Management of sugarcane root grub, *Holotricha serrata* (Fabricius), with an entomopathogenic nematode, *Heterorhabditis indica*, in sugarcane areas of Karnataka, India

Manjunatha S Rao and M Sankar

*Sugarcane Research and Development (R&D), EID Parry (I) Ltd., Pugalur, Karur Dt. Tamil Nadu-639113, India; msankar@parry.murugappa.com*

**Abstract**  The sugarcane root grub *Holotricha serrata* is a scarabaeid beetle that feeds below the ground on plant roots with maximum damage being death of the plant. It is a major pest in Karnataka state (India) and in Bagalkot and Ramdurg districts where thousands of fields are infested. There is a growing interest in India to use a strain of the entomopathogenic nematode (EPN) *Heterorhabditis indica* as a biocontrol agent for grub management. Parry India Sugar Ltd (PISL) took steps to test and popularize this nematode as an alternative strategy for root grub management in sugarcane. To conduct our experiments, a mixture of EPN and talc powder with appropriate moisture was applied to individual sugarcane stools covering the entire root zone, then the treated block was irrigated immediately to maintain moisture to support survival and movement of infective juveniles. The EPNs killed all grub stages from 1st to 3rd instars and significantly reduced pupal numbers and adult emergence in the treated blocks. Based on this success, we are exploring better ways to apply this nematode as a soil application in infested fields of our Parry command area.

**Key words**  Biological control, entomopathogenic nematode (EPN), root grub, sugarcane

**INTRODUCTION**  Intensive agricultural practices relying heavily on chemical pesticides are a major cause of widespread ecological imbalances, resulting in serious problems of insecticide resistance, pest resurgence and pesticide residues. There is a growing awareness across the world on the need to promote environmentally sustainable agriculture practices. Identifying pests and associated beneficial insects helps farmers make appropriate pest management decisions.

Sugarcane root grub, *Holotricha serrata* (Coleoptera, Scarabaeidae), is a pest of economic importance in India. The C-shaped grub is pale yellow, whilst adults are nocturnal and active during the day. The grubs mostly live underground or under debris, so are not exposed to sunlight. Sugarcane root grubs are root feeders and are serious pests in Maharashtra and Karnataka, India where it is known to inflict considerable losses in cane yield of up to 70% (Yadava *et al.* 1995). The mated females return to the soil in early morning and start laying eggs within 2-3 days of mating. Emerged beetles live for 35-49 days, and females lay an average of 20-40 eggs/beetle at a depth of 6-10 cm in the soil. Egg development takes from 7 to 13 days. The average durations of 1st, 2nd and 3rd instar larvae are 16, 32 and 49 days, respectively. The pupal period is 15 days, and the duration of the total life cycle is 122 days. Damage to sugarcane is done by feeding on roots and underground stems. The first symptoms are of yellowing leaves, with stunted growth, dense browning, lodging, plant uprooting, and death observed in highly infested areas. Damage is usually more severe in ratoon crops than in plant crops and is most evident around the edges of a field. Grub damage is worse on muck and sandy soils and spreads slowly in an irregular pattern throughout the field.

The objective of this study was to manage the sugarcane root grub by using an entomopathogenic nematode (EPN), *Heterorhabditis indica*, in areas of high damage in our sugarcane command areas of Tamil Nadu and Karnataka.
MATERIALS AND METHOD

Initially, we surveyed adult insects in Bagalkot Unit (Karnataka state) sugar command area during the monsoon season of May 2014. The second half of June 2014 was the peak period of beetle emergence as trapped by solar light traps that we used as a monitoring device. Before establishing the experiment, we set 4 solar light traps per acre in the corner of the plot to check for beetle flights during the monsoon. The number of beetles trapped in the solar light traps was recorded daily for 3 days.

We used the entomopathogenic nematode (EPN) *H. indica* that is commercially available as a biocontrol agent from Kaveri Microtech Pvt Ltd (Hyderabad). The experiment was done during October 2014 in the Chelumi division of Kali Section (Bagalkot Sugar Unit), Karnataka where more than 50% of damage by the sugarcane root grub, *H. serrata* had been recorded.

We mixed 2 kg of EPN-talc formulation at 50,000 infective juveniles/gram with 5 kg of sand before treatment. Eight replications were maintained with 2 rows of each and an untreated eight replications of control block was maintained separately with a 1.5 m gap from the treated block. Thoroughly mixed EPN talc powdered formulation with appropriate moisture was applied to each sugarcane stools individually, covering the entire root zone, then the treated block was irrigated immediately to maintain moisture to support survival and movement of infective juveniles. We monitored numbers of larvae 7 days after application.

RESULTS AND DISCUSSION

Before treatment, the presence of beetles was confirmed by solar light traps (Fig. 1).

