**Biocontrol Agents For Sustainable Management Of Whitegrub, *Holotrichia serrata* (Fabricius, 1781) In Sugarcane**

**Abstract**

A field experiment was carried out in farmers’ fields in Mastipur, Amarachinta and Itikyala villages, Wanaparthy dt.,Telangana state in the wet seasons of 2021-22 and 2022-23 to evaluate eco-friendly strategies for the management of *Holotrichia serrata*, the whitegrub in sugarcane using three modules viz., eco-friendly module, chemical check module and an untreated control module. Data on plant damage and no. of grubs per 10m row length was taken at 60 days after treatment. Results revealed that the chemical check module recorded least damage of plants (29.66%), lesser grubs/10m row length i.e., 10.9 grubs; highest cane yield (35.25 t/acre); net gain of Rs.53,283.00 over control treatment and an Incremental cost benefit ratio (ICBR) of 9.69, while eco-friendly module recorded higher damage of plants (47.22%) and more grubs/10m row length i.e., 12.99 at 60 days after treatment, cane yield of 27.96 t/acre, net gain of Rs.33,842.00 over control treatment and an Incremental cost benefit ratio of 8.91 indicating the larger role of the chemicals in managing the pest. Additional monetary gain to the farmer at the cost of natural enemies, soil microbes and unwanted chemical residues in the canes will not benefit the farmer and the ecosystem in the long run.

**Keywords:** Sugarcane, whitegrub, biopesticides, ICBR, chemical control

**Introduction**

Sugarcane (*Saccharum officinarum* L.) is one of the important commercial crops in tropics and sub-tropics and serves as the main source of sugar in the world. It is the world’s most efficient living collector of solar energy and stores this energy in a huge quantity of biomass in the form of fibre and fermentable sugars (Kumar and Pandey, 2022). India ranks second after Brazil in production, producing nearly 25% of total global production (Mishra et al., 2021). Production in India increased from 126 million tonnes in 1971 to 370 million tonnes in 2020 growing at an average annual rate of 2.78% (Knoema, 2020). Telangana ranked 12th in sugarcane area and production (0.33 lakh ha and 2.64 million tons respectively) in 2022-23 and 8th in yield (79.85 tons/ha) (Anonymous, 2023). Besides directly supporting to 5-6 million farmers by being a cash earning crop, sugarcane supports large number of industries like sugar mills (642) producing refined sugars, distilleries (more than 200) producing liquor ethanol, millions of jaggery manufacturing units (mostly handled by farmers themselves), few cooperative bora sugar units (unrefined brown powdered sugar) and millions of families depend on them (Anonymous, 2013). Beside these contribution to the economy, sugar industry produces huge quantity of by-products such as molasses (800 million L/annum), which is a source of producing ethanol, which can replace the petrol partially and reduce the dependence on the imports of petroleum products (Anonymous, 2013).

Crop productivity is often impaired by pests and diseases, which impede the attainment of complete yield potential of this commercial crop. Pests like borers, root/white grubs, whiteflies, scale insects and woolly aphid are regular pests throughout the year, but among them white grub damage is severe in belts of northern Karnataka (Kambrekar et al. 2015). Root grubs or June beetles are the most devastating pests in sugarcane. They attack plantation crops such as areca nut, cashew nut, coconut, tea, coffee, etc. and fruit crops with varying damage levels (Khan and Ghai, 1974; Veeresh, 1974). **They have become the most important polyphagous pest causing serious threat to sugarcane crop since 1960 (Mohalkar et al.** 1977). Yadava and Sharma (1995) reported 70% damage in several commercial crops due to white grubs infestation. White grubs of the genus *Holotrichia* with four species *viz*., *H*. *consanguinea* (Blanchard), *H. serrata* (Fabricius), *H. staudingeri* Brenske and *H*. *longipennis* (Blanchard) were the most dominant one attacking seven crops*.* The other species included *Anomola bengalensis* (Blanchard)*, A. ruficapilla* (Burmeister), *Adoretus* sp., *Lepidiota* sp., *Maladera* sp., *Popillia* sp*.* and *Schizonycha ruficollis* (Fabricius) (Sreedevi., 2019). *Holotrichia serrata* (Fabricius) caused 30 to 40% loss in sugarcane crop under irrigated ecosystem of northern Karnataka (Anonymous, 2013). Lamani et al (2017) reported 32.93%, yield decline, 39.16% reduction in gross return, 11.75% increase in cost of cultivation and 130% reduction in net return in sugarcane crop infested with white grub compared to the uninfested crop.

