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An Evaluation of Biocontrol Agents Against Sugarcane Lesion Nematode, *Pratylenchus Zeae*

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Abstract

Field experiments were conducted at Sugarcane Research Station, to find out the field efficacy of ecofriendly management of lesion nematode, Pratylenchus zeae in sugarcane. The experiment was laid out in randomized block design with thirteen treatments replicated three times. The initial nematode population was assessed prior to planting by analysing the soil samples. Soil samples were collected on 90, 180, 270 and 360 days after planting the cane. The soil samples were processed and analyzed for nematode population. The germination percentage was counted on 35 days after planting. The tiller count was taken up on 90 days after planting. Cane samples were collected on 10th month and analyzed the juice for commercial cane sugar percentage. The pooled analysis of the two years, main and ratoon crop data revealed significant reduction in the population of lesion nematode, Pratylenchus zeae in sugarcane plants treated with Carbofuran 3G 1kg a.i/ha followed by neem cake @ 2t/ha and Purpureocillium lilacinum 2.5kg/ha. Significant reduction in nematode population was observed upto harvest of the crop. The above treatment also significantly enhanced the cane yield. The treatment Carbofuran @ 1kg a.i/ha, neem cake 2t/ha and Purpureocillium lilacinum 2.5kg/ha resulted 79.87, 77.65 and 75.94 percent reduction in lesion nematode population over control. The above treatments also enhanced the no. of millable cane/ha, cane yield, sugar yield, commercial cane sugar and benefit cost ratio. The cost benefit ratio worked out for the treatments Carbofuran @ 1kg a.i/ha, neem cake 2t/ha and Purpureocillium lilacinum resulted 1:2.89, 1:2.66 and 1:2.58 respectively.

Keywords: *Sugarcane nematode, biocontrol agent, management, cane yield*

1. Introduction

Plant parasitic nematodes are one of the important biotic constraints in sugarcane production in subtropical and tropical regions of the world. It is estimated that nematodes cause an average annual yield loss of 15.3% in sugarcane (Sasser and Freckman, 1987 and Mehta, 1987). Among the 20 life sustaining crops of the world, highest monetary loss due to nematodes is reported in sugarcane. In India nematodes are reported to cause about 10-40% yield loss in sugarcane. Sugarcane is cultivated under varied conditions ranging from the tropics to the sub-tropics. At present 48 genera and 275 species of nematodes have been associated with sugarcane from 36 countries. Species of five genera viz., *Pratylenchus spp, Hoplolaimus spp, Helicotylenchus spp, Tylenchorhynchus spp* and *Meloidogyne spp* were be listed as the major parasitic nematode. All these nematodes have a wide distribution and are common in sugarcane cultivated areas in India (Mehta, 1992). More than 200 species of nematodes have been reported to infest sugarcane. In India five genera viz., *Pratylenchus sp, Meloidogyne sp, Hoplolaimus sp, Tylenchorhynchus sp* and *Helicotylenchus sp* were widely prevalent in sugarcane ecosystem. Tamil Nadu has shown the association of *Helicotylenchus, Pratylenchus, Hoplolaimus, Tylenchorhynchus* and *Meloidogyne spp* in sugarcane crop (Mehta, 1992). Of these, Lesion nematode *Pratylenchus spp* is the most predominant and economically important genera. The lesion nematode, *Pratylenchus zeae* are migratory endoparasites are responsible for injuries owing to its invasion of the