![Fig. 1. Number of beetles captured by each solar trap on each of 3 days.](image-url)

All the stages of the root grub, eggs, larvae and pupae, were recorded from each of the treated and untreated stools after 7 days. An average number of 11.5 eggs per stool was recorded in the untreated control stool, varying from 5.0 to 16.0 eggs/stool. The average numbers of 1st, 2nd and 3rd instar grubs were 8.0, 8.15 and 8.75/stool, respectively, and there were 14.25 pupae/stool in the untreated control block. The number of eggs collected from the treated block varied from 2.0 to 8.0/stool with an average of 6.0/stool. There was a very low population of grubs, 0.5, 0.75 and 0.25/stool for 1st, 2nd and 3rd instars, respectively. Hence, we observed that the EPN killed all grub larvae from 1st to 3rd instars and significantly reduced pupal formation and adult emergence in the treated blocks.

Grewal *et al.* (2005) reported that entomopathogenic nematodes from the Heterorhabditidae and Steinernematidae are eco-friendly and IPM compatible to alternative chemical pesticides. The efficacy and superiority of *H. indica* is in accordance with Maneesakar *et al.* (2010), who reported greater virulence against Japanese beetle, *Popillia japonica*, on 3rd instar larvae in the soil environment. EPN populations can be conserved during agronomic practices by a reduced tillage system, with lower temperatures, and greater pore size, soil moisture and numbers of antagonist organisms.
The efficacy of EPN is influenced by biotic and abiotic factors and, therefore, it is difficult to guarantee their potential. This is an area for further study.

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REFERENCES


Gestion du ver des racines, *Holotricha serrata* (Fabricius), avec un entomopathogène nématode, *Heterorhabditis indica*, dans les zones de canne à sucre du Karnataka, Inde

Résumé. Le ver blanc des racines de canne à sucre *Holotricha serrata* est un coléoptère Scarabaeidae qui se nourrit du système racinaire causant un maximum de dégâts qui ne peuvent guère être identifiés à moins que la plante ne meurt. C’est un ravageur majeur sans l’état de Karnataka (Inde), et plus particulièrement dans les districts de Bagalkot et Ramdurg où des milliers de champs sont infestés. Il y a un intérêt croissant dans notre pays pour l’utilisation du nématode entomopathogène (EPN) *Heterorhabditis indica*, un agent de lutte biologique utilisé dans la gestion des vers blancs. Parry India Sugar Ltd (PISL) a pris des initiatives pour tester et vulgariser ce nématode comme une stratégie alternative pour le management de ce ver blanc des racines de canne à sucre. Pour conduire ces expérimentations, une formulation en poudre (talc) mixée avec l’EPN et à une humidité appropriée a été appliquée à chaque souche de canne à sucre couvrant la zone racinaire, puis les blocs traitées ont été immédiatement irrigués pour maintenir l’humidité afin d’aider les stades juvéniles infectants à survivre et se déplacer. Nous avons observé que l’EPN tuait tous les vers blancs du 1er au 3ème stade larvaire et réduisait significativement la formation des chrysalides et l’émergence des adultes dans les blocs traités. Basé sur le succès enregistré avec ce nématode dans le contrôle du ver blanc, nous explorons une voie d’application de cet agent biologique au sol dans tous les champs infestés application dans notre zone de commande Parry.

Mots-clés: Contrôle biologique, entomopathogenic nematode (EPN), ver des racines, canne à sucre

Manejo en caña de azúcar del gusano blanco de suelo, *Holotrichia serrata* (Fabricius), con un nematodo entomopatógeno, *Heterorhabditis indica*, en las áreas de caña de azúcar de Karnataka, India

Resumen. El gusano blanco de la caña de azúcar *Holotrichia serrata* es un coleóptero Scarabaeidae que se alimenta de las raíces de las plantas por debajo del suelo llegando a dañar a la planta hasta la muerte. Es una plaga importante en el estado de Karnataka (India) y en los distritos Bagalkot y Ramdurg donde se infestaron miles de campos. Para su manejo existe un interés creciente en la India de utilizar un agente biocontrolador una cepa del nematodo entomopatógeno (EPN) *Heterorhabditis indica*. Parry India Ltd. Azúcar (PISL) dio pasos para poner a prueba y popularizar este nematodo como una estrategia alternativa de manejo de este gusano comedor de raíz en caña de azúcar. Para llevar a cabo nuestros experimentos, se aplicó una mezcla de PEN y polvo de talco con la humedad adecuada en forma individual en la caña de azúcar cubriendo toda la zona de la raíz, entonces el bloque tratado se regó inmediatamente para mantener la humedad para apoyar la supervivencia y movimiento de los estadios juveniles infecciosos. Las EPN mataron a todas las larvas del 1º al 3 de estadios y las pupas se redujeron de manera significativa como la emergencia de adultos en los bloques tratados. Sobre la base de este éxito, se está buscando mejores maneras de aplicar este nematodo al suelo en campos infestados de nuestra área de influencia Parry.

Palabras clave: Control biológico, nematodos entomopatógenos (EPN), gusano de raíz, caña de azúcar