Bioagents: an effective and ecofriendly option for the management of maize cyst nematode, *Heterodera zeae* on sweet corn (*Zea mays* L. *saccharata*)

B.L. Baheti, Mukesh Dodwadiya, B.S. Rathore and S.S. Bhati

ABSTRACT

The aim of this investigation was to study the effect of seed treatment through bio-agent on maize cyst nematode, *Heterodera zeae* on sweet corn (variety- Madhuri). For this study, bio-agents viz., *Paecilomyces lilacinus, Pochonia chlamydosporia* and *Trichoderma viride* were tested as seed treatment at 1, 2 and 4 % w/w for the management of maize cyst nematode, *H. zeae* on sweet corn. A standard chemical (Acephate 2%w/w) and untreated check was also maintained for comparison. Observations on shoot weight (g), root weight (g), cyst per 100 cc soil, cyst per plant, and final larvae population per 100 cc soil were recorded to interpretate the experimental findings. Results showed that *Paecilomyces lilacinus* at 4 per cent was found most effective followed by *Pochonia chlamydosporia* at 4 per cent and *Paecilomyces lilacinus* at 2 per cent in enhancing plant growth of sweet corn and to reduced the infection of *Heterodera zeae*. Seed treatment with *Paecilomyces lilacinus* at 4 per cent w/w was found most effective to enhanced plant growth of sweet corn and management of *H. zeae*.

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INTRODUCTION

Maize is one of the most important cereal crop of the world and is widely used as food, feed and fodder. It accounts about 9.43 million hectares of area with production and productivity of 24.35 million tonnes and 2583 kg/ha, respectively during 2014-15 (Anonymous, 2015). Maize being multi-utility crop, is unique among the cereals with more than 3500 different uses. Based on the grain composition different types such as flint, dent, sweet, pop, pod, waxy and floury maize are suitable for specific usages. Among various types of maize, sweet corn is most popular for table purpose as well as green cobs. It differs from the general maize due to its higher sweetness (high amount of sugar) and alcoholic material. Besides, its consumption as boiled grains and vegetable purpose, it is also utilized for extracting sucrose as an industrial purpose. It's very profitable to peri-urban farmers due to high cost of green cobs. The crop is harvested in about 75 to 90 days after sowing. It gives good return to the growers and the green stalk used as fodder.

Maize suffers from number of pest and pathogens including nematodes in India (Rai 1969, Payak and Sharma 1980). It is attacked by number of phytonematodes viz. *Heterodera*, *Prataylenchus*, *Tylenchorhynchus*, *Meloidogyne*, *Hoplolaimus*, *Helicotylenchus, Rotylenchus, Longidorus*, *Trichodorus*, *Xiphinema* and *Belonolaimus* (Berg *et al.* 2001 and Singh *et al*. 2007). These nematodes apart from causing losses by themselves interact with other disease causing agents and adversely affect the quantity and quality of maize production. Among nematodes, maize cyst nematode, (*Heterodera zeae*) is considered to be the most important nematode of this crop (Singh and Rathore, 2001). It was first reported by Koshy *et al.*

(1970) from Chhapli village of Udaipur (Presently part of Rajsamand) district of Rajasthan. It is widely distributed in maize growing areas of Rajasthan, Delhi, Punjab, Haryana, Himachal, U.P., Bihar, M.P., Gujrat, Tamilnadu, Karnataka, A.P. and Maharasthra (Koshy and Swarup 1971; Kaushal *et al.,* 2007). Srivastava and Chawla (2005) reported yield losses of maize to the tune of 17-29 % by maize cyst nematode, *H. zeae* in India.

