

Original Research Article

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Field Efficacy of *Metarhizium anisoplae* (Metschnikoff) Sorokin and (*Heterorhabditis indica*) for the Management of White Grub in Small Onion

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ABSTRACT

Field experiments were conducted on small onion for white grub management using entomopathogenic fungi *Metarhizium anisoplae* (Metschnikoff) Sorokin and entomopathogenic nematode (*Heterorhabditis indica*) and synthetic insecticides (farmers' practices) at Kurumbalur pudhur village, Perambalur district. Application of commercially available EPN (*Heterorhabditis indica*) @ 1 kg/acre against onion white grub *Holotrichia serrata* (Blanch) was found effective (95.28 %) followed by *Metarhizium anisoplae* @ 1 kg/ acre registered 83.02% reduction in grub population on 60th DAT. The highest bulb yield was recorded when basal application of *H. indica* (130.6 q ha⁻¹), followed by *M. anisoplae* (101.8 q ha⁻¹) and Farmer practices (84.6 q/ ha⁻¹). Benefit cost ratio (BCR) was high with application of *H. indica* (3.15) followed by *M. anisoplae* (2.52) and farmers practices (1.90).

Keywords

Onion, White grub
Holotrichia serrata,
Heterorhabditis
indica, *Metarhizium*
anisoplae

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Introduction

India is the second largest producer of onion, *Allium cepa* L. in the world after China. It is cultivated in an area of 10.52 lakh hectares in india with an annual production of about 168.13 lakh tonnes. In the state of Tamil Nadu, the southernmost part of India, onion is cultivated in an area of 30,255 ha with a production of 286,000 tonnes (Dinakaran *et al.*, 2013). The average productivity of onion in Tamil Nadu is 9.45 tonnes/ha

(www.tn.gov.in). The major biotic factors contributing to yield loss in onion production are pest and diseases. Among several factors that limit onion cultivation, insect pests stand foremost in reducing the yield in India and each year about 10 to 25 per cent of the world's total production is lost due to pests attack (Diaz-Montano *et al.*, 2011). The yield loss due to white grubs was reported to be as high as 100 per cent in Tamil Nadu (Thamarai Selvi *et al.*, 2010). In India, more than 1000 species of white grubs are known of which

over 40 species attack wide range of plants. White grubs have become serious pests of most agricultural crops, fruits, vegetables, ornamental plants, plantation crops, pastures, turf and meadow grasses, lawns, golf courses and forest trees in different part of the world (Guppy and Harcourt, 1970). The Perambalur district is one of the major small onion growing districts of Tamil Nadu with an average area of 7490 ha under onion cultivation. The average onion productivity of the district is 8.5 t/ ha. In Perambalur district apart from onion, white grub (*Holotrichia serrata*) attack maize, turmeric, brinjal, sugarcane and yam.

The White grub are hidden enemies of field crops because much of their life cycle is subterranean and remain unnoticed even after complete destruction of a healthy crop. The white grub is the most destructive pest of onion for the past three years. It attacks onion at all the stages of crop growth, but their number increases from vegetative stage and remain high up to bulb development and maturity. Grub stages under the ground cause direct damage by feeding the roots and bulbs of onion with mandibular mouth parts.

It causes damage directly through feeding and indirectly through the bacterial infection leads to rotting of bulbs. It is difficult to control this pest with insecticides because of its life stages found inside the ground. Yadava and Sharma (1995) reported that the presence of one grub/m² may cause 80-100 per cent plant mortality

In a majority of the farming situations, control of white grub has become difficult because of the lack of control over the damage. Farmers mostly depend primarily on the use of highly poisonous chemical pesticides at high infestation. Several tactics have been adopted 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). Thamarai chelvi *et al.*, 2010 reported that first time report in India about the bioefficacy of the biopesticide *M. anisopliae* at field level for the control of sugarcane white grub (*H. serrata*) effectively. EPNs in the genera 104 *Steinernema* spp and *Heterorhabditis* spp are found to be potential agents for control of insect pests mainly belonging to order Diptera, Coleoptera, Lepidoptera and Orthoptera (www.sac.org.bd). Forchler and Gardner (1991) showed When a host has been located, the nematodes penetrate the insect through body openings and release symbiotic bacteria that multiply and rapidly kill the insect.

Chemical control is practically uneconomical, difficult and associated with high cost, environmental pollution and pesticide residues. Hence, there is a need for development of alternate eco-friendly and economically feasible strategy for the control of white grubs. White grubs are naturally infected by various entomopathogens which include fungi, bacteria and nematodes (Ravinder *et al.*, 2018). EPNs are naturally found in soil and are extra ordinarily lethal to many important soil insect pests and safe to plants and animals (Smart, 1995).

