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Integrated Management of Foot Rot in Betel Vine under Rayalaseema Zone of Andhra Pradesh

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ABSTRACT: A field study on integrated management of foot rot in betel vine was undertaken to find out the response of bio agents and fungicides in management of foot rot disease in betel vine crop during 2016-17 and 2017-18. The experiment was laid out in Randomized Block Design with eight treatments and replicated thrice. Experimental findings indicate that the pathogen isolated from root and petiole portions of the infected plant and identified as *phytophthora* from root and petiole portions. Further isolated another pathogen *Rhizoctonia bataticola* in betel vine field of chinavorumpadu village of YSR Kadapa dt. of Andhra Pradesh. All the treatments viz. application of *Trichoderma harzianum*@ 5kg/ha (Oct-Dec) along with FYM + Neemcake @500 kg/ha, spraying of Fosetyl AL @ 0.2% + Drenching of Potassium Phosphonate @ 0.3%, soil application of *Bacillus subtilis* @ 5kg/ha), soil application of Consortium (IIHR) @ 12.5kg/ha. in 1250kg FYM/ha, soil drenching with Bordeaux mixture (1%) and soil application of *Trichoderma harzianum* @ 5kg/ha along with foliar spray of Potassium Phosphonate @ 0.3% was found effective in controlling the disease when compared to control. The lowest percentage of foot rot incidence (1.28, 3.85, 5.34, 7.05, 8.28), leaf rot percent disease index (0.98, 1.05, 4.06, 5.76, 7.65) and leaf fall (0.20/vine) in Nov, Dec, Jan, Feb, March was recorded where the soil application of Consortium (PGPR) @5 capsules/ha along with sanitation and raised beds with drip irrigation was superior in controlling the foot rot disease in betel vine than other treatments.

Keywords: IDM, Betel vine, foot rot, *Phytophthora, Rhizoctonia bataticola.*

INTRODUCTION

Betel vine (*Piper betle* L.) belongs to the family Piperaceae and it is an important plantation vine crop, cultivated largely in Rayalaseema Districts of Andhra Pradesh. Betel vine leaf used as a many traditional as well medicinal purposes to treat stomach ailments, skin infections etc (Guha 2006; Rai *et al*., 2011; Manjesh *et al*., 2020). The cultivation of betel vine plants is very much affected by foot rot disease produced by the fungus of *Phytophthora* spp. and outcome of the cultivator is big loss for betel vine plants cultivation. The fungus that lives in the soil and attacks roots, stem and leaves, so use of cultural, chemical and biological methods resulted in reducing the disease incidence. The main objective is identification of the pathogens from the infected foot rot samples and to find out the response of Bio agents and fungicides in management of the diseases in Betel vine (Dasgupta *et al.,* 2003).

Betel vine crop is being affected by foot rot disease (*Phytophthora* spp.), which results in mortality of vines and complete death of plant and causing huge loss for farmers. The fungus mainly spread from field to field through irrigation water and it is soil borne disease and survives in infected plant debris and in soils (Dastur, 1935; Ramachandran and Sarma, 1985; Das *et al.,* 2000). The present recommendation is seed treatment with 0.5% Bordeaux mixture and drenching of the 1.0% Bordeaux mixture in plant basins from the month of November to February. Application of fungicides for controlling the disease could be a difficult task and leads to environmental pollution (Nandeesha *et al.,* 2020). Hence, the present study was undertaken for

integrated management practices for sustainable betel vine production.

MATERIALS AND METHODS

The field experiment was conducted at Chinavorumpadu village and lab work was done at College of Horticulture, Anantharajupeta, DR.YSR Kadapa District, Andhra Pradesh to study the integrated management of foot rot in tellaku variety of betel vine (Fig. 1, 2). The experiment was laid out in Randomized Block Design (RBD) with eight treatments and replicated thrice. The crop was raised as per the recommended package of practices followed in local region, except plant protection measures.

Fig. 1. Foot rot disease in betel vine in Chinavorumpadu village.

Fig. 2. Betel vine field infected with *Rhizoctoia bataticola* fungus.

Observations were recorded on disease severity in each treatment before sprays and after completion of sprays as per the standard methods. Finally, the betel vine yield per plot was recorded and converted into quintals/ha and data was analyzed statistically. The observations of betel vine disease severity of foot rot, leaf fall and leaf rot were recorded using the formula and disease rating scale given as below:

Disease rating scale: Foot rot disease incidence is determined on the basis of disease score an estimate of the area decayed using 0-9 scale as follows:

Foot rot and leaf fall: Percent disease incidence (PDI) of foot rot and leaf fall was calculated using the formula (Townsend and Heuberger 1943):

Percent disease index for leaf rot =

$$\frac{\text{No. leaves/stems infected} \times 100}{\text{Total no. of leaves/stem}}$$

*0- healthy leaf
*1- up to 10% leaf area covered
*3- 11-25%leaf area covered
*5-26-50% leaf area covered
*7- 51-75% leaf area covered
*9 - >75% leaf area covered

Leaf rot: The percent leaf rot disease index (PDI) was calculated according to the formula suggested by Wheeler (1969) given as below

PDI =

$$\frac{\Sigma \text{ of rating of infected leaves} \times 100}{\text{No. of leaves observed} \times \text{Maximum disease score}}$$

*Arka microbial consortium (AMC) is a carrier (lignite) based microbial product which contains N fixing, P & Zn solubilizing and plant growth promoting bacterial strains. This can be applied through seed, soil, water & necessary media like cocopeat.