White grubs have become serious pests for most of the agricultural crops, fruits, vegetables, ornamental plants, plantation crops, pastures, turf and meadow grasses, lawns and forest trees in different parts of the world (Potter et al. 1992). With the first onset of rains, adults which emerge from the soil and migrate to the nearby neem or subabul trees, mate and feed on them. They are leaf feeders and feed on the foliage of many species resulting in crop losses, while the young grubs feed on the roots of many cultivated species causing wilting of the plant and huge yield losses finally if not managed in time. The female lays eggs in the soil near the root zone of the crop. Eggs hatch to larvae which feed voraciously on the root causing huge damage to standing crop. In the initial stages leaves wither and dry, but as the infestation increases, plants die and dry up in patches resulting in crop losses. Fields surrounded by neem or guava or subabul trees are more damaged compared to those without the trees.

Sugarcane is grown in areas in Nizamabad, Medak, Wanaparthy and Karimnagar districts of the state. Cane growing areas of Wanaparthy dt. of Telangana state have been recording higher infestation of whitegrub, *H. serrata* since the past few years in isolated pockets and this has been a cause of concern since the pest is polyphagous and attacks many crops *viz.*, vegetables, groundnut, maize and fruit crops like guava, mango, etc. Several techniques have been evaluated for the management of white grubs including cultural, mechanical, biological, chemical and integrated methods suggested by various workers (Sahayaraj and Borgio, 2009; Srikanth and Singaravelu, 2011).

Many authors have reported chemicals to show great efficacy in managing the pest. Patel et al., (2020) reported lowest grub population (0.88 grubs/m2), maximum pod yield (1907 kg/ha) and highest dry fodder yield (6146 kg/ha) were recorded in Imidacloprid 40% + Fipronil 40% - 80% WG @ 250 g per ha and it was at par with Clothianidin 50% WDG @ 250 gm per ha (0.96 grubs/m2), (1803 kg/ha) and 6042 kg/ha, while Chlorpyriphos 20% EC @ 4000 ml per ha recorded 1.13 grubs/sq.m.,1664 kg/ha and 5903 kg/ha of dry fodder respectively. Kumar and Pandey (2022) recorded highest sugarcane yield (78.61 t/ha) and cost benefit ratio (1:4.92) in Fipronil 40% + imidacloprid 40% WG applied @ 300 g a.i./ha followed by Clothianidin 50WDG @ 120 g a.i./ha (75.64 t/ha and 1.422) during 2020-21. However, Patil et al. (1986) reported that chemical control measures are ineffective since the pest lives within the soil and that the chemical insecticides evaluated against the grubs so far proved less effective and costly and poor farmers can’t afford. Moreover, there are many disadvantages with complete reliance on chemical control practices, major being harmful residues in the cane and juice and contamination of water, air and soil resources in the crop. Also, usage of spurious chemical pesticides has led to unnecessary increase in input costs in addition to failure to control pests at the right time. Hence, the use of non-chemical methods for grub management have been gaining popularity among the farmers.

