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Management of brinjal disease complex caused by root knot nematode (*Meloidogyne incognita*) and bacterial wilt (*Ralstonia solanacearum*)

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Abstract
Meloidogyne incognita is one of the most widespread and damaging plant-parasitic nematodes in all vegetable crops ((Roy, 1972). A yield loss of 22.15 per cent due to attack of *M. incognita* on brinjal in Orissa was recorded by Subhrajyoti (2014). In addition, root-knot nematode facilitates the entry and establishment of pathogenic fungi and bacteria (Powell, 1971). The disease complex formed by the interaction between *M. incognita* and *Ralstonia solanacearum* on brinjal (Swain *et al.*, 1987). Hence this experiment was designed to standardize bio management practices for the nematode wilt complex in brinjal. The results revealed that the plots treated with the bioagents *Pseudomonas fluorescens* (Pf 1) @2.5kg/ha and *Purpureocillium lilacinum* @2kg/ha recorded the highest reduction in the nematode population with soil (71.44) and root (84.24) at the time of harvest when compared to control. Significant reduction in root knot index (1.3) was also observed in treated plot. These results subsequently increase the yield of brinjal yield(33t/ha) when compared to control and also recorded the highest cost benefit ratio of 1:2.2. While the untreated control plants recorded the lowest yield of (20t/ha).

Keywords: Brinjal, bioagents, *Ralstonia solanacearum Meloidogyne incognita Purpureocillium lilacinum Pseudomonas fluorescens* (Pf 1)

Introduction
Brinjal (*Solanum melongena* L.) is one of the most popular vegetable crops grown throughout the country except hilly regions. Tamil Nadu contribute 0.85 percent share in production in India. The root-knot nematode (*Meloidogyne incognita*) and bacterial wilt caused by *Ralstonia solanacearum* has emerged as a major problem, causing enormous yield loss in egg plant.
R. solanacearum constitutes a serious obstacle to the cultivation of many solanaceous plants in both tropical and temperate regions and disease severity mostly increases if *R. solanacearum* is found in association with root nematodes. The disease is predominant in warm humid tropical and temperate regions of the world (Hayward, 1991) [5] Combined pathogenic effects of *R. solanacearum* and root-knot nematodes (*Meloidogyne javanica*) were greater than the independent effects In some cases hundred percent loss were also recorded (GOP. 2010) [4].

Materials and Methods
Two field experiments was conducted at farm of RRS,Paiyur during the period of 2018-2019 in Krishnagiri district with the following treatments *P. fluorescens* (Pf 1) (2.5kg/ha), *P. lilacinum* (2.5kg/ha), Pf1(2.5kg/ha) + *P. lilacinum* (2.0kg/ha), streptomycin sulphate (100ppm), carbofuran 3G @1kg a.i./ha, and copper oxycholoride (0.25%)+ streptomycin sulphate (100ppm) in randomized block design with three replications .
Three months after planting, the plants were uprooted, washed and the growth parameters *viz*., plant length, fresh weight of shoot and root and fruit weight were assessed. The number of plants with galled root system and the root-knot index were expressed on a 0-5 scale (0 = no galling; 1 = 1-2 galling; 2 = 3-10 galling; 3 = 11-30 galling; 4 = 31-100 galling; and 5 = more than 100 galling per root system) (Heald *et al.*, 1989) [6]. The nematode population in the soil was determined by Cobb’s sieving and decanting method, followed by the modified Baermann funnel technique (Southey, 1986) [12].

Number of adult females within the roots examined by staining using lactic acid-fuchsin technique (Byrd *et al*., 1983) [2]. The number of females within the root segment was determined using dissecting microscope (x 40). The total number of adult females present in root was calculated by multiplying the number of adult females present in 5g of root by the total weight of root. The data were statistically analysed and critical differences determined by following Gomez and Gomez, 1984 [3]. The standard cultural practices will be followed as recommended by Tamil Nadu Agricultural University, Coimbatore, Tamilnadu.

Result and Discussion

The plant growth, nematode population and yield were recorded at the time of harvest. It was found that the plots treated with the bioagents *Pseudomonas fluorescens* (Pf 1) @2.5kg/ha and *Purpureocillium lilacinum* @2kg/ha (T3) recorded the highest reduction in the nematode population with soil (71.44) and root (84.24) respectively at the time of harvest (Table 1).

