Eco-friendly management of root-knot nematodes using acacia compost and bioagents in brinjal

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Abstract

A field experiment was conducted in root-knot nematode infested plot to evaluate the efficacy of acacia compost individually and in integration with bioagents viz., *Pochonia chlamydosporia* and *Paecilomyces lilacinus*. Acacia compost, poultry manure and carbofuran were also tested. All the treatments were significantly superior over untreated check. Acasia compost enhanced the growth parameters with drastic reduction in root-knot index. However, the treatment combinations of acasia compost with different bioagents performed well with highest growth shoot, root length, root weight, yield and lowest root-knot indices. Among the integrated treatments, *P. lilacinus* with acacia compost recorded maximum growth parameters and yield with least root-knot index. In contrast with other works of combination treatments of two bioagents, *P. lilacinus* + *P. chlamydosporia* with acacia compost registered high root-knot index and decreased growth parameters and yield among the other integrated treatments. Further, poultry manure and carbofuran were on par with all the parameters studied.

The root-knot nematodes are reported as one of the important factors affecting the production of brinjal (*Solanum melongena* L.) and reducing the yield by more than 30% (Bhatti & Jain, 1977). Infection by root-knot makes the plants highly susceptible to the attack of bacterial wilt caused by *Ralstonia solanacearum* Frank. Recent surveys indicated the widespread distribution of root-knot nematode in most of the fields in southern India where brinjal is cultivated (Rao *et al*., 2001).

Nematode control is far more complex than any other kind of pathogens because nematodes mainly attack underground parts of plants (Sikora & Fernandez, 2005). The control of plant parasitic nematodes has mainly depended on synthetic nematicides (Akhtar & Malik, 2000). Although, nematicides are efficient and fast-acting, they are currently being reappraised with them and in addition they are relatively unaffordable to many small scale farmers.

One of the alternative strategies for management of plant parasitic nematodes is the application of organic amendments in the soil (Agyarko & Asante, 2005). Organic amendments have consistently been shown beneficial effects on soil nutrients, soil physical conditions, soil biological activity and thereby improving the health of plants and reducing populations of plant parasitic nematodes (Oka *et al*., 2000).

Different practices are used in the integrated pest management (IPM) but the biological control would be the most enviable. Various fungi such as *Paecilomyces*, *Verticillium*, *Fusarium*, *Aspergillus*, *Trichoderma*, *Pochonia* and *Penicillium* were tested against juvenile mortality and on egg inhibition of nematodes. These filtrates proved to be toxic due to the release of antibiotics or enzymes (Dorcas *et al*., 2010).

An increase in nematicidal efficacy of microorganisms appears possible when such bio-

control agents integrate with either organic amendments or nematicides into an integrated control (Rao *et al*., 1997; Al-Rehiayani *et al*., 1999; Radwan, 1999, 2007; Radwan *et al*., 2004; Ashraf & Khan, 2010).

The objective of the present study was to assess the effectiveness of *P. lilacinus* and *P. chlamydospora* alone and in integration with acacia compost for the management of root-knot nematodes on brinjal. Acacia was not used extensively for the management of root-knot nematode and extensive literature survey indicates that this kind of experiment is among the preliminary attempts to integrate the bioagents with acacia compost for the management of root-knot nematodes.

Materials and Methods

A field experiment was conducted in root-knot nematode infested plot maintained at Zonal Agricultural Research Station, Navile, Shimoga during 2012. The experiment was conducted in randomized block design (RBD) with three replications and ten treatments. Brinjal cultivar was sown with a spacing of 75×60 cm. The soil type was sandy loam. The treatments included bioagents procured from Indian Institute of Horticultural Research (IIHR), Hesarghatta, Bangalore and acacia compost was prepared using leaves and young stems.

The treatments viz., *Paeciliomyces lilacinus* 2 $\times 10^6$ cfu (250 g/m^2), *Pochonia chlamydospora* 2 $\times 10^6$ cfu (250 g/m^2), acacia compost (1 kg/m^2), *Paeciliomyces lilacinus* 2×10^6 cfu (250 g/m^2) + acacia compost(1 kg/m^2), *P. chlamydospora* 2×10^6 cfu (250 g/m^2) + acacia compost, *P. lilacinus* + acacia compost (1 kg/m^2), poultry manure (100 g/m^2), carbofuran 3G (0.3 a.i) and untreated control (check).

The observations on RKI (0-5 scale) and plant growth parameters like shoot length, root length and root weight were recorded. The data obtained were analyzed statistically.

Results and Discussion

All the treatments were high over the untreated check. Organic amendments viz., acacia compost and poultry manure have the lowest root-knot indices indicating efficacy managing the nematodes. These present results confirm the early findings of organic amendments in control of root-knot nematodes (Akhtar & Alam, 1993; Akhtar & Malik, 2000; D'Addabbo, 1995; Litterick *et al*., 2004; Muller & Gooch, 1982; Oka, 2010; Rodriguez-Kabana, 1986; Stirling, 1991; Trivedi & Barker, 1986). A number of mechanisms have been proposed to explain observed beneficial effects of organic amendments on plants in the presence of nematodes. Release of nematicidal compounds from decomposing materials, stimulation of natural enemies of nematodes and improved plant growth and tolerance to nematodes was reported by researchers (Akhtar & Malik, 2000; Oka, 2010; Stirling, 1991; Thoden *et al*., 2011). Multiple mechanisms may operate simultaneously, so it is difficult to distinguish which are most important (Akhtar & Malik, 2000).

