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22

COMPATABILITY OF *PSEUDOMONAS FLUORESCENS*, VAM (*GLOMUS FASCICULATUM*), *TRICHODERMA HARZIANUM* AND PESTICIDES ON ESTABLISHMENT AND GROWTH OF BLACK PEPPER UNDER NURSERY CONDITION

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ABSTRACT

Black pepper, commercially important spice propagated mainly by rooted cuttings raised in the nurseries. In order to produce vigorous plants for better establishment, an experiment was undertaken with various combination of *Pseudomonas fluorescens,* (IISR6), VAM (*Glomas fasciculatum*) and *Trichoderma harzianum*, fungicides and nematicides. It was observed that combined use of VAM+ IISR6 along with phorate and COC spray resulted in better establishment and growth of black pepper plants. The production of significantly higher number of leaves, leaf area, maximum root length and total biomass were noted in this treatment followed by the application of IISR6 alone. Application of IISR6 alone or combination with other biocontrol agents are suggested for ecofriendly management of diseases and production of vigorous black pepper rooted cuttings in the nursery.

INTRODUCTION

Black pepper, (*Piper nigrum* L.) is an important foreign exchange earner for the Country. The crop is the major source of income and employment for rural house holds in the predominantly pepper growing regions of Kerala. Non availability of quality planting material is one of the reason for decreasing the black pepper productivity. Disease caused by fungi *Phytophthora capsici, Rhizoctonia solani, Sclerotium rolfsi*, and viruses are making substantial loss in the nursery. Foliar spraying can be given to all the cuttings with either bordeaux mixture 1% or Copper oxi chloride (COC 0.2%) or bavistin 0.2% at 15-30 days intervals during June-July to control the diseases in the nursery (Sarma 2000). Spurred by the ecological effects of chemical based management tools, pest management strategies have now shifted their focus to ecofriendly practices, which maintain soil health. It is desirable to raise the cuttings in solarised mixture and mixing with *Trichoderma harzianum* and VAM inoculum to produce robust disease free rooted black pepper cuttings (Sarma 2000; Anandaraj 2001).

In the black pepper nursery, it is seen that seedling raised in fortified potting mixture without any plant protection measures are susceptible to disease. Plant growth promoting rhizobacteria (PGPR) are naturally occurring soil bacteria that are able to aggressively colonise plant roots and stimulate plant growth when applied to roots, tubers or seeds (Weller 1998). The use of PGPR as biofertilizer is one of the most promising biotechnologies to improve primary production in the low inputs in fertilizers, through any of many mechanism possible, mobilization of phosphorous (DeFreitas *et al.* 1997) production of growth stimulating phytohormones (Arshad & Frankenberger 1998) Siderophores production (Raaska *et al.*1993), antibiotics production (Schinder *et al.* 1994), inhibition of plant ethylene synthesis (Glick *et al.*1994) and induction of plant systemic resistance to pathogens (Klopper *et al.* 1993). It is important that the biocontrol agent should be compatible with recommended dose of pesticides applied. Application of *Trichoderma harzianum* and *Pseudomonas fluorescens* were recommended for promoting growth and suppressing the disease caused by pathogens in black pepper, ginger and cardamom (Jisha *et al.* 2002a). In order to develop healthy plantation, pathogens free vigorous planting material is essential. Hence, the present investigation was undertaken to compare efficacy of *Pseudomonas fluorescence* (IISR 6), VAM and *Trichoderma harzianum* to promote growth of black pepper cuttings in the nursery along with the recommended pesticides.

MATERIALS AND METHODS

The study was conducted from March-July 2003 at Indian Institute of Experimental Farm, Peruvannamuzhi using the variety Panniyur-1. Healthy, single nodes, with a leaf and root, were transplanted into polythene bags (20 x 10 cm size) containing sand, soil and FYM in 1:1:1 proportion. Lower half of each bag was provided with 10 -12 holes to drain excess water. The biocontrol agents used for incorporation in the polythene bags were PGPR isolate IISR 6, VAM and *Trichoderma harzianum*. VAM (*Glomus fasciculatum* ~550 propagules, 100 cc), *Trichoderma harzianum* (1g x 10^9 cfu), were mixed with one kg of potting mixture and 500gm used for filling the polythene bags for the corresponding treatment. Neem cake and lime (6 gm each /kg of potting mixture) were mixed for another treatment and used for filling the bags. Phorate @1g/bag and carbofuran @ 3g/bag were applied at the time of planting and one month after planting respectively. Since, copper oxichloride is not compatible with *Trichoderma harzianum*, COC spray was given one month after planting (Sarma 2000). Ridomil @ 30 ml/bag was used for drenching in the polythene bags. *Pseudomonas fluorescens* isolate IISR6 maintained at Pathology division of IISR was applied @50ml per bag which had 10^8 cfu/ml at the time of application. Nutrient solution as per package of recommendation of IISR was added to the polythene bags one month after planting. The trial was laid out in CRD with three replications and ten treatments with ten plant in each treatment.

