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Eco-friendly approaches for the management of root knot nematode, *Meloidogyne incognita* in butter beans (*Phaseolus lunatus* L.)

P. VETRIVELKALAI

Department of Fruit Crops, Tamil Nadu Agricultural University, Coimbatore- 641 003, Tamil Nadu, India

E-mail: vetrinem@gmail.com

ABSTRACT: Root knot nematode (RKN), *Meloidogyne incognita* is one of the most important pests of Butter beans, *Phaseolus lunatus* L. Organic amendments *viz*., FYM, eucalyptus distillery waste, neem cake and pungam cake bio-inoculants *viz*., Rhizobium and biocontrol agents *viz*., *Pseudomonas fluorescens* (Pf1) *Trichoderma viride* (Tv 1) were evaluated under field condition during 2013-2014 at upper pulney hills region of Tamil Nadu. The result revealed that seed treatment with Rhizobium 600g/ha seed combined with soil application of FYM @ 10 t/ha, Neem cake and Pungam cake @ 250 kg/ha (each) along with *P. fluorescens* @ 1.25 kg/ha at the time of sowing significantly high plant growth parameters and yield (5.16 t/ha) coupled with lower RKN population in soil (60.02%) and root (67.76%) and least gall index 1.33 over untreated control and resulted in increased pod yield by 59.48 per cent with benefit cost ratio of 2.22 over the untreated control.

Keywords: Root knot nematode, biocontrol agents, Organic amendments, bio-inoculants, butter beans, eco friendly methods.

INTRODUCTION

Butter beans (*Phaseolus lunatus* L.) is an important grain legume species which contains protein, carbohydrates, fiber, lipids, vitamins and minerals. Beans are adversely affected by several pests, diseases and nematodes. Among, root knot nematode, *Meloidogyne incognita* caused root galls as a primary symptom. In India, the annual losses caused by root knot nematode, *M. incognita* is 10 per cent in beans (Jain *et al*., 2007). Present strategies for nematodes management largely depend on cultural practices and chemical applications and often in combinations (Hague and Gowen, 1987). Further, few nematicides are available to growers in the Indian market. Nematicides are neurotoxic and have residual effects which reflected in the food chain. The prohibitive costs and associated environmental health hazards limit the use of chemical nematicides. Recent studies have shown the influence of microbial antagonists and organic amendments are not only safe to human and environment but also the have capacity to improve the physicochemical properties of soil besides suppressing nematode population. Under these circumstances, it will be appropriate to develop eco-friendly and cost effective control measures using beneficial natural antagonists combined with organic amendments for the management of root knot nematode in upper pulney hill region of Kodaikanal.

MATERIALS AND METHODS

The field experiments were conducted for two consecutive years from 2013-2104 at Horticultural Research Station, Kodaikanal in butter beans cv. KKL 1. The experiments were conducted in a randomized block design in plots of 5 x 3 m having three replications for each treatment. The talc-based commercial formulations of *P.fluorescens* (Pf-1), *T.viride* (Tv-1) was obtained from Tamil Nadu Agricultural University, Coimbatore. Bio-control agents, bio-fertilizers, neem cake, pungam cake, FYM, eucalyptus distillery waste and carbofuran were applied to the soil before planting. The standard agronomic practices were followed for raising the crop. The treatments *viz*., T_1- FYM @ 20 t/ha + neem cake and pungam cake @ 0.5t/ha (each), T_2- Eucalyptus distillery waste @ 1t/ha + neem cake and pungam cake @ 0.5t/ha (each), T_3- Seed treatment with Rhizobium 600g/ha seed + *P.fluorescens* (Pf-1) @ 2.5kg/ha, T_4- Seed treatment with Rhizobium 600g/ha seed + *T.viride* (Tv-1) @ 2.5kg/ha, T_5- T_1 +T_3 @ 50 % dose, T_6- T_2 +T_4 @ 50 % dose, T_7- Carbofuran 3G @ 1kg a.i/ha, T_8- Untreated control were imposed at the time of planting.

The observations on plant growth parameters *viz*., plant height (cm), pod length (cm), no. of pods/plant, no. of grains/pod, yield (t/ha), and nematode multiplications *viz*., initial and final soil nematode population/200cc soil, no. of adult females/5g root, no. of egg masses/5g root and gall index were recorded and benefit cost ratio for each treatment was also computed. The initial population of root knot nematodes averaged 205/200cc soil. Soil samples were taken before sowing and final harvest and then, soil samples were processed by Cobb's decanting and sieving method followed by modified

Table 1. Impact of biocontrol agents and organic amendments on plant growth parameters and yield in butter beans cv. KKL-1 (Pooled analysis)