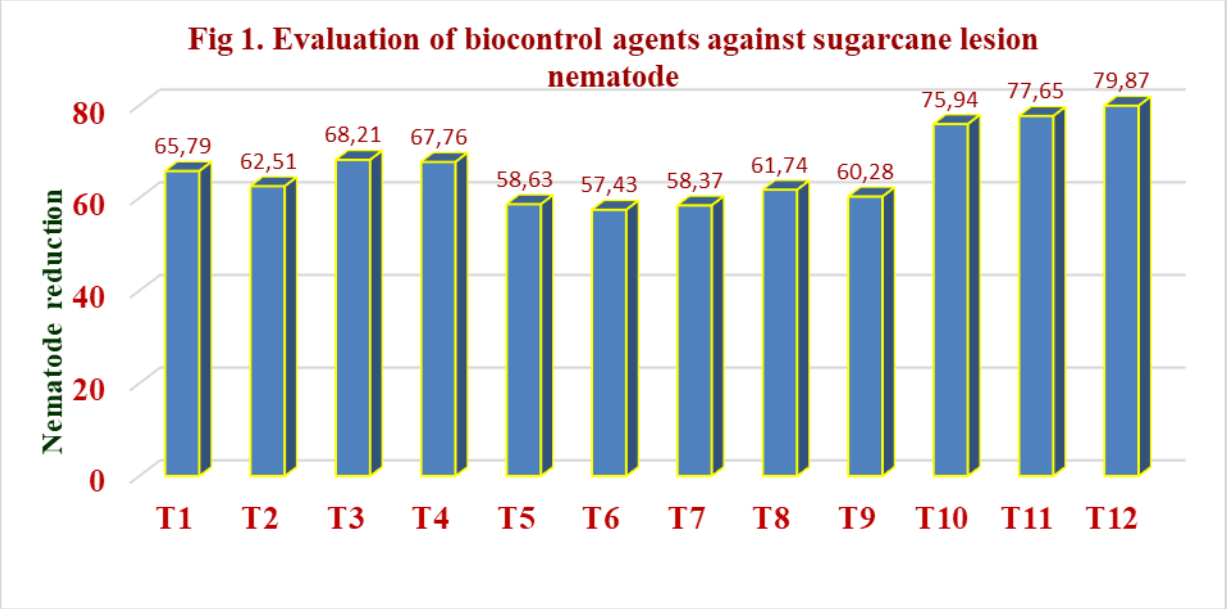
cortical parenchyma of roots, producing yellowing-chlorosis occurring in patches spread out all over the field and causing serious economic losses. A new technique through bioaugmentation, a method that involves biocontrol agent additions for remediation could curtail the problem related to soil (Harisudan *et al*.,2010). Scientific agriculture should aim to achieve the twin objectives of higher productivity and addressing the production constraints (Harisudan and Subrahmaniyan, 2020). Studies conducted at Sugarcane Research Station, Cuddalore has shown the frequent association of *Pratylenchus spp* with the sugarcane crop. Considering the above facts involve an attempt was made to evaluate the available eco-friendly management strategies against lesion nematode, *Pratylenchus zeae* in sugarcane.

2. Materials And Methods

At Sugarcane Research Station, in a sick plot field condition infested with lesion nematode *P*. zeae sugarcane plant crop was raised and it was subsequently ratooned in which the proposed thirteen treatments in randomized block design. Initial population load of lesion nematodes in the experimental site was assessed by taking the pre plant soil samples in which mean population was 398 nematodes /250g. soil. Soil and root samples were collected at 90, 180, 270 and 360 days after planting for assessing the lesion nematode population load in the soil. Nematodes were extracted from soil samples by Cobbs decanting and sieving method (Cobb, 1918) followed by modified Baermann's funnel method (Schindler, 1961) for extraction of vermiform stages of males and second stage juveniles. Observations on the germination percentage and number of tillers per ha was recorded 30 and 90 days after planting respectively. The quality parameters *viz.*, sugar yield and commercial cane sugar (ccs %) were estimated (Chen, 1985) at tenth month and cane yield was recorded. The data recorded were statistically analyzed. Finally, the two-year data were pooled and analyzed.

3. Results and Discussion

The statistical analysis of the first-year study revealed significant reduction in the population of lesion nematode *Pratylenchus zeae* in plots treated with Carbofuran @ 1kg a.i/ha, neem cake 2t/ha and *Purpureocillium lilacinum* 2.5kg/ha. The above treatments resulted in reduction in lesion nematode population by 79.87, 77.65 and 75.94 percent reduction in lesion nematode population over control (Fig 1). The treatments were also enhanced the number of millable canes, commercial cane sugar percent cane yield and sugar yield.