Treatments

T1. Neem cake + lime (ATP)
T2. Phorate (1g, ATP) + Carbofuran (3g, 1 MAP)
T3. Ridomil spray 1.25% (ATP)+ COC drenching 0.2% (1MAP).
T4. IISR 6 (ATP)
T5.VAM + Ridomil drenching1.25% (ATP) + Carbofuran (1 MAP)
T6. VAM + IISR6 (ATP) + COC spray (1MAP) + Phorate (1 MAP)
T7 .TD + Ridomil drenching 1.25% (ATP) + Carbofuran (1 MAP)
T8.TD + VAM + COC Spray 0.2% (1MAP).
T9. TD + VAM + IISR6 + COC spray 0.2% (1 MAP)
T10. Control
Where ATP-At the time of planting, MAP- Month after planting.

Observations on growth parameters such as height, number of leaves per plant, total leaf area /plant were recorded at 3rd month after planting. The lengths of roots and total biomass per plant were recorded at four month after planting. Leaf area was estimated using an equation LA = 0.6 l x w and by summing the areas of individual leaves where LA = Leaf area, L = Length of leaves and w = Width of leaves (Ibrahim *et al.* 1985). After recording the growth measurements, plants were cut at the basal portion and separate the parts into roots, leaves and stem and dried in an oven at 60^0 C for 48 hours. The dry weight of stem, leaves and roots were recorded separately and added together to estimate the total biomass.

RESULTS AND DISCUSSIONS

Influence of different biocontrol agents and pesticides on growth of black pepper plants grown in polythene bags are shown in Table1. Number of leaves

produced three months after the growth of black pepper plants varied significantly among the treatments. Significantly higher leaf production was observed for the treatment VAM + IISR6 along with phorate and COC spray.

Table 1. Effect on plant growth when different biocontrol agents were applied to black pepper cuttings.

Treatment	Height (cm)	No. of Leaves	Leafarea(cm^2)
NC+ Lime	29.0	5.7	322.0
Phorate + Carbofuran	27.4	7.0	435.0
Ridomil + COC	34.9	7.4	481.7
IISR6	36.0	7.9	512.4
VAM+Ridomil+Carbofuran	33.7	7.3	438.0
VAM+ IISR6+ COC + Phorate	37.0	9.3	552.0
TD+Ridomil+Carbofuran	38.3	8.7	476.8
TD+VAM+COC	30.3	7.4	429.0
TD+VAM+IISR6+COC	39.3	8.6	479.0
Control	27.6	6.6	321.0
CD (0.05)	NS	1. 5	124.2

Effect of different biocontrol agents on leaf area of black pepper cuttings were significant. Maximum leaf area was again recorded for the treatment VAM+IISR6 along with COC and phorate followed by IISR6 alone.

Root and total biomass.

The pronounced effect of biocontrol agents on root and total biomass production was evident from Table 2. Average root length was higher for the isolate IISR6 which was on par with the treatment Phorate (1g, ATP) + Cabofuran (3g,1MAP), Ridomil+COC, VAM+IISR6 along with Phorate and COC spray, and TD+VAM+IISR6 along with COC. Maximum root length was recorded for the treatment VAM+ IISR6 along with phorate and COC spray. Maximum root length was significantly inferior in Phorate + Carbofuran and control. Seedling development and outplanting success depends on root health and the root architecture which have been shown to greatly influence the seedling survival after outplanting (Wisniewski *et al.* 1991).

