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RESEARCH PAPER

Study the bioefficacy of aqueous formulation of various antagonists against *M. incognita* in tomato (*Solanum lycopersicum* L.) under field condition

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ABSTRACT

Field trials were conducted to assess the efficacy of biocontrol agents *viz*., *Pseudomonas* spp. and *Bacillus* spp. against root knot nematode, *Meloidogyne incognita* in tomato (PKM1variety). The liquid formulations of six native bacterial isolates delivered through seedlings root dip treatment @ 200 ml/ ha of seedling followed by soil application through drip irrigation @ 500 ml/ha along with two standard check. The results indicated that the most of the tested treatments reduced root galls and increased tomato plant growth characters. *Pseudomonas fluorescens* (Pfpv1) was most effective treatment on both root and soil population achieving 67.17 and 59.80 per cent reduction, respectively followed by *Bacillus subtilis* (Bsvn11).

Key Words : Tomato, Root knot nematode, *Pseudomonas* spp., *Bacillus* spp.

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Root knot nematodes are one of the most economically important pest causing severe damages and losses in a wide variety of crops worldwide (Kiewnick and Sikora, 2006). Estimates of nematode damage of tomato yield worldwide ranged from 28 to 68 per cent. To manage this nematode various management practices *i.e.* chemical, physical and cultural methods are used in the country, but they are not economical for farmers. Plant Growth Promoting Rhizobacteria (PGPR) are eco-friendly and economically feasible and can benefit plant growth by different mechanisms (Bashan and de-Bashan, 2005). In recent year, PGPR, are reported to be effective in managing *M. incognita* infestation in many crops *viz.,* banana (Jonathan *et al*., 2006) and brinjal (Liza Barua and Bora, 2008). Therefore, the present investigation was carried out to manage the root knot nematode infestation using the effective isolate of *Pseudomonas* spp. and *Bacillus* spp.

RESEARCH METHODOLOGY

Field evaluation of liquid formulations against root knot nematode :

Field experiments were conducted in nematode sick

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field of Kallukkadai and Theethipalayam village, Coimbatore district, to evaluate different formulations of bacterial isolates against *M. incognita* in tomato (PKM1). The liquid formulations of six native bacterial isolates delivered through seedlings root dip treatment @ 200 ml/ ha of seedling followed by soil application through drip irrigation @ 500 ml/ha along with standard. The experiment was conducted in a Randomized Block Design (RBD) with the following treatments which were replicated three times.

Treatments details :

T_1 - *Pseudomonas fluorescens* (Pfpv1)
T_2 - *Pseudomonas* spp. (Pfks 23)
T_3 - *Pseudomonas* spp. (Pfpv12)
T_4 - *Pseudomonas fluorescens* (Pf1)
T_5 - *Bacillus subtilis* (Bsvn11)
T_6 - *Bacillus pumilus* (Bsvn12)
T_7 - *Bacillus cereus* (Bsks 2)
T_8 - *Bacillus subtilis* (Bbv57)
T_9 – Control

Observations :

Plant growth parameters *viz.*, shoot length, root length, shoot weight, root weight and yield and nematode multiplication *viz.*, number of adult females, number of egg masses, soil and root nematode population, root knot index and bacterial population were recorded.

RESULTS AND REMONSTRATION

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Pooled analysis of field evaluation of liquid formulation of *Pseudomonas* spp. and *Bacillus* spp. isolates on tomato :

Field experiments revealed that the liquid formulations of bacterial isolates Pfpv1 and Bsvn11 significantly increased plant growth parameters and reduced nematode population in tomato.

The highest shoot length and shoot weight in Pfpv1 treated plants (72.06 cm and 60.76 g) followed by Bsvn11 (69.20 cm and 58.05 g). The untreated control recorded the lowest shoot length and shoot weight (44.46 cm and 30.55 g) (Table 1). Earlier Jonathan *et al.* (2005) reported that the combined treatment of Pfbv22 and Bbv57 recorded the highest plant growth parameters in betelvine and the lowest population of *M. incognita* and wilt (*Phytophthora capsici*) incidence. Several mechanisms were attributed to the suppression of phytonematodes and plant growth promotion by application of bacteria. These bacteria were reported to produce antibiotics and hydrogen cyanide (Ali *et al.*, 2002). The increase in plant growth may be associated with secretion of auxins, gibberllins and cytokines (Ramamoorthy *et al.*, 2001).

Highly reduction in number of adult female (16.96/ 5g root) was observed in tomato plants treated with the liquid formulation of Pfpv1 (Table 2). It showed 70.74 per cent decrease over the control. This was followed by Bsvn11 (18.45/5g root), which attributed for 68.17 per cent decrease over the control. The highest number of adult females (57.97) was recorded in the untreated control. Ali *et al*. (2002) reported that *Pseudomonas* strains multiplied on talc powder and applied in soil reduced the root knot nematode development and population density under field condition in mungbean raised as first crop or succeeding crop. *B. subtilis* reduced *M. incognita* multiplication and improved growth of chickpea plants (Oka *et al*., 1993; Siddiqui and Mahmood, 1995).

The yield increase in the tomato plants treated with liquid formulation of Pfpv1 under field condition (47.47 t/ha) was significantly higher than the untreated control (29.79). Similar result was recorded in the studies conducted by Siddiqui *et al.* (2001) who reported that *P. aeruginosa* enhanced the plant growth and yield of mungbean on seed dressing or soil drenching. Significant increase in the fruits quality was also observed in *P. fluorescens* treated tomato fruits (Kavitha, 2005). The yield increase in the fields experiment treated with liquid formulation of Pfpv1 and Bsvn11was significantly higher than the untreated control. Similar result was recorded in the studies conducted by Oostendorp and Sikora (1989), where *P. fluorescens* significantly reduced the juvenile penetration of *H. Schachtii* and resulted in significant increase in sugarbeet yield.