Organic amendments were followed by the combination treatment of *Paeciliomyces lilacinus* + *Pochonia chlamydospora* + acacia compost. Similar findings were reported by Cannayane & Rajendran (2001) in an integrated application of *P. lilacinus*, *Verticillium chlamydosporium* and oil cakes viz., neem, castor were evaluated for the control of *Meloidogyne incognita* in brinjal cv. 60-2, under micro plot condition, result showed that integrated application of these agents significantly reduced *M. incognita* population and increased yield.

In whole, bioagents individually performed well than in combination with acacia compost. *P.*

lilacinus both individually and in combination performed very close to the recommended check carbofuran 3G while, *P. chlamydospora* both in combination and individually recorded higher root-knot indices than the Carbofuran 3G.

Nematicidal properties are present in acacia extracts and particularly in funicles of acacia seeds (Datta *et al*., 1997, 1998, 2000; Datta, 1999, 2005, 2005a, 2006, 2006a, 2007; Datta & Datta, 2006, 2006a, 2007, 2007a, 2008, Sultana *et al*., 2011).

Growth parameters: Length and weight of plant shoots and roots were also influenced by the treatments (Table 1). The application of acacia compost significantly increased the length of shoots compared to the untreated check. *Paeciliomyces lilacinus* performed well than in combination with acacia compost whereas, *P. chlamydospora* with acacia compost registered longer shoots than *P chlamydospora*. No significant difference in shoot length was noticed between *P. lilacinus* + *P. chlamydospora* + Acacia compost and recommended check carbofuran 3G.

Among the combination treatments, none of the treatment was effective over carbofuran 3G except *P. lilacinus* + acacia compost in enhancing the root length and reducing the root weight. Application of biogents individually resulted in smaller and heavier roots than other treatments.

Application of organic matter to the soil has beneficial effects on soil nutrients, soil physical properties, soil biological activity and crop performance. The nutrient content of the amendments and the large quantities of these materials added to the soil result in increased soil fertility, plant growth and tolerate nematode attack (Rodríguez- Kábana *et al*., 1987; Stirling, 1991). The enhancement of plant growth by organic amendments in the present study could be due to the combination of the suppressive effect on nematodes with a direct fertilizing effect on the plants.

Table 1. Effect of integrated management of root-knot nematode on growth parameters and yield by acasia compost and bioagents in brinjal field.

Treatments	Shoot length (cm)	Root length (cm)	Root weight (g)	RKI (0-5)
Paeciliomyces lilacinus 2×10^6 cfu (250 g/m^2)	14.53	3.40	3.60	1.30
Pochonia chlamydospora 2×10^6 cfu (250 g/m^2)	11.20	3.63	2.67	1.50
Acacia compost (1 kg/m^2)	16.33	5.73	1.97	0.73
Paeciliomyces lilacinus 2×10^6 cfu (250 g/m^2) + acacia compost (1 kg/m^2)	11.77	4.73	2.13	1.47
Pochonia chlamydospora 2×10^6 cfu (250 g/m^2) + acacia compost (1 kg/m^2)	11.50	3.63	4.00	1.67
Paeciliomyces lilacinus 2×10^6 cfu (250 g/m^2) + *Pochonia chlamydospora* 2×10^6 cfu (250 g/m^2) + acacia compost (1 kg/m^2)	10.93	4.33	2.27	1.00
Poultry manure (100g/m^2)	9.37	4.27	2.07	0.93
Carbofuran 3G (0.3 a.i/ m^2)	10.67	4.60	2.13	1.47
Check	7.90	2.40	6.73	3.67
SE±	1.33	0.34	0.49	0.24
CD (0.05)	3.98	1.04	1.47	0.72
CV(%)	19.88	14.72	27.71	27.25

Biological control agents are often applied to soils in combination with organic materials that contribute to enhance biological activities against the target pathogen. The organic materials provide the nutrients needed for initial growth of the bio-control agents in soil and may be used as carriers to facilitate distribution. The breakdown of the organic materials may release toxic and nematicidal substances that contribute to nematode control (Rodríguez-Kábana *et al*., 1987).

Thus, the study has demonstrated the efficacy of acacia compost in managing the root-knot nematode. Acacia compost had drastically reduced the root-knot indices and enhanced the growth parameters. However, further investigation on nematicidal properties and its mechanism is suggested. Combination treatment of two bioagents are most effective than individual bioagent. However, the outcome of this trail is in contrast with their findings and needs further investigation.

Acknowledgement

The authors are thankful to Dr. A.S. Kumaraswamy, Director of Education, UAHS, Shimoga for providing acasia compost and for valuable guidance during the course of investigation.

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(Received: 03 December, 2013)