Total biomass was significantly higher for the treatment VAM+ IISR6 along with phorate and COC spray followed by IISR6 alone. Similarly VAM+ IISR6 along with phorate and COC spray recorded 88% increase in biomass production over control. Biomass production was less for the bags in which fungicides and nematicides were applied alone. Enhanced growth observed in biocontrol treated plants was not only due to disease suppression but may be due to production of growth hormones by microorganisms. VAM enhance the growth of black pepper and offers protection against *Phytophthora capsici*, *Radopholus similis* and *Meloidogyne incognita* (Anandaraj *et al.* 2001). Enhancement of uptake of P and other nutrients by VAM fungal hyphae is the primary mechanism responsible for plant growth stimulation which includes root and shoot length (Hayman 1980). Increased vigour and yield due to application of PGPR, VAM and *Trichoderma harzianum* in tomato seedlings were reported (Varshney *et al.* 2000). Similar results were reported in

ginger, cardamom and black pepper when *Trichoderma harzianum* and *Psedomonas flouresens* were applied together (Jisha *et al.* 2002a; Jisha *et al.* 2002b). Earlier workers have also recorded significant improvement in growth by the application of PGPR (Weller 1988; Viswanathan & Samiyappan 2000)

Table 2. Effect on root length and total biomass when different biocontrol agents were used in polythene bags.

Treatment	Length of root (cm)		Total biomass (g)	% increase over control
	Average	Maximum		
NC+ Lime	12.2	17.5	7.7	10.0
Phorate + Carbofuran	15.5	16.4	7.8	11.4
Ridomil + COC	16.5	17.3	8.4	20.0
IISR6	17.8	19.2	12	71.4
VAM+Ridomil+Carbofuran	13.1	18.4	11.4	62.9
VAM+ IISR6+ COC + Phorate	16.9	21.2	13.2	88.6
TD+Ridomil+Carbofuran	12.2	18.6	9.5	35.7
TD+VAM+COC	12.8	18.5	9.1	30.0
TD+VAM+IISR6+COC	15.6	20.9	10.5	50.0
Control	10.9	13.0	7.0	0
CD (0.05)	3.8	3.9	0.6	

Biomass production by the treatment TD along with Ridomil and Carbofuran was less, compared to the treatment VAM+IISR6 along with Phorate and COC spray and IISR6 alone. PGPR isolated from black pepper rhizosphere is more efficient for controlling *Phythophora* infection and growth promotion of black pepper cuttings as compared to control in green house studies (Lisha *et al.* 2001.). Growth of tomato plant was significantly higher when treated with isolates of *Pseudomonas* followed by VAM and Trichoderma (Varshney *et al.* 2000; Ganeshan & Poonam Sinha 2001).

An overall assessment of results indicated that application of VAM+ IISR 6 along with Phorate and COC spray resulted in significantly higher number of leaves, maximum length of roots, leaf area and total biomass followed by IISR6. Pest management strategies based on eco-friendly practices, application of IISR6 alone or in combination with other biocontrol agents are suggested for the production of healthy black pepper rooted cuttings in the nursery.

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BIOCONTROL POTENTIAL OF *PSEUDOMONAS FLUORESCENS* (P-1) TO MANAGE COCONUT ERIOPHYID MITE AND THE SCOPE OF USING HONEYBEES AND ANTS FOR ITS DISPERSAL

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ABSTRACT

A particular strain (P-1) of *P. fluorescens* showed some kind of antagonism to the population of CEM on coconut. Since the lack of a cost effective delivery system was the major constraint of biocontrol in coconut, vectoring of Pf using foraging bees *Trigona irridipenis, Apis cerana indica* and the black ant, *Polyrhachis exercita* and its dispersal on the inflorescence was studied. The results indicated Indian honey bee as a potential agent for vectoring Pf to coconut inflorescence. The scope of using *P. exercita* to vector bio-agent to female flowers at the receptive phase was also indicated.

INTRODUCTION

Coconut Eriophyid mite (CEM) *Aceria guerreronis* Keifer has emerged as a very serious problem to coconut (Nair et al., 2000; Paul and Mathew 2002a, Saradamma et al.,) and coir industry (Paul and Mathew, 2002b) in southern states of India and it caused 20-40 percent fall in production in Kerala. CEM starts colonization in young bunches just after fertilization (Mariau and Julia, 1970) and since a new inflorescence is produced at an interval of 20-25 days, it is practically impossible to protect each of them at critical age (Moore and Alexader,1987). Attempts were made to tackle the problem on a massive scale in Kerala state (where the number of affected palms were as high as 59 million in 1999-2000) chiefly by spraying dicofol, wettable sulphur, neem oil- garlic-soap emulsion (Mathew et al., 2002) or azadirachtin based formulations. But all these met with limited success mainly due to the practical problems faced with climbing 10 to 20 m tall palms and