The highest bacterial colonies (7.83×10^6 cfu/ml) was observed in Pfpv1 at 30 DAT. The *Bacillus* population was observed highest in Pfpv1 (6.84×10^6 cfu/ml). The bacterial colonies showed a declined phase as the number of days increased with the least of (1.00×10^6 cfu/ml) for *Pseudomonas* and (1.00×10^6 cfu/ml) for *Bacillus* at 90 DAT (Table 3). Samuthiravalli (2006) reported colonization of *Pseudomonas* strains EPC 27 and EPC

Table 1 : Evaluation of bacterial liquid formulations on growth and yield of tomato infested by *M. incognita* under field condition (Pooled data)

Treatments	Shoot length (cm)	Per cent increase over control	Root length (cm)	Per cent increase over control	Shoot weight (g)	Per cent increase over control	Root weight (g)	Per cent increase over control	Yield t/ha	Per cent increase over control
T_1-Pfpv 1	72.06	38.30	36.92	48.37	60.76	49.72	30.80	55.74	47.47	37.24
T_2-Pfks23	66.71	33.35	33.16	42.52	56.22	45.65	26.13	47.83	43.6	31.67
T_3-Pfpv12	63.01	29.43	29.00	34.27	51.88	41.11	22.96	40.63	42.01	29.08
T_4-Pf1	64.75	31.33	30.83	38.17	54.01	43.43	24.55	44.48	43.48	31.48
T_5-Bsvn11	69.20	35.75	35.09	45.68	58.05	47.37	28.36	51.93	45.5	34.52
T_6-Bsvn12	60.31	26.28	27.51	30.71	50.06	38.97	20.98	35.03	40.28	26.04
T_7-Bsks2	55.22	19.48	24.43	21.98	46.22	33.90	16.83	19.01	38.6	22.82
T_8-Bbv 57	57.73	29.84	26.07	26.88	47.71	35.96	19.06	28.48	39.49	24.56
T_9-Control	44.46	-	19.06	-	30.55	-	13.63	-	29.79	-
S.E. ±	0.13		0.09		0.14		0.09		0.08	
C.D. (P=0.05)	0.28		0.19		0.30		0.19		0.17	

Values are mean of three replications

Table 2 : Evaluation of bacterial liquid formulations on *M. incognita* in tomato under field condition

Treatments	No. of females (5g root)	Per cent decrease over control	No. of egg mass (5g root)	Per cent decrease over control	Root knot index	Root population (5g root)	Per cent decrease over control	Soil population (250cc soil)	Per cent decrease over control
T_1-Pfpv 1	16.96	70.74	3.54	85.77	1.00	29.47	67.17	42.30	59.80
T_2-Pfks23	24.48	57.77	8.00	67.85	1.47	46.96	47.69	62.60	40.51
T_3-Pfpv12	39.68	31.55	13.33	46.44	2.11	63.86	28.87	77.58	26.28
T_4-Pf1	26.65	54.02	8.99	63.88	1.68	51.00	43.19	70.67	32.84
T_5-Bsvn11	18.45	68.17	4.20	83.12	1.22	33.61	62.56	46.86	55.47
T_6-Bsvn12	37.02	36.13	11.19	55.04	2.29	66.60	25.81	82.70	21.41
T_7-Bsks2	47.23	18.52	16.52	33.62	2.72	76.06	15.28	95.55	09.20
T_8-Bbv 57	42.21	27.18	14.33	42.42	2.50	71.70	20.13	88.93	15.49
T_9-Control	57.97	-	24.89	-	4.00	89.78	-	105.24	-
S.E. ±	0.22		0.10			0.32		0.34	
C.D. (P=0.05)	0.47		0.23			0.69		0.73	

Values are mean of three replications

Table 3 : Reisolation of antagonistic bacteria under field condition (Pooled data)

Treatments	Pooled data (Log 10 cfu g^{-1} fresh weight)					
	Pseudomonas spp.			*Bacillus* spp.		
	30 DAT	60 DAT	90 DAT	30 DAT	60 DAT	90 DAT
T_1-Pfpv 1	7.83	6.67	5.00	6.84	5.33	4.34
T_2-Pfks23	7.17	5.84	4.34	5.67	4.50	3.17
T_3-Pfpv12	6.34	4.67	3.84	5.00	3.17	2.33
T_4-Pf1	6.67	5.34	4.17	5.33	4.17	3.00
T_5-Bsvn11	7.50	6.17	4.67	6.50	5.00	4.00
T_6-Bsvn12	5.84	4.34	3.50	4.67	2.84	2.33
T_7-Bsks2	5.00	3.50	2.84	4.00	2.17	1.67
T_8-Bbv 57	5.50	4.00	3.17	4.34	2.50	2.00
T_9-Control	4.17	2.83	2.00	3.00	1.67	1.00
S.E. ±	0.0205	0.0200	0.0155	0.0202	0.0225	0.0183
C.D. (P=0.05)	0.0434	0.0424	0.0329	0.0428	0.0478	0.0387

30 on tomato roots more at 60 DAT than at 90 DAT. Hallmann *et al*. (1998) found the bacterial strain *Enterobacter asburiae* and *P. fluorescens* colonies in high number on the root surface around the nematode penetration sites of seed treated cucumber and cotton plants.

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