To manage the nematodes, chemicals proved effective but due to their hazardous effects and non judicious use have enhanced the development of biological control strategies for integrated management of plant parasitic nematodes with various types of antagonistic organisms (Jatala, 1986).The action of fungal parasite on eggs in reducing the nematode population is a promising factor in the crop protection against cyst nematode. *Paecilomyces lilacinus, Pochonia chlamydosporia* and *Trichoderma viride* have been reported as an effective fungal parasite of nematodes egg which is not only reduce the nematode population but also increase plant growth. Most of the research on fungus as biocontrol agent of nematodes is focused on biocontrol of cyst nematode and root-knot nematode.

However, such type of work was lacked on sweet corn so kept in view present investigation had been under taken to evolve economical and eco-friendly management technology against maize cyst nematode, *Heterodera zeae* on sweet corn.

MATERIALS AND METHODS

An experiment was carried out to test the efficacy of bio-agents *viz. Paecilomyces lilacinus, Pochonia chlamydosporia* and *Trichoderma viride* for the management of maize cyst nematode, *H. zeae* on sweet corn. The bio-agents were used @ 1, 2 and 4 % w/w as seed dressing. A chemical (Acephate 2% w/w) and untreated check was also maintained for comparison. 1 kg seeds were taken in a beaker, added few drops of gum and stirred with the help of glass rod and thereafter required quantity of bio- agents/chemicals were added to it and mixed thoroughly to provide uniform smooth coating of bio-agent and chemical over seeds. The chalk powder was used as drying agent. Initial nematode population was estimated before sowing. The experiment was laid out in completely randomized design and all the treatments were replicated four times. Utmost care was taken right from sowing till harvest of experiment for proper growth and development of plants. Observation on shoot weight (g), root weight (g), number of cyst per 100cc soil, cyst per plant and final larvae population per 100cc soil were recorded for comparison between various treatments. Statistical analysis was done after termination of experiment.

RESULTS AND DISCUSSIONS

In present investigation bio-agents (*Paecilomyces lilacinus, Pochonia chlamydosporia* and *Trichoderma viride*) were used as seed treatment at 1, 2 and 4 % w/w for the management of maize cyst nematode, *H. zeae* on sweet corn. Observations on shoot weight (g), root weight (g), cyst per 100 cc soil, cyst per plant and final larvae population per 100 cc soil were recorded to interpretate the experimental findings.

Results exhibited that shoot weight of sweet corn was enhanced when bio-agents were used as seed treatment. Among bio-agents, *Paecilomyces lilacinus* at 4 per cent (20.25 g) was found to be the best with respect to shoot weight followed by *Pochonia chlamydosporia* at 4 per cent (19.50 g), *Paecilomyces lilacinus* at 2 per cent and *Trichoderma viride* at 4 per cent (19.00 g). These results found at par with each other but significantly better over untreated check. *Trichoderma viride* at 1 per cent (16.25 g) was found least effective and at par with untreated check (15.75 g). Among all the treatments, maximum shoot weight (22.50 g) was obtained with acephate at 2 per cent and it was found significantly superior over rest of the treatments. Seed treatment with *Paecilomyces lilacinus* at 4 per cent increased

shoot weight to the tune of (28.57%) followed by *Pochonia chlamydosporia* at 4 per cent (23.81%), *Paecilomyces lilacinus* at 2 per cent and *Trichoderma viride* at 4 per cent (20.63%) over untreated check. The shoot weight increased with the increase of bio-agent dose. However, highest increase in shoot weight (42.86 %) was observed when sweet corn seeds were treated with acephate at 2 per cent. Almost similar trend was noticed with respect to root weight.

The results of present investigation are in accordance with the findings of previous worker who reported that seed treatment with bio-agents improved plant growth infested with nematodes. Jayakumar *et al.* (2002) reported that bio-agent, *P. lilacinus* was found most effective in controlling the reniform nematode and improving the growth and yield of cotton. In similar way the efficacy of *Trichoderma viride* and *Pochonia chlamydosporia* were reported by Devi and Sharma (2002) and Sivakumar (2009), respectively. However, different bio-agents exert different reaction with respect to plant growth parameters. This may be perhaps due to variation in their nematicidal value, environmental conditions, physical properties etc.