Metarhizium anisopliae (Metschnikof) Sorokin can be effectively utilized as one of the components in the management of white grubs (Mohi-ud-din *et al.*, 2006; Chroton, 2007). Both the bioagents are eco-friendly, cost effective, highly persistent and also self-perpetuating in nature and the microclimate of onion eco-system is ideal for their multiplication. Keeping these aspects in view, experiments were conducted to study the efficacy of entomopathogenic fungi and entomopathogenic nematode for the management of white grub in onion.

Materials and Methods

The field experiments were carried out to evaluate the efficacy of *Metarhizium anisoplae* (Metschnikoff) Sorokin and (*Heterorhabditis indica*) and chemical treatment for the management of white grub in small onion at Kurumbalur Pudhur village, Perambalur District, Tamil Nadu, India, during the seasons Kharif 2018/19 (July 2018 to September 2018). The experiments were conducted in ten farmers' field.

The experimental material was consist of three treatment schedules viz., two different bioagents with farmer practices of using only synthetic chemical pesticides (conventionally cultivated farmers' practice). Treatments were as follows

T1 - Soil application of *Metarhizium anisoplae* @ 1 kg/acre before sowing

T2 - Soil application of EPN (*Heterorhabditis indica* @1kg/acre before sowing.

T3 - Farmers practices (Spraying Chlorpyrifos or pyrethroid group of insecticide at high infestation)

The application of chemical insecticides was started at when the infestation was very high. All other agronomical practices were performed as per need in all the treatments. Observations were recorded on plant damage due to white grubs, the number of white grubs per 10 meter row in the root zone recorded at 30, 45, 60 days after treatment (DAT). The percent decrease in white grub damage and white grub population was calculated and compared.

The cost benefit ratio was also worked out and data was analyzed statistically and presented in Table 1.

Results and Discussion

Basal application of two different Biopesticides i.e., *M. anisoplae*, *H. indica* before sowing and farmers practices of applied insecticide when the infestation was severe with Chlorpyrifos or Cypermethrin were tested for determining efficacy against white grub. The treatment with *H. indica* consistently effective and found to be significantly superior over all other treatments. Percent reduction in plant damage due to white grub recorded high in *Heterorhabditis indica* (79.86%), *Metarhizium anisoplae* (67.74%) and farmer practices (72.91%). The treatment of Bioagent *H. indica* application was more efficient and reduced the grub population to the extent of 0.25 grubs/10 m row followed by 0.9 grubs/ 10 m and 5.3 grubs/10 m for *M. anisoplae* and Farmers practices respectively.

Higher yield increase was recorded in *Heterorhabditis indica* (130.66 q/ha) compared to *Metarhizium anisoplae* (101.80 q/ha) and farmer practices (84.6 q/ha) (Table 2). The economics of different management methods presented in table 2 revealed that the *H.indica* and *M. anisoplae* application recorded 3.15 and 2.52 BC ratio with the yield of 130.6 q/ha and 101.8 q/ha. The farmers practice recorded a BC ratio of 1.90 and obtained the yield of 84.6 q/ha As the farmers practice depends heavily on the usage of insecticides for the management of white grub the cost of cultivation in this method is higher than the other methods. The cost of plant protection measures per hectare in *H. indica*, *M. anisoplae* and farmers practice are 1875, 1375 and 2500 (Table 2).

These results indicate that EPF (*M. anisoplae*) played a less little bit less management efficacy comparing to EPN in grub control. EPNs generally kill the host within 48 h by releasing the symbiotic bacteria, i.e.

Photorhabdus spp. associated with *H. indica*. In contrast, time until death is much longer for fungus-infected grubs, and the nematodes may have killed the host early in this period.

A much higher percentage of EPN-infected carcasses were found in the treated field comparing to EPF-infected grubs. Overall, the use of the nematodes or fungi achieved efficacy comparable to the farmers practices of only using insecticides at last stage in the control of 3rd instar grub.

The results of our studies suggest that *H. indica* is better for controlling white grubs. This may be due to the better survival and adaptability in the soil and being irrigated and short duration crop microclimate was also suitable in the field of small onion its control on grub is excellent and appreciated by the farmers. Therefore, it is recommended for the management of white grubs in onion crop.

The present study was in line with observation on application of *M. anisopliae* at higher dosage was as good as Fenthion in reducing root damage by *Lepidiota negatoria* in sugarcane as observed by Samson *et al.*, (1999).