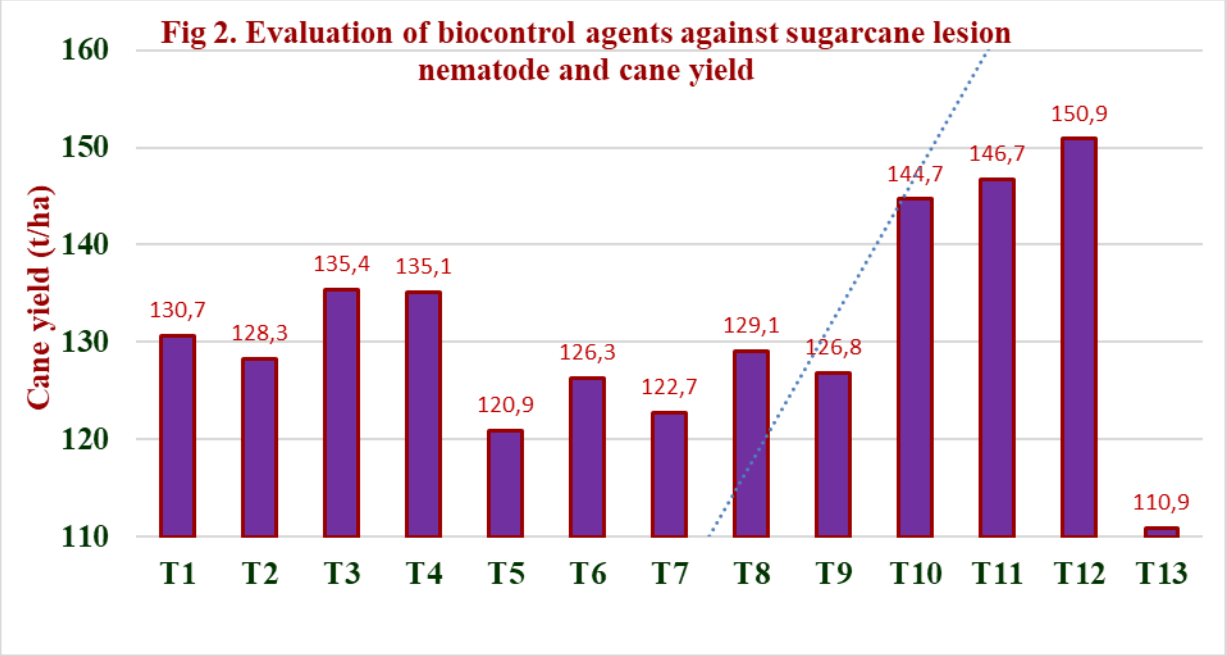


The results of the first ratoon crop study revealed significant reduction in the population of lesion nematode, *Pratylenchus zeae* in sugarcane plants treated with Carbofuran @ 1kg a.i/ha, neem cake 2t/ha and *Purpureocillium lilacinum* 2.5kg/ha. Significant reduction in nematode population was observed upto harvest of the crop. The above treatment also significantly enhanced the cane yield. The treatment *viz*.,Carbofuran @ 1kg a.i/ha, neem cake 2t/ha and *Purpureocillium lilacinum* 2.5kg/ha resulted in80.32, 77.22 and 75.50 percent reduction in lesion nematode population over control.

Table 1. Evaluation of biocontrol agents against sugarcane lesion nematode, *Pratylenchus zeae* (Nematode population in Pooled analysis)