Application of *Paecilomyces lilacinus, Pochonia chlamydosporia* and *Trichoderma viride* at 1, 2 and 4 % w/w as seed treatment reduced cyst per 100 cc soil over untreated check. Among bio-agents, minimum cyst per 100 cc soil (13.50) was obtained with the application of *Paecilomyces lilacinus* at 4% followed by *Pochonia chlamydosporia* at 4% (15.75) and *Paecilomyces lilacinus* at 2% (16.25) as compared to untreated control (21.00). These treatments significantly proved better over untreated check.

However, minimum cyst per 100 cc soil (11.75) was observed with acephate at 2% and it significantly reduced cyst per 100 cc soil over other treatments. Seed treatment with *Paecilomyces lilacinus* at 4% reduced cyst per 100 cc soil to the tune of 35.71 per cent over untreated control. It was observed 25.00 per cent, 22.62 per cent in *Pochonia chlamydosporia* at 4% and *Paecilomyces lilacinus* at 2%, respectively. However, highest reduction in cyst per 100 cc soil (44.05%) was recorded when sweet corn seeds were treated with 2% acephate. Similar trend was observed with regards to cyst per plant and final larvae population per 100 cc soil.

Several workers have earlier reported efficacy of bio-agents for the management of plant parasitic nematodes on different crops. Kerry (1978) found that almost all *Heterodera avenae* cysts were parasitized by naturally occurring soil fungi which controlled the population of nematodes in British soil. The culture filtrate of nematophagous fungus, *Pochonia chlamydosporia* was found as a potential bio-control agent against root-knot and cyst nematodes reported by Atkins *et al.* (2004).

Shanmuga *et al.* (2006) observed that application of *P. lilacinus* as seed treatment significantly reduced root-knot nematode on tomato. These studies revealed that seed treatment with various bio-agents not only reduced nematode infection but also enhanced the plant growth characters.

Thus, it is suggested from present investigation that bio-agents can be effectively employed as seed treatment on sweet corn to promote plant growth and to reduce the infection of maize cyst nematode. The results have been presented in Table-1 and illustrated through Fig.-1 & 2. On the whole, seed treatments with bio-agent *Paecilomyces lilacinus* at 4 per cent w/w was found most effective to enhanced plant growth and management of *H. zeae* on sweet corn.