Out of the many ecofriendly tactics to manage the pest, fires in the field in the vicinity of the trees during late evenings in the weeks after first rains have shown good attraction for the adult beetles. This tactic in combination with the use of any biopesticide targeted at the root zone helps manage the pest in a better way. Entomopathogenic fungi (EPF) are quite effective in managing pests in different crops and their efficacy depends on a wide range of conditions like the virulence of the strain used, soil moisture levels, the time of application and the stage of the insect when the formulation is applied. EPFs when used incur no environmental losses and when the right strain is applied at the susceptible stage of the insect, insect mortality rates soar up.

Literature available shows that among the many biopesticides available, *Metarhizium* *anisopliae* (Metschnikoff) Sorokin has greater success in the management of white grubs. *Metarhizium* can be effectively utilized as one of the components in the management of white grubs (Mohi-ud-din *et al*., 2006; Chroton, 2007). Higher colony-forming unit counts of *M. anisopliae* found in association with plant roots and root exudates suggest these fungi may be capable of survival in soils without an insect host (Hu and St Leger, 2002). *M. anisopliae* is safe to the environment and can be used in varied forms like liquid form suited for the drip system or the talc-based formulation which can be inoculated into farm yard manure, allowed to multiply for 10-12 days and thereafter applied at the root zone of the crop. This holds great promise for the use of *M.anisopliae* to manage *H.serrata* and could mean that continuous use of *M.anisopliae* over a period of years or so could help them colonise the root zone better and protect it from the root grub. Hence, the present study was conducted to evaluate its efficacy in comparison with farmers practices and untreated control to throw light on the future prospects of its use in managing *H.serrata* effectively*.*

**Materials and Methods**

A field experiment was carried out in 2 hectares area in farmers’ fields in Mastipur, Pamireddypally, Pudur, Mittanandimalla, Dharmapur and Shekpally villages, Wanaparthy dt., under the Krishnaveni sugar factory limits, Kothakota, Wanaparthy dt., Telangana for two consecutive years 2021-22 and 2022-23 to evaluate the efficacy of chemical and non-chemical methods against the root grub in sugarcane. A preliminary survey was carried out in the area to assess the damage caused by the whitegrub. Many awareness meetings and workshops about ecofriendly methods of pest management were conducted for the farmers. The varieties grown by farmers in this study were Co86032, a variety known for its hardiness, high sugar recovery, and resistance to extreme and deficit rainfall, 2003V46 also called Co V 09-356, a high-yielding variety with good ratooning ability and suitability for jaggery production and 93V297, a variety known for its high yield, good sucrose content and early maturity and suitable for irrigated and water-logged conditions). The varieties were grown in both ratoon and first crop.

The experiment was carried out in three modules as below with 1.6 acres in each module:

1. Ecofriendly module which included lighting fires in late evenings two days after the first showers in June in fields where neem trees were present; regular intercultivation between the rows in sugarcane to uproot larvae /pupae in the soil; two applications of *Metarhizium anisopliae* NBAIR *Ma*-4 @ 10 ml/l water liquid formulation once in june and again in July through drip with 30 days gap.
2. Chemical check module which consisted of two applications of insecticide combination of imidacloprid 40% + fipronil 40%- 80wg at 200g/acre through drip.
3. An untreated control module.

Observations on no. of damaged plants before and after the treatment imposition, no. of grubs/10 m row length before and after the treatment imposition and final yield were taken. Additional returns over control and incremental cost benefit ratios were calculated to compare the modules.

**Results**

Results revealed that both the Eco-friendly and Chemical check modules performed better than the untreated control module. Plant damage decreased from 67.45 to 47.22% in Eco-friendly Module plots while it decreased from 68.99 to 29.66% in the Chemical check Module and from 68.45 to 65.45% in the Untreated control module respectively at 60 days after transplantation (DAT). No.of grubs/ 10 m row length also decreased from 15.56 to 12.99 in Eco-friendly Module, while in Chemical check module it decreased from 16.03 to 10.9 at 60 DAT and Untreated control Module from 16.33 to 16.22/10m row length respectively at 60 days after transplantation (DAT). Cane yield recorded was higher in Chemical check Module (35.25 t/acre) than Eco-friendly Module (27. 96 t/acre), while it was least (14.98 t/acre) in the Untreated control Module (Table. 1).