Treatment	Plant height (cm)	Pod length (cm)	No. of pod / plant	No. of grains / pod	Yield (t/ ha)
T_1 - FYM @ 20t/ha + neem cake, pungam cake @ 0.5 t/ha (each)	275.20	11.34	10.83	4.83	4.54
	(23.21)	(67.53)	(61.54)	(51.72)	(54.03)
T_2 -Eucalyptus distillery waste @ 1t/ha + neem cake, pungam cake @ 0.5t/ha (each)	251.37	7.43	7.50	4.00	2.50
	(15.93)	(50.45)	(44.44)	(41.67)	(16.44)
T_3 -Seed treatment with rhizobium @ 600g/ha seed + *P. fluorescens* @ 2.5kg/ha	271.23	9.37	9.17	4.50	3.71
	(22.09)	(60.68)	(54.55)	(48.15)	(43.71)
T_4 - Seed treatment with rhizobium @ 600g/ha seed + *T. viride* @ 2.5kg/ha	267.67	9.08	8.33	4.17	3.42
	(21.05)	(59.45)	(50.0)	(44.0)	(38.96)
T_5 - T_1 +T_3 @ 50 % dose	278.95	12.58	13.00	6.50	5.16
	(24.25)	(70.73)	(67.95)	(64.10)	(59.48)
T_6 - T_2 +T_4 @ 50 % dose	259.07	7.20	7.67	3.83	2.78
	(18.43)	(48.84)	(45.65)	(39.13)	(24.80)
T_7 – Carbofuran 3G @1kg a.i/ha	238.90	6.38	6.33	4.50	2.67
	(11.55)	(42.30)	(34.21)	(48.15)	(21.67)
T_8 – Untreated Control	211.32	3.68	4.17	2.33	2.09
S.Ed	0.835	0.373	0.661	0.546	0.084
CD (5%)	1.791	0.800	1.418	1.172	0.180

Figure in parenthesis are per cent increase over control

Baermann's funnel technique (Southey, 1986). The roots cut into small pieces and then stained with acid fuchsin – lactophenol. Gall index was recorded by carefully uprooting the plants at the time of harvest by adopting 1-5 scale rating (Headle *et al*., 1989). The data from both years of experiments were pooled and statistically analyzed (Panse and Sukhatme, 1985).

RESULTS AND DISCUSSION

The results (Table 1) revealed that among treatments, the highest plant growth parameters *viz*., plant height, pod length, number of pod, number of grains were recorded in the soil application of FYM (10t/ha), neem cake (0.25t/ha), pungam cake (0.25t/ha), along with *P. fluorescens* (1.25kg/ha) combined with seed treatment with Rhizobium (600g/ha seed) (T_5) with percentage of 24.25, 70.73, 67.95, 64.10, respectively and subsequently increased the yield by 59.48% over control followed by application of FYM (20t/ha), neem cake (0.5t/ha), pungam cake (0.5t/ha) (T_1) with percentage of 23.21, 67.53, 61.54, 51.7, respectively and subsequently increased yield by 54.03% over control.

The soil application of FYM (10t/ha), neem cake (0.25t/ha), pungam cake (0.25t/ha), along with *P. fluorescens* (1.25kg/ha) combined with seed treatment with Rhizobium (600g/ha seed) (T_5) resulted in highest reduction of soil population (60.02%), number of adult female (67.76%), number of egg mass (85.56%) which results in recorded least gall index (1.50) over control (Table 2) followed by application of FYM (20t/ha), neem cake (0.5t/ha), pungam cake (0.5t/ha) (T_1) which recorded soil population (55.50%), no. of adult female (56.42%), no. of egg mass (72.92%) over control with gall index (1.83).

The soil application of FYM, neem cake, pungam cake along with *P. fluorescens* followed by seed treatment with rhizobium (T_5) recorded highest benefit cost ratio of 2.22 followed by seed treatment with Rhizobium 600g/ha seed along with soil application of *P.fluorescens* @ 2.5kg/ha (T_3) recorded benefit cost ratio of 1.92. The untreated control recorded the lowest benefit cost ratio of 1.16. Among the biocontrol agents and organic amendment tested, the highest yield (5.16t/ha) with lowest nematode reproductive factor of 0.53 were recorded in combined soil application of FYM, neem cake, pungam cake along with *P.fluorescens* combined with seed treatment with rhizobium (T_5) followed by application of FYM, neem cake, pungam cake (T_1) with yield of 4.54 t/ha with nematode reproductive factor of 0.59. The untreated control recorded the lowest yield of 2.09t/ha with highest nematode reproductive factor of 1.32.

The results of the present study, showed that all the treatments involving each biocontrol agents and organic amendment reduced nematode buildup in the root and soil as well over control. Among the biocontrol agents and organic amendment evaluated, application of FYM, neem cake, pungam cake along with *P. fluorescens* combined with seed treatment with rhizobium was most effective in controlling of root knot nematode and increased yield of butter beans. Nayak and Mohanty (2008) also observed that the combined application of neem cake, *P.fluorescens* was most effective in reducing root knot nematode, *M.incognta* in pulses. Several workers have also reported the bioefficacy of plant growth promoting rhizobacteria, *Pseudomonas fluorescens* against root knot nematode, *M. incognita* in tomato (Shanthi and Sivakumar, 1995), *M. incognita* in tomato and banana (Jonathan *et al.,* 2006).