Kamaliya *et al.*, 2019 reported that Bio-efficacy of *H. indica* against groundnut white grub in pot revealed that mortality of white

grub reached up to 73.34 % at higher inoculums level (100 IJs/grub) after 120 hrs of application. Dinesh (2018) reported that effect of entomopathogenic nematodes (EPN) on ash weevils in brinjal caused 74.8% mortality under field conditions. The result are supported by the finding of Entomopathogenic nematode, *Heterorhabditis indica* was found significantly effective in reducing white grub damage compared to entomopathogenic fungus, *Metarhizium anisopliae*. Percent reduction in plant damage due to white grub recorded high in *Heterorhabditis indica* (79.86%), *Metarhizium anisopliae* (67.74%) and chlorantraniliprole (72.91%) over untreated control.

This is in conformity with the findings of Bharathi and Mohite (2015). That the *H. indica* recorded 75.66 to 92.33 per cent mortality of first instar grubs at 7DAT, 55.00 to 82.00 per cent mortality of second instar grubs at 7DAT and 62.00 to 95.00 per cent mortality of third instar grubs at 10DAT in laboratory. Entomopathogenic nematode, *Heterorhabditis indica* was found significantly effective in reducing white grub damage compared to entomopathogenic fungus, *Metarhizium anisopliae* resulted in higher bulb yield. Use of entomopathogenic fungi and entomopathogenic nematodes reduces the cost of plant protection and in turn increases the economic yields (Fig. 1).

Table.1 Efficacy of *M. anisopliae* and *H. indica* against onion white grub, *Holotrichia serrata*

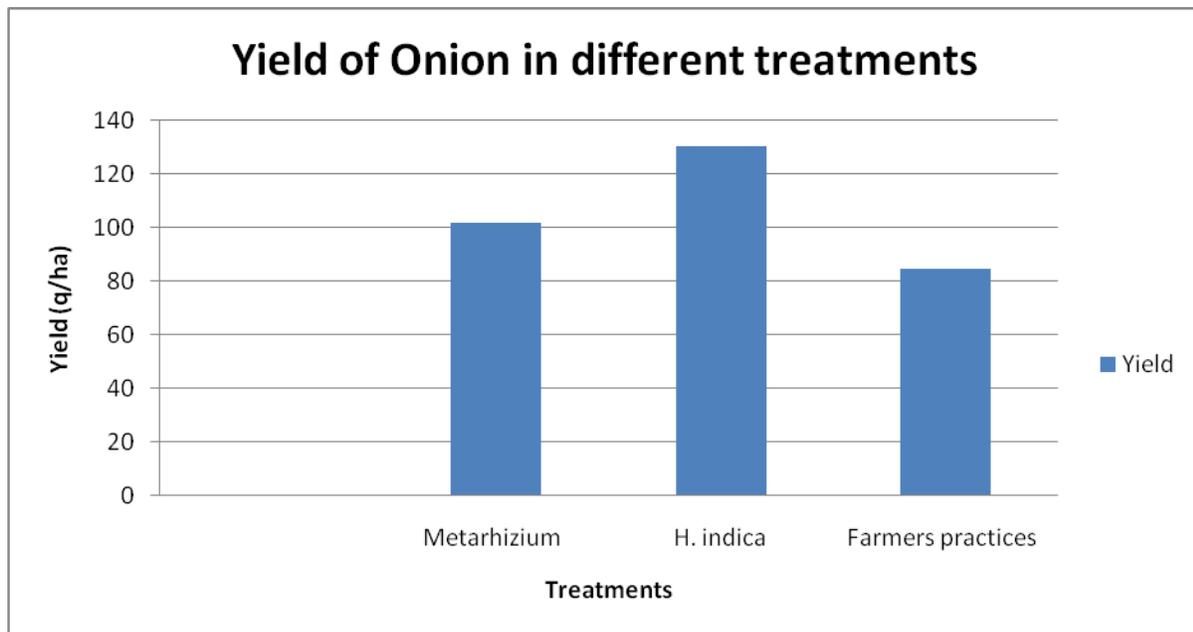
Treatments	White grub population (No. of white grub per 10 m row)			Percent reduction over control	White grub damage (%)		
	30 DAT	45 DAT	60 DAT		One month after treatment	Two month after treatment	Reduction in white grub damage over control (%)
T1	1.6	1.1	0.90	83.01	1.16	2.13	92.5
T2	1.2	0.6	0.25	95.28	1.14	1.72	94
T3	3.9	6.4	5.3	-	5.6	28.63	-

DAT: Days After Treatment

Table.2 Economics of *M. anisoplae* and *H. indica* in the control of small onion white grub, *H. Serrata*

Treatments	Yield q/ha	Cost for plant protection	Gross cost Rs./ha	Gross return Rs./ha	Net return Rs./ha	IBCR
T1	101.8	1875	40457	89125.8	61343	2.52
T2	130.6	1375	41474.2	130600	89125.8	3.15
T3	84.6	2500	44492	40108	40108	1.90

Fig.1 Comparison of yield between IPM field and Non IPM Framers practices against white grub in onion crop



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