Treatments	Initial nematode population	Nematode population 90 DAP	Nematode population 180 DAP	Nematode population 270 DAP	Nematode population 360 DAP
T_1 - *T. viride* @ 2.5kg/ha	401.4	244.1	264.8	277.1	294.3
T_2 - *B. subtilis* @ 2.5kg/ha	378.4	260.8	280.8	294.8	310.1
T_3 - *P.chlamydosporia* @2.5kg/ha	405.1	227.0	275.9	265.0	278.2
T_4 - *T. harzianum* @ 2.5kg/ha	379.4	224.2	248.9	262.7	275.9
T_5 - *B. firmus* @ 2.5 kg/ha	419.9	293.9	319.9	326.8	347.3
T_6 - *T. asperellum* @ 2.5kg/ha	401.8	245.6	300.3	276.6	302.8
T_7 - *L. fusiformis* @ 2.5kg/ha	396.4	279.1	293.1	305.7	322.9
T_8 - *C. frosea* @ 2.5kg/ha	408.8	245.3	293.0	305.1	322.4
T_9 - *T. reesei* @ 2.5kg/ha	427.9	282.9	297.8	309.4	327.8
T_{10} - *P. lilacinum* @ 2.5kg/ha	429.6	165.8	194.5	217.3	220.6
T_{11} - Neem cake @ 2t/ha	415.8	157.6	183.7	199.9	210.3
T_{12} - Carbofuran @ 1kg a.i/ha	408.9	149.6	172.9	187.3	200.7
T_{13} - Untreated control	396.3	566.4	642.3	714.4	824.5
CD (P=0.05)	4.42	11.61	14.3	29.7	15.73

The pooled analysis of the two years, main and ratoon crop data revealed significant reduction in the population of lesion nematode, *Pratylenchus zeae* in sugarcane plants treated with the treatment *viz*., Carbofuran @ 1 kg a.i/ha, neem cake 2t/ha and *Purpureocillium lilacinum* 2.5kg/ha. Significant reduction in nematode population was observed upto harvest of the crop. The above treatment also significantly enhanced the cane yield (Fig 2). The treatment *viz*., Carbofuran @ 1kg a.i/ha, neem cake 2t/ha and *Purpureocillium lilacinum* 2.5kg/ha resulted in 79.87, 77.65 and 75.94 percent reduction in lesion nematode population over control. The above treatments also enhanced the no. of millable cane/ha, cane yield, sugar yield, commercial cane sugar and cost benefit ratio (Table 2). The cost benefit ratio of the above treatments was 1:2.89, 1:2.66 and 1:2.58 respectively. Such effective reduction in nematode soil population and subsequent increase in yield parameters of sugar cane crop under field conditions supports the view that the eco-friendly use of intercropping and organic amendments can be effective in management of the lesion nematode in sugarcane. As observed in the present study, Jonathan *et al*., 1991 showed that the effect of organic amendments on the control of sugarcane nematodes and found that neem cake @ 2 t/ha and pressmud @ 25t/ha were most effective in reducing the population of *Meloidogyne incognita, Pratylenchus coffeae* and *Helicotylenchus dihystera*. Combined application of pressmud 1t/ha, farm yard manure 12.5 t/ha, poultry manure 1t/ha and *Trichderma viride* 1.25 kg/ha + *Pseudomnas fluorescens* 1.25 kg/ha caused significant reduction in population of lesion nematode population in soil and significant increase in cane yield, cane sugar per cent and sugar yield (Jayakumar, 2016).