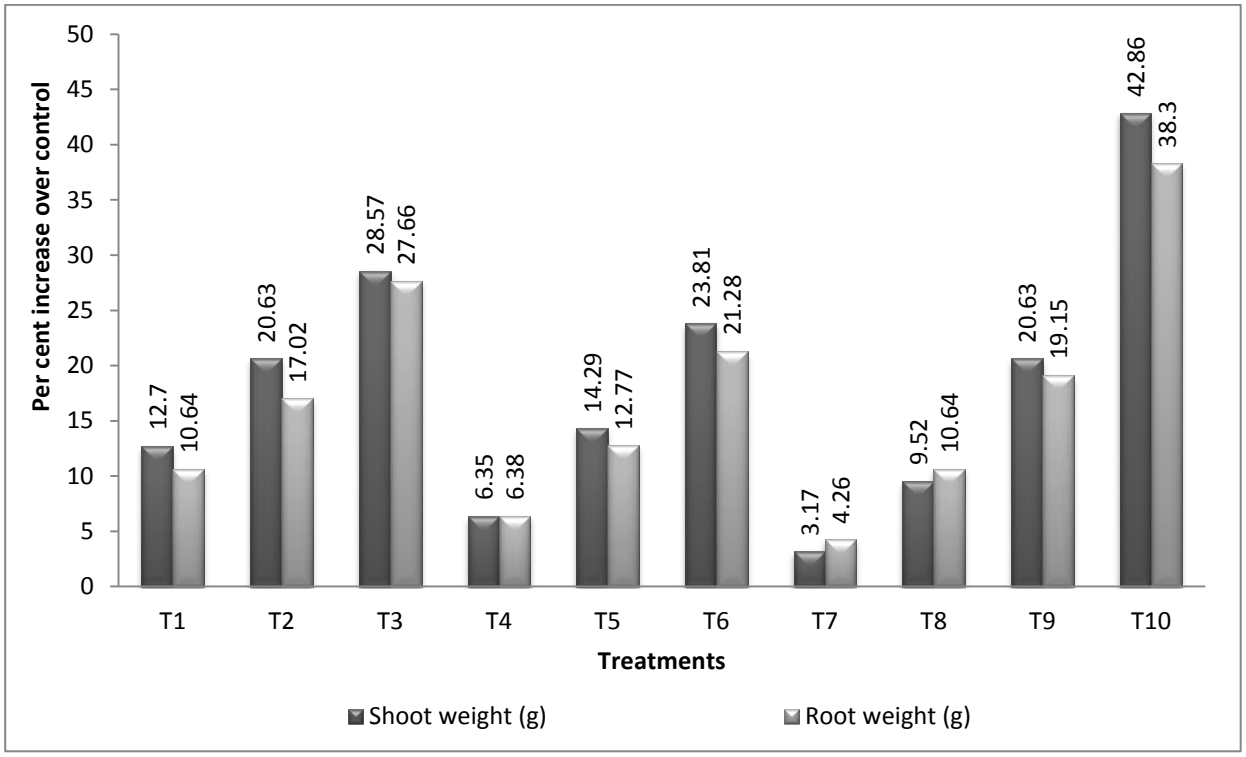

Fig 1. Effect of bio-agents as seed treatment on plant growth of sweet corn infested with *Heterodera zeae.*