Economics of the study showed that increased yield over control and Increased benefit over control were 20.27 t/acre and Rs.58,783/- (Rs.2900/t was the average selling price of the cane) in the Chemical check module, while they were 12.98 t/acre and Rs.37,642/- in the Eco-friendly module. Incremental Cost Benefit Ratio was highest in the Chemical Check (9.69), while it was 8.91 in the Eco-friendly module (Table.1). Chemical check and Eco-friendly modules thus can be considered to be almost similar in their efficacy against the white grub, however the eco-friendly module requires much advanced planning compared to the former.

**Discussion and Conclusions**

The study concluded that both the chemical check and ecofriendly modules evaluated for root grub management in sugarcane were successful in managing the pest effectively. Chemical check module recorded little higher incremental cost benefit ratio than the eco-friendly module, however the difference was less. Similarly, Visalakshi et al (2023) reported that cost-benefit ratio of treatment with *M.anisopliae* (NBAIR Ma-4) was 1.39 and *Holotrichia consanguinea* (NBAII *H*38) was 1.49 and these were found to be superior to Chlorantraniliprole18.5SC insecticidal application (1.31) in the management of sugarcane white grubs in coastal Andhra Pradesh. Kammar et al (2022) recorded 16.77 % and 10.89 % increase in yields of sugarcane in the treatment applied with *M. anisopliae* and EPN (*H. indica*) over the farmers’ practice respectively*.* They concluded that soil application of *M. anisopliae* (4 x 109) CFU @ 5 kg/ha at the time of planting was significantly effective in reducing white grub population, followed by application of EPN.Similarly, Manisekaran *et al*., (2011) recorded 92% mortality in grubs using *M. anisopliae* @ 4x109 conidia at 60 DAT and was next to drenching of chlorpyriphos which was found to be most effective recording 100% reduction in grub population. They also reported higher incremental benefit cost ratio (IBCR) (7.58) with higher doses of *M. anisopliae* followed by drenching of chlorpyriphos (6.09). Nagaraj et al. (2017) found that *M. anisopliae* when used with FYM was found effective in managing root grub compared to application of chlorpyriphos 20 EC. Additional monetary gain to the farmer at the cost of loss of natural enemies and soil microbes may not always benefit in the long run. Moreover, excessive reliance on chemical control agents exclusively leads to residues in the cane affecting human health adversely.

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Table 1. Efficacy of M.anisopliae against whitegrub, H.serrata in sugarcane

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **S.No** | **Modules** | **Damaged plants (%)** | | **No.of grubs/10m row length** | | **Cost of inputs for pest management (Rs.)** | **Cane Yield t/acre** | **Increased yield over control**  **(t/acre)** | **Increased benefit over control**  **(Rs.)** | **Net Gain over control**  **(Rs.)** | **ICBR** |
| **Before treatment** | **60 DAT** | **Before treatment** | **60 DAT** |  |  |  |  |
| 1 | *Eco-friendly Module :*  *Fires in field/light trap + Metarhizium anisopliae* NBAIR *Ma*-4 strain @ 10ml/L) | 67.45 | 47.22 | 15.56 | 12.99 | 3,800 | 27.96 | 12.98 | 37,642 | 33,842 | 8.91 |
| 2 | Chemical Check Module : (Fipronil 40% + imidacloprid 40 WG @ 5ml/L) | 68.99 | 29.66 | 16.03 | 10.9 | 5,500 | 35.25 | 20.27 | 58,783 | 53,283 | 9.69 |
| 3 | Untreated control | 68.45 | 65.45 | 16.33 | 16.22 | - | 14.98 |  |  |  |  |

Appendix

