recorded

The observations on pests, and yield data were recorded from IPM and non-IPM demonstrations. The data were recorded on plant damage due to white grubs, the number of white grubs per 10 meter row in the root zone recorded at 60 days after treatment (DAT). The percent decrease in white grub damage and white grub population was calculated and compared. Data on maize stem borer infested plants was recorded at fortnights (15 days intervals). Maize stem borer infestation data were recorded by counting the number of infested plants (shot holes and dead hearts) on randomly selected ten plants in each plot. Data on yield was recorded at harvest.

Data analysis

The homogeneity of the data was tested through paired T-test

Results and Discussions

Efficacy of the treatments on yield and economics

In the present study the effect of IPM treatments have directly influence on yield of maize, which was evaluated and presented in Table 1. It is revealed that the maize yield was the highest (543.4 q/ha) whereas (330 q/ha) in farmers field. The lowest yield was observed in farmers practice (Fig.1). As the farmers practice depends on the usage of synthetic pyrithroid insecticides for the management of white grub when the infestation is very high and no management practices was adopted against stem borer attack in farmers practices. Even cost of cultivation (Rs. 31196.6) was low, due to heavy yield loss net return (Rs. 8406.4) and BCR (1.27) was very much reduced. Whereas in IPM adopted fields cost of cultivation was (Rs. 31452.5) higher compared to farmers practices but due to increase in yield net return (Rs. 33755.5), gross return of (Rs. 65208) and BCR (2.08) respectively.

Table 1: Effect of IPM technology on the yield and economics of maize production

Treatment	Yield t/ha	Gross cost Rs.	Gross return Rs.	Net return Rs.	B:C
T1 Farmers practice	3.30	31196.6	39603	8406.4	1.27
T2 IPM field	5.43	31452.5	65208	33755.5	2.08

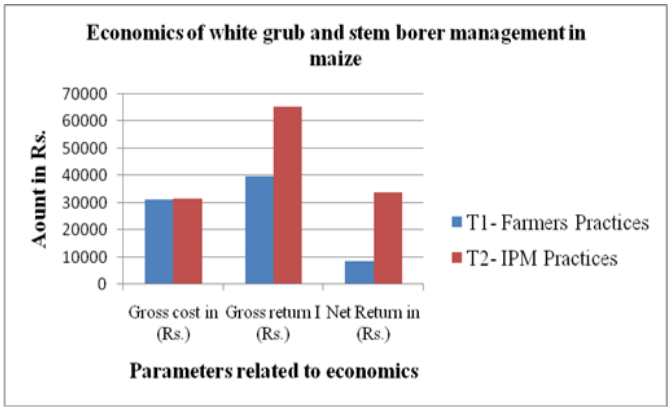

Fig 1: Economics of white grub and stem borer management in IPM and Non IPM maize fields

The lowest maize stem borer percent infested plants were observed in IPM treatment (4.0%) wereas in farmers practices it was (15.4%) during the 60 DAT (Days After Treatment). From Table 2. it is evident that soil application of Entomopathogenic fungi (*H. indica*) and *Metarhizium anisopliae* @ 1 kg/ acre mixed with farm yard manure (FYM) was effective in reducing plant damage and also white grub population in IPM field compared to farmers practices. Observations on incidence of white grub is presented in table -2. The white grub population number/10 m row at vegetative stages 30 DAS and cob forming stage 60 DAS was recorded. The maximum number of population was recorded as 2.2 and 6.7 respectively in non IPM farmers practice and whereas 1.1 and 0.3 respectively in IPM fields.

Table 2: Efficiency of IPM technology against maize white grub and stem borer

Treatment	White grub population No. of grub/ 10 m row		White grub Per cent decrease over control	Percent of plant infested infected with white grub	Per cent infested plant by maize stem borer	Stem borer infestation analysis		
	30 DAT	60 DAT	60 DAT	60 DAT	60 DAT	Mean	Variance	t Stat
T1 Farmers practice	2.2	6.7	-	35.5	15.4	1.66	2.25	2.30
T2 IPM field	1.1	0.3	95.52	0.3	4	2	0.75	

In the present study, application of *Metarhizium anisopliae* and *Heterorhabidities indica* mixed with FYM was found effective and registered 84.51% decrease in white grub damage and 95.52% decrease in white grub population compared to farmers practice. The adoption of IPM technologies resulted in higher net income in economic terms also which was exhibited by high incremental cost benefit ratio 1: 2.08 whereas 1:1.27 in farmers practices. The present study is in agreement with Shelton and Badenes [8] who studied the effectiveness of different methods for control of maize stem borer and proved that IPM was most effective in controlling the maize stem borer and the yield losses due to these pests can be managed by the adoption IPM modules. It was also concluded that the demonstrated IPM module is eco-friendly and safer to non-targeted organism in comparison to conventional insecticides.

The present findings are in line with observations on large scale field application of *M. anisopliae* @ $3.3x10^{13}$ conidia ha^{-1} against gray back cane grub in Australia. They have recorded 50-60 and 70-90 per cent reduction in grub population in sugarcane plant crop and next ratoon crop [9]. Manisegaram *et al*. (2011) [10] also reported that *Metarhizium anisopliae* @ $4x10^{9}$ conidia ha^{-1} at 60 days after treatment recorded 92% mortality in grubs resulted in higher cane yield.

The present achievements are in accordance with the finding of Samantha *et al.* [11] who observed that the infestation of maize stem borer greatly decreased by IPM control method. The results are in close agreement with the findings of Ramkumar and Tanweer Alam, 2017 [12]. Who reported that timely application of chlorantraniliprole and carbofuron against maize stem borer recorded highest kernel yield.

Conclusion

IPM was most effective control method having the lowest maize stem borer infestation and white grub infestation and highest yield because in IPM all control methods were applied at proper stage and time of crop and insects. In the present study, it is evident that the treatment was significantly effective in reducing the maize stem borer and white grub infestation as compared to farmers practices. So IPM technology should be applied for controlling insect pests and obtaining maximum yield of maize.

Acknowledgement

The authors are grateful to the Zonal Project Directorate (Zone–X), ICAR, Hyderabad for providing necessary facilities to carry out the experiments.

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