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Ecofriendly Management of Seedling Diseases of Mango (*Mangifera indica* L.)

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A B S T R A C T

A greenhouse experiments were conducted at Regional Research Station, Tamil Nadu Agricultural University, Paiyur, Krishnagiri District during 2018 to 2020 on bioinoculants augmented disease-free seedling production in mango for the management of collar rot and root rot diseases through bioagents. The collar rot disease caused by *Sclerotium rolfsii* affecting mango seedlings in nurseries were effectively controlled by treating the mango stones with *Trichoderma asperellum* (2%) along with soil application of*T. asperellum* (10g) + VAM (15g) + Vermicompost (250g) /sq. m and recorded the lowest incidence of collar rot (19.6 %). The root rot caused by *Macrophomina phaseolina* in potted mango seedlings were effectively controlled by the application of *T. asperellum* (10g) +VAM (15g) /graft in the pot mixture of Red soil (1): Sand (1): FYM (1) and recorded minimum incidence of root rot (2%). The per cent germination, root stock success was recorded more in the biocontrol treated pot mixture compared to untreated one.

Introduction

Mango (*Mangifera indica* L.) commonly called as King of fruit, belonging to the family Anacardaceae is the most important crop among the tropical and sub-tropical fruit crops. India is the world's largest producer of mango followed by China and Thailand. It is the national fruit of India, which occupies nearly half of the total area under fruits in the country. In the world scenario, India shares about 56 per cent of total mango production. About 40 per cent of total fruits grown in India is only mango. In India, it is cultivated in an area over 2,262,800 hectares with a production of 19,686,900 metric tonnes of fruit (Horticulture Statistics, 2017). Although India is the largest producer of mango, in terms of productivity it ranks lower. The low productivity is due to the diversity of the pest and disease problems associated in addition to wide range of climatic conditions and environmental situations in which it is grown. Mango crop is affected by a number of diseases at all stages of its development right from the plants in the nursery to the fruits in transit and storage. Nursery diseases are an important constraint for mango production.Healthy and disease free seedlings are one of the prime need and is basic raw material for establishment of orchard for production of mango.

The seedling diseases are one of the important problems in the tropics. Although a huge number of nurseries are engaged in producing seedlings, they fail to produce quality seedlings due to lack of their knowledge about diseases. Seeds after germination are liable to attack by different soil borne organisms. Even after emergence of the seedling, it could be attacked by different diseases which may produce distinct symptoms in the nursery bed or it may carry the organisms when it is transplanted in the pot or in orchard. In severe cases, diseases cause mortality of many seedlings after plantation.

Among the diseases that affect the mango seedlings in nursery, collar rot caused by *Sclerotium rolfsii* and root rot caused by *Macrophomina phaseolina* is the most important soil borne fungus affecting the production of quality mango seedlings. *Sclerotium rolfsii* is a polyphagous soil borne pathogen infecting over 500 plant species worldwide causing huge losses. Though the fungus is seed and soil borne, soil borne inoculum is more important in causing infection and disease development. The pathogen causes a great economic loss in various crops. In groundnut, it caused 25 per cent of seedling mortality in the cultivar JL-24 at Parbhani (Ingale and Mayee, 1986). Thiribhuvanamala *et al.,* (1999) observed that 30 per cent of crop loss in tomato was due to *S. rolfsii*. Harinath Naidu (2000) reported that *S. Rolfsii* caused 40-50 per cent mortality in crossandra. Root rot caused by *Macrophomina phaseolina* is a soilborne fungus which can infect the root and lower stem of over 500 plant species and is widely distributed. The fungus is an agriculturally important plant pathogen which causes inhibition of seed germination, wilting of seedlings, and root rot in several crop plants, like soybean, tobacco, ground nut, and beans.

Considering the above, an attempt was made to develop a sustainable management strategy against the seedling diseases through an integrated approach by combining organic amendments and antagonistic biological agents for the production of quality and disease free mango seedlings.

Materials and Methods

Isolation of collar rot and root rot pathogen

The collar rot (*Scleritium rolfsii*) and root rot (*Macrophomina phaseolina*) pathogens were isolated from the infected mango seedlings showing typical symptoms by using potato dextrose agar (PDA) medium and identified as *S. Rolfsii* and *M. Phaseolina* based on various cultural and morphological characters.

Effect of seed treatment and soil application of bioagents and Vesicular Arbuscular Mycorrhizal (VAM) fungus on Mango collar rot and growth promotion.

The stones of mango var Bangalora were purchased from the pulp factory. The stones were treated with biocontrol agents viz., *Trichoderma asperellum* and *Pseudomonas fluorescens* at three different concentrations each at 0.5%, 1.0% and 2% respectively. The bioagents at various doses viz., 2.5g, 5g and

10g and vermicompost @ 250g per sq. m were applied to the soil. The treated stones were sown in the bed. The observations like days for commencement of germination, germination per cent, collar rot incidence, height of the seedlings and seedling vigour was recorded.