Organic treatment was most effective in improving carrot growth and yield and also provided maximum reduction of *M. hapla* population both in soil and root (Devrajan *et al*., 2003). The higher dose of 50g neem leaves with poultry manure 5g/kg soil totally prevented the formation of root knots on the carrot roots (Agyarko *et al*., 2006). The combined use of *Paecilomyces lilacinus* KIA with rhizobium was better in reducing the galling and multiplication of root knot nematode, *M.javanica* in chickpea than other treatments (Siddiqui and Akhtar, 2009).

This might be due to the nematicidal and nutritional components of oil cakes released during decomposition and growth promotion activity and carbohydrate- lectin metabolism of *P. fluorescens.* The PGPR produce antibiotics, hydrogen cyanide and these compounds have been implicated in the reduction of pathogenic rhizosphere microorganism creating an environment favorable for root growth (Kloepper *et al*., 1980). These rhizobacteria reduce the hatching and invasion due to the production of toxic metabolites inside the plant.

Application of oilcakes increased microbial activity, saprophytic bacteria and fungi population (Tyagi and Alam 1995) saprozoic nematode population (Vemana *et al* 1999) during decomposition of oilcakes release of many compounds like ammonia, phenol, aldehyde and fatty acids which leads to reduction of root knot nematode population in soil and root of butter beans. The present investigation concluded that the soil application of biocontrol agents and organic amendments combined with seed treatment with rhizobium may be a viable preposition for the management of nematodes and enhancing soil fertility of upper Pulney hills region of Kodaikanal.

Table 2. Impact of biocontrol agents and organic amendments on root knot nematode multiplication in butter beans cv. KKL-1 (Pooled analysis)

Treatment	Final Soil nematode population /200cc soil	No. of adult females / 5g root	No. of egg masses / 5g root	Gall index	Cost benefit ratio
T_1 - FYM @ 20t/ha + neem cake, pungam cake @ 0.5 t/ha (each)	121.33 (55.50)	24.33 (56.42)	12.50 (72.92)	1.83	1:1.37
T_2 -Eucalyptus distillery waste @ 1t/ha + neem cake + pungam cake @ 0.5t/ha (each)	181.83 (33.31)	51.33 (8.06)	37.00 (19.86)	3.33	1:1.26
T_3 -Seed treatment with rhizobium@ 600g/ ha seed + *P. fluorescens* @ 2.5kg/ha	133.33 (51.10)	30.00 (46.27)	17.50 (62.09)	2.17	1:1.92
T_4 - Seed treatment with rhizobium 600g/ha seed + *T. viride* @ 2.5kg/ha	144.17 (47.13)	35.67 (36.12)	19.17 (58.48)	2.17	1:1.81
T_5 - T_1 +T_3 @ 50 % dose	109.00 (60.02)	18.00 (67.76)	6.67 (85.56)	1.50	1:2.22
T_6 - T_2 +T_4 @ 50 % dose	170.17 (37.59)	47.17 (15.52)	33.00 (28.52)	3.17	1:1.40
T_7 – Carbofuran 3G @1kg a.i/ha	158.00 (42.05)	42.00 (24.78)	26.83 (41.88)	2.50	1:1.39
T_8 – Untreated Control	272.67	55.83	46.17	4.67	1:1.16
S.Ed	2.812	1.632	1.403	--	--
CD (5%)	6.032	3.501	3.009	--	--

Figure in parenthesis are per cent decrease over control

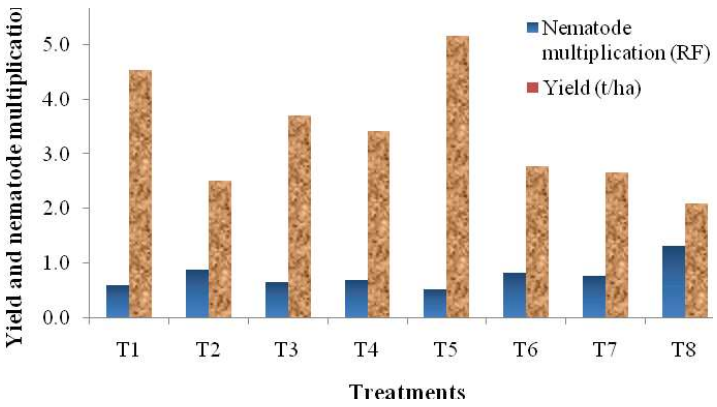

Fig. 1. Effect of biocontrol agents combined with organic amendment on yield and RKN multiplication in butter beans

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