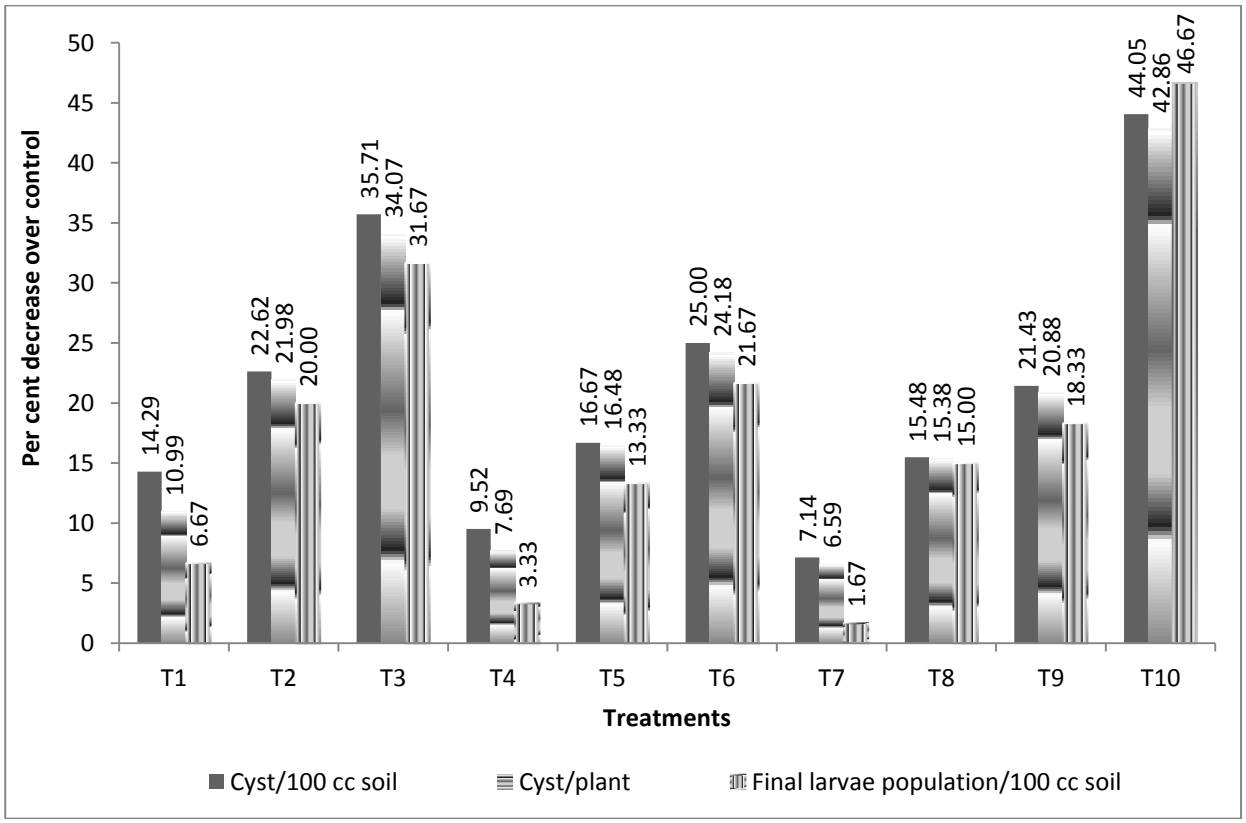

Fig 2. Effect of bio-agents as seed treatment against maize cyst nematode, *Heterodera zeae* on sweet corn.

Table 1. Effect of bio-agents as seed treatment against maize cyst nematode, *Heterodera zeae* on sweet corn (Var.-Madhuri).

Treatments		Plant Growth Characters (P.G.C.)		Nematode Parameters (N.P.)		
		Shoot weight (g)	**Root weight (g)**	**Cyst / 100 cc soil**	**Cyst/ plant**	**Final larvae population / 100 cc soil**
Paecilomyces lilacinus 1% w/w	(T_1)	17.75 (12.70)	13.00 (10.64)	18.00 (14.29)	20.25 (10.99)	560.00 (6.67)
Paecilomyces lilacinus 2% w/w	(T_2)	19.00 (20.63)	13.75 (17.02)	16.25 (22.62)	17.75 (21.98)	480.00 (20.00)
Paecilomyces lilacinus 4% w/w	(T_3)	20.25 (28.57)	15.00 (27.66)	13.50 (35.71)	15.00 (34.07)	410.00 (31.67)
Pochonia chlaymydosporia 1 % w/w	(T_4)	16.75 (6.35)	12.50 (6.38)	19.00 (9.52)	21.00 (7.69)	580.00 (3.33)
Pochonia chlaymydosporia 2 % w/w	(T_5)	18.00 (14.29)	13.25 (12.77)	17.50 (16.67)	19.00 (16.48)	520.00 (13.33)
Pochonia chlaymydosporia 4 % w/w	(T_6)	19.50 (23.81)	14.25 (21.28)	15.75 (25.00)	17.25 (24.18)	470.00 (21.67)
Trichoderma viride 1 % w/w	(T_7)	16.25 (3.17)	12.25 (4.26)	19.50 (7.14)	21.25 (6.59)	590.00 (1.67)
Trichoderma viride 2 % w/w	(T_8)	17.25 (9.52)	13.00 (10.64)	17.75 (15.48)	19.25 (15.38)	510.00 (15.00)
Trichoderma viride 4 % w/w	(T_9)	19.00 (20.63)	14.00 (19.15)	16.50 (21.43)	18.00 (20.88)	490.00 (18.33)
Acephate 75 SP 2 % w/w	(T_{10})	22.50 (42.86)	16.25 (38.30)	11.75 (44.05)	13.00 (42.86)	320.00 (46.67)
Untreated check	(T_{11})	15.75	11.75	21.00	22.75	600.00
SEm ±		0.693	0.498	0.847	0.712	14.152
CD at 5 %		1.995	1.434	2.437	2.049	40.718

Initial nematode population: 600 larvae /100 cc soil

Figures in parentheses are per cent increase (P.G.C.) or decrease (N.P.) over control

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