Effect of pot mixture (Red soil): Sand(1): FYM(1) with bioagents and VAM fungus on root rot and vigour

One hundred and ten days old mango seedlings were potted in pot mixture containing red soil, sand and FYM in the ratio of 1:1:1 mixed with talc formulation of bio agents at 2.5g, 5g and 10g and vermiculite formulation of VAM fungus at various doses of 5g, 10g and 15g per graft each separately to study the effect of potting mixture on seedling rot and vigour. One hundred plants were maintained for each treatment with 25 plants per replication. The following observations on root rot incidence, per cent root stock success and days taken for sprouting were recorded.

The per cent disease incidence

$$= \frac{\text{Number of plants infected}}{\text{Total number of plants observed}} \times 100$$

Results and Discussion

Isolation of the pathogen

The pathogen isolated on PDA medium from the collar rot infected mango seedlings showed that the fungus *Sclerotium rolfsii* produces abundant white fluffy mycelium which spread like a fan. Small white tufts were formed on mycelium which later gives rise to smooth, hard and dark brown sclerotia. Sclerotia may be spherical or irregular in shape and at maturity resemble the mustard seed (Boonthong and Sommart, 1985; Harinath Naidu, 2000 and Mohan *et al.*, 2000). The root rot infected seedlings showed that the fungus produces profuse white mycelium later turn brown to black on PDA. Black hard sclerotia were formed after 10-15 days at the periphery of the colony. Microsclerotia of *M. phaseolina* are jet black in color and appear smooth and round to oblong or irregular.

Effect of seed treatment and soil application with bioagents and Vesicular Arbuscular Mycorrhizal (VAM) fungus on mango collar rot and growth promotion.

The results of the study reveals that the average days taken for commencement of germination of mango seedlings was 20 to 21 days in the biocontrol treated plots whereas it took 23 days for the germination in control plot.

The maximum germination (31%) and minimum collar rot incidence (19.6 %) was recorded in the stones treated with *T. asperellum* (2%) and soil treatment with *T. asperellum* (10g) + VAM (15g) + Vermicompost(250g)/sq mcompared control. The maximum mean seedling height (20 cm) and seedling vigour (587) was recorded in stones treated with *Pseudomonas fluorescens* (TNAU-Pf1) (0.5%) and soil treatment with *P.fluorescens* (2.5g) + VAM (5g) + vermicompost (250g) /sq m (Table 1).

Effect of pot mixture (Red soil): Sand(1): FYM(1) with bioagents and VAM fungus on root rot and vigour

The effect of pot mixture with bioagents and VAM fungus on seedling rot and vigour revealed that there was a significant reduction on the incidence of seedling rot which recorded 2 per cent in the pot mixture treated with *Trichoderma* @ 10g along with vermicompost @ 15g per graft compared to control (27 per cent).

Table.1 The effect of seed treatment and soil application of bio agents with VAM and Vermicompost

Treatments	Common cement of Germination (days)	Germination (%)	Collar rot (%)	Height of seedlings (cm)	Seedling vigour
T1- Stone treatment with *T. asperellum* (1%) and soil treatment with *T. asperellum* (5g) + VAM (10g) + Vermicompost (250g) /Sq. m	21.3	28.0 (31.93)	25.6 (30.43)	17.3	**492**
T2- Stone treatment with *T. asperellum* (2%) and Soil treatment with *T. asperellum* (10g) + VAM (15g) + Vermicompost (250g) /Sq. m	21.3	29.3 (32.73)	21.6 (27.70)	18.3	**529**
T3- Stone treatment with *T. asperellum* (2%) and Soil treatment with *T. asperellum* (10g) + VAM (15g) + Vermicompost (250g) /Sq. m	21.3	31.3 (34.02)	19.6 (25.91)	18.5	**579**
T4- Stone treatment with *Pseudomonas fluorescens* (TNAU-Pf1) (0.5%) and Soil treatment with *P. fluorescens* (2.5g) + VAM (5g) Vermicompost (250g) /Sq. m	21.0	28.3 (32.13)	28.3 (32.13)	20.6	**587**
T5- Stone treatment with *P. fluorescens* (1%) and Soil treatment with *P.fluorescens* (5g) + VAM (10g) + Vermicompost (250g) /Sq. m	21.0	29.0 (32.57)	27.6 (31.49)	19.5	**564**
T6- Stone treatment with *P. fluorescens* (2%) and Soil treatment with *P.fluorescens* (10g) + VAM (15g) + Vermicompost (250g) /Sq. m	20.6	31.0 (33.76)	28.0 (31.83)	18.2	**563**
T7- Stone treatment and soil drencing with carbendazim (1 g/lit)	22.6	27.3 (31.34)	24.0 (28.79)	16.6	**458**
T8- Untreated control	23.3	27.0 (30.95)	37.3 (37.35)	15.5	**449**
CD(>0.05)	**3.72**	**6.43**	**10.80**	**7.02**	**281.43**
SEd	**1.75**	**3.03**	**5.09**	**3.31**	**132.75**

Figures in parantheses are arc sine transformation values

Table.2 The effect of pot mixture with bio agents and VAM fungus on seedling rot and vigour.