Significant reduction in root knot index (1.3) was observed in T3 treatment Application of talc formulation of *Pseudomonas fluorescens* (Pf 1) significantly reduced the infestation of *Helicotylenchus multicinctus* in banana and increased the plant growth parameters and yield (Jonathan *et al*., 2004) [9]. Similar growth promotion activity of *P. fluorescens* was recorded by several authors in a range of crops such as potato (Burr *et al*., 1998; Kloepper *et al*., 1980) [1], citrus (Gardner *et al*., 1984) [3], cotton (Howell and Stipanovic, 1980) [7].

The untreated control plant root recorded the highest lesion index of 5.00 (Table 2). More number of lignified cells were also recorded in the same treatment. Significant increase in brinjal yield was observed in all the plants treated with biocides. However, highest yield (33t/ha) was observed in the treatment with *P. fluorescens* (Pf1) (2.5kg/ha) + *P. lilacinus* (2.0kg/ha). The application of same treatment recorded the highest cost benefit ratio of 1:2.2. While the untreated control plants recorded the lowest yield of (20t/ha). (Table 2).

Conclusion

Finally, the results of this study confirms the need to control root-knot nematodes in fields that heavily infested with *R. solanacearum* in order to gain maximum control of disease in brinjal. This could be recommended as a component of integrated nematode and bacterial disease complex management in brinjal.

Table 1: Assessment of morphmetric characters, status of galls and egg masses in brinjal var. (Co2) against nematode disease complex

Treatments	Root length (cm)	Shoot length (cm)	Shoot weight (g)	No of galls /root system	No of egg masses /gall
T_1- *P. fluorescens* (Pf 1) (2.5kg/ha)	31.22	76.44	220.34	112.24	31.24
T_2-*P. lilacinum* (2.5kg/ha)	28.41	62.44	250.24	131.28	*21.26*
T_3- Pf1(2.5kg/ha) + *P. lilacinum* (2.0kg/ha)	*43.26*	*85.64*	*304.66*	*65.24*	11.44
T_4- Streptomycin sulphate (100ppm)	24.52	41.24	156.48	102.54	21.28
T_5- Carbofuran 3G @1kg a.i./ha	30.28	58.64	220.44	98.21	25.84
T_6- Copper oxycholoride (0.25%)+ streptomycin sulphate (100ppm)	24.24	36.64	158.84	81.24	*31.46*
T_7- Copper oxycholoride (0.25%)+ Streptomycin sulphate(100ppm) + Carbofuran 3G @1kg a.i./ha	18.44	26.44	147.46	76.44	29.54
T_8-Untreated control	12.86	21.36	102.24	174.48	55.86
CD (p=0.05)	1.39	2.80	10.02	6.52	2.03
SED	0.64	1.30	4.67	3.04	0.94

Table 2: Assessment of population and yield in brinjal var. (Co2) treated with various components against root knot against nematode disease complex

Treatment	Population at harvest (soil 200cc)	Population at harvest (root 5g)	Root knot index %	Percent of Wilt incidence	Yield kg/plot (m^2)	B:C:R
T_1- *P.fluorescens* (Pf 1) (2.5kg/ha)	127.64	90.28	3.3	25.88	1.8	1:1.5
T_2-*P. lilacinum* (2.5kg/ha)	89.22	74.36	2.0	35.64	2.4	1:1.8
T_3- Pf1(2.5kg/ha) + *P. lilacinus* (2.0kg/ha)	71.44	84.24	1.3	18.42	3.3	1:2.2
T_4- Streptomycin sulphate (100ppm)	550.24	230.84	5.0	40.24	1.0	1:1.25
T_5- Carbofuran 3G @1kg a.i./ha	71.28	72.26	3.2	58.56	2.0	1:1.5
T_6- Copper oxycholoride (0.25%)+ streptomycin sulphate (100ppm)	365.48	250.44	2.9	20.66	2.5	1:2.0
T_7- Copper oxycholoride (0.25%)+ Streptomycin sulphate(100ppm) + Carbofuran 3G @1kg a.i./ha 33kg/ha	75.22	78.54	2.0	9.64	2.1	1:1.5
T_8-Untreated control	550.48	242.26	5.0	60.44	2.0	
CD (p=0.05)	45.73	45.55	0.19	2.24	0.12	
SEd	21.32	21.23	0.09	1.04	0.05	

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