Addition of organic amendments such as farm yard manure, oil cakes, green manure and pressmud etc encourages the multiplication of nematode antagonistic microbes which inturn checks the plant parasitic nematodes. Jayakumar 2019 reported that Maximun and significant reduction in lesion nematode in soil was observed in plots with incorporated with combination of all the treatments compared to the untreated control. Significant increase in the cane yield, commercial cane sugar percentage and sugar yield of canes was noted as compared to untreated check. The addition of organic amendments acts in several ways against the plant parasitic nematodes. Organic acid such as formic, acetic propionic and butric acids are released in soil during microbial decomposition or organic amendments. Ammonia and hydrogen sulphide gases are also released in soil during decomposition. These organic acids and gases are toxic to nematodes. Nematode antagonistic microbes multiply rapidly due to addition of organic matter. Organic amendments improve soil conditions and helps the plants to grow. The organic matter also provides nutrition for the crop plants. The intercropping and incorporation also add 10 to 12 tonne biomass/ha which helps to improve the physico-chemical properties of soil (Mahendran, 1994). Among seven nematicides tested, carbofuran 3G was found most effective to enhance the plant growth and significantly reduced the *P. zeae* population in soil (Sahoo & Sahu 1993). The intercropping and incorporation also add 10 to 12 tons biomass/ha which helped to improve the physico-chemical properties of soil (Sahoo & Sahu 1994). Application of five oilcakes *viz*, groundnut, sesame, cotton seed and coconut significantly increased yield and quality of sugarcane. Application of *Pseudomonas fluorescens* (Pf1) at 2.5 kg/ha significantly reduced the population of *Pratylenchus zeae* and enhanced the number of millable cane, commercial cane sugar, cane yield and sugar yield (Jayakumar, 2019). Population of *P. zeae* in soil and roots was significantly suppressed by all the treatment as reported by Mehta and Sundararaj (1996). They further reported that organic amendments like neemin, neemark, FYM pressmud and *Calotropis* were effective against *P. zeae* and carbofuran 3G was found at par. Application of *Pseudomonas fluorescens* was better that minimized lesion nematode population by 73.2% and enhanced germination %, number of tillers, commercial cane sugar %, cane yield and sugar yield by 87.2, 161.5, 12.7, 121.4 and 16.4%, reported by Jayakumar and Seenivasan (2020). However, Haider and Askary (2011) reported maximum reduction of plant parasitic nematodes including *P. zeae* on sugarcane in Bihar state and growth was higher in *Brassica campestris* followed *Ocimum sanctum* in field. Haider and Dutta (2004) reported integration of pressmud @ 200 q/ha with carbofuran 3G @ 1 kg a.i/ha at planting time resulted minimum nematode population and increased growth, yield, juice quality and CCS%. Further, significant pressmud alone could reduce *P. zeae* population by 19% and increased yield by 16% sugarcane. Jonathan and his coworkers in 1999 also observed in significant reduction in spiral nematode infestation in sugarcane plants intercropped and incorporated with either marigold (*Tagetes erecta*) or daincha (*Sesbania aculeata*) coupled with the application of either pressmud (25 t/ha) or neem cake (2 t/ha) and these treatments also enhanced the yield and quality of canes.

Table 2. Evaluation of biocontrol agents against sugarcane lesion nematode, *Pratylenchus zeae* on plant growth and yield characters (Pooled analysis)

Treatments	Establishment percentage	No. of millable cane (x1000/ha)	Cane sugar percent	Sugar yield (t/ha)	Cost Benefit ratio
T_1 - *T. viride* @ 2.5kg/ha	82.66	169.81	12.28	16.39	1:1.52
T_2 - *B. subtilis* @ 2.5kg/ha	84.75	164.38	12.15	15.84	1:1.44
T_3 -*P.chlamydosporia* @2.5kg/ha	83.60	174.94	12.21	16.73	1:1.75
T_4 - *T. harzianum* @ 2.5kg/ha	82.30	180.58	12.31	16.97	1:1.38
T_5 - *B. firmus* @ 2.5 kg/ha	84.85	143.79	12.12	14.71	1:1.26
T_6 - *T. asperellum* @ 2.5kg/ha	83.35	145.51	12.17	14.55	1:1.18
T_7 - *L. fusiformis* @ 2.5kg/ha	84.71	156.45	12.23	15.12	1:1.34
T_8 - *C. frosea* @ 2.5kg/ha	83.47	151.89	12.21	15.76	1:1.19
T_9 - *T. reesei* @ 2.5kg/ha	78.97	160.55	12.15	15.27	1:1.14
T_{10} - *P. lilacinum* @ 2.5kg/ha	80.40	186.22	12.36	17.66	1:2.58
T_{11} - Neem cake @ 2t/ha	84.30	189.44	12.41	18.43	1:2.66
T_{12} - Carbofuran @ 1kg a.i/ha	85.70	194.19	12.44	18.87	1:2.89
T_{13} - Untreated control	76.50	117.16	12.03	13.25	-
CD (P=0.05)	7.2	1.80	0.15	1.65	-

Conflict of Interest Statement

The authors declare that there is no conflict of interest

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