Treatments	Root rot incidence (%)	Root stock success (%)	Days taken for sprouting
T1-*Trichoderma asperellum* (2.5g) + VAM (5g) /graft	6.0 (13.98)[b]	99 (84.96)[a]	**12.7**
T2- *T. asperellum* (5g) +VAM (10g) /graft	3.0 (9.36)[ab]	99 (84.96)[a]	**12.7**
T3 - *T. asperellum* (10g) +VAM (15g) /graft	2.0 (7.19)[a]	95 (78.18)[b]	**12.7**
T4- *Pseudomonas fluorescens* -TNAU-Pf1 (2.5g) + VAM (5g) /graft	18.0 (24.14)[c]	96 (78.18)[ab]	**12.2**
T5- *P.fluorescens* (5g) + VAM (10g) /graft	19.0 (25.67)[c]	92 (73.57)[bc]	**13.0**
T6 - *P. fluorescens* (10g) + VAM (15g) /graft	18.0 (24.60)[c]	92 (73.57)[bc]	**13.0**
T7- Carbendazim @ 1 g/lit (Soil drenching)	21.0 (26.75)[c]	89 (71.21)[c]	**15.0**
T8- Untreated control	27.0 (31.22)[c]	88 (69.86)[c]	**15.5**
CD (>0.05)	**8.08**	**1.15**	**0.84**
SEd	**3.91**	**0.55**	**0.40**

Figures in parantheses are arc sine transformation values

The per cent root stock success ranged from 92 to 99 per cent in bio agents treated pot mixture irrespective of the concentration compared to 88 per cent in control. The number of days taken for sprouting of root stock ranges from 12-13 days in bioagents treated pot mixture whereas untreated pot mixture recorded 15 days for the sprouting of the seedlings (Table 2).

The results of the study showed that the seed and soil treatment of *Trichoderma asperellum* along with soil amendments FYM, vermicompost and VAM decreased the collar rot infection by *Sclerotium rolfsii* and root rot infection by *Macrophomina phaseolina in* mango seedlings. Similar results were reported by Kulkarni (1994) that seed and soil treatment with *T. viride* and *T. Harzianum* were the most effective in reducing the mortality percentage of groundnut incited by *S. rolfsii.* The application of biocontrol agents controlled the *Phythium* root rot of broccoli plants under greenhouse conditions (El Mohamady, 2012). Anahosur (2001) reported that tuber treatment with *T. harzianum, T. viride, G. virens*, and *P. fluorescens*@ 10 g/kg of tuber effectively controlled wilt of potato caused by *S. rolfsii*. The corm treated with *T. Harzianum* and *B. subtilis* significantly reduced the collar rot of elephant's foot yam incited by *S. Rolfsii* was reported by Gogoi *et al.,* (2002). Seed and soil treatment with *T. Harzianum* plus neem cake significantly reduced stem rot of groundnut caused by *S. Rolfsii* with increased dry shoot and root weight was reported by Sakthi Kumaran (2000). Ramezani (2008) reported that soil application of talc based formulation of *T.polysporum* and *T.viride* effectively controlled the root rot *M. phaseolina* of egg plant under field condition. Several *Trichoderma* spp. suppress the soil-borne pathogens by diversified mechanisms viz., production of a wide range of broad spectrum antifungal metabolites, mycoparasitism, competition with the pathogen for nutrient and for occupation of infection court, induced resistance, production of protease and fungal cell wall degrading enzymes (Perello, 2003). The VAM fungus competes with the pathogens for the uptake of essential nutrients in the rhizosphere and at the root surface (Reid, 1990) and stimulating the microbial activity and competitions in the root and thus preventing the pathogens to get access to the roots (Rambelli, 1973). Roots colonized by VAM fungi may also harbour more actinomycetes antagonistic to root pathogen (Secilia and Bagyaraj, 1987) and compensating the nutrient absorption system from damage to roots by pathogens.Kjoller and Rosendahl (1996) who found a positive effect of VAM treatments in decreasing root rot caused by *Aphanomyces euteichus* in pea. Thilagavathi (2012) reported that vermicompost based bioformulations of bacterial and fungal biocontrol agents were effective in reducing the root rot in sugarbeet in both pot and field condition. Bulluck and Ristaino (2002) reported the reduction of the viability of sclerotia after the mixing of compost or manure to natural soils. The combined application of *T. viride*+ neem cake+ vermicompost significantly reduces the stem rot incidence in groundnut and also increases the root length, shoot length and pod yield was reported by Surjana and Sunil Zacharia (2020). The addition of organic amendments to soil exerted favourable effect on disease reduction due to its suppressive nature (Adiver, 2003). Saad (2006) reported that organic amendments increase the availability of nutrients besides improving physical condition of soil, increase the yield and reduce the soil-borne diseases. Besides the nutrient content, these amendments may have a possible role in enhancing the host growth and vigour, increasing antagonistic microbial activity and enabling them to resist the attack of pathogen. The production of volatile and non-volatile toxic compounds during the decomposition of organic amendments suppresses root diseases.

The results revealed that the integration of bioagent *T. asperellum* along with soil amendment vermicompost and VAM attributed to additive growth effects that enhanced plant vigour and antagonistic activity against seedling diseases of mango.

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