♦ Soil application: for one acre of land 5kgs of AMC can be mixed with 500kgs of FYM & applied at root zone of standing crop

♦ IISR consortium (PGPR) capsule

♦ Suspend one capsule in 1000ml sterile water (boiled & cooled) for activation

♦ Dilute this suspension to 1000 litres with ordinary water

♦ Apply 5 litres of this suspension per vine (this will suffice for 200 vines)

♦ For mixing FYM, the overnight culture is diluted to 10L and mixed with 500kg organic manure & applied @ 5-10kg per vine

♦ 2 capsules per acre

Site of the experiment: Farmer field in chinavorumpadu village of DR YSR Kadapa dt.

(i) T_1: Application of *Trichoderma harzianum*@ 5kg/ha (Oct-Dec) in FYM + Neemcake @500 kg/ha in 3 splits at monthly interval (Oct-Dec.)

(ii) T_2: Spraying of Fosetyl AL @ 0.2% + Drenching of Potassium Phosphonate @ 0.3%

(iii) T_3: Soil application of *Bacillus subtilis* @ 5kg/ha (enumeration of antagonistic bacteria after mass multiplication)

(iv) T_4: Soil application of Consortium (IIHR) @ 12.5kg/ha. in 1250kg FYM/ha

(v) T5: Soil application of Consortium (IISR) PGPR capsule @5 capsules/ha.

(vi) T6: Soil drenching with Bordeaux mixture (1%) 4 times at monthly intervals

(vii) T7: Soil application of *Trichoderma harzianum* @ 5kg/ha + foliar spray of Potassium Phosphonate @ 0.3%

(viii) T_8: Control (Farmers practice)

*Sanitation and raised beds with drip irrigation is common for T_1 to T7

Two rows of 10 M length vines are considered as one treatment/replication

RESULTS AND DISCUSSION

The pathogen isolated from root and petiole portions of the infected plant and identified as *phytophthora* (Fig. 3, 4). The cultures sent to NCFT, New Delhi, during 2017-18, isolated another pathogen *Rhizoctonia bataticola* (I.D. No. 2084.17) in betel vine field of chinavorumpadu village (Fig. 5) and pathogenicity was proved. Butler (1918) reported that the fungus known as *M. phaseoli* was in fact *Rhizoctonia*, identification on the occasional occurrence of what were considered to be clamp connections, structural characteristics of Basidiomycetes, and general similarity of the mycelia to that of *Rhizoctonia solani*. A buff- colored to dark-brown, regularly septate mycelium with a slight constriction at the septum. Lateral branches arise near the distal septum at an angle of about 45° from the main hyphae, with a septum soon after the branch. Sclerotia were irregular in shape, light to dark brown. Hyphal branches when young grew inclined to the assumed a right-angle relationship to the latter. Identification of the pathogen *M. phaseolina* was based on observation of shape and size of the pycnidospores and sclerotia under the microscope.

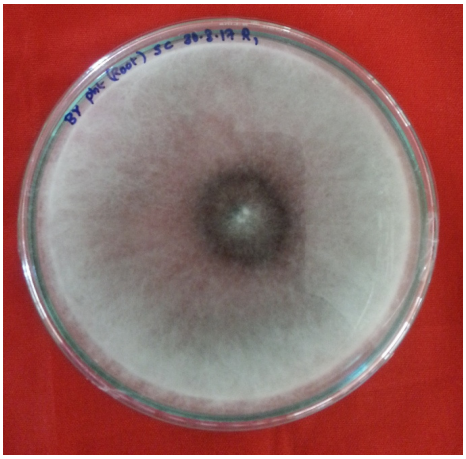

Fig. 3. Culture of *Phytophthora.*

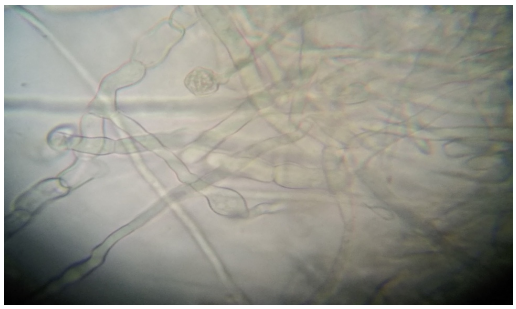

Fig. 4. Microscopic image of *phytophthora.*

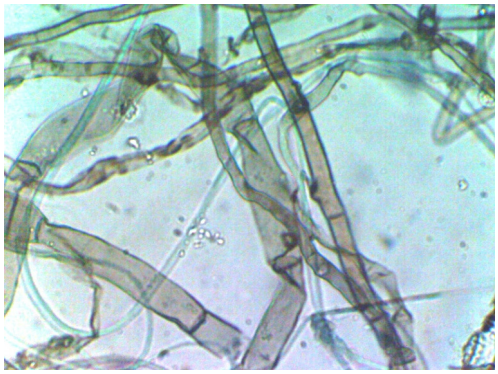

Fig. 5. Microscopic image of *Rhizoctonia bataticola.*

The minimum percent foot rot incidence (1.28, 3.85, 5.34, 7.05, 8.28), leaf rot percent disease index (0.98, 1.05, 4.06, 5.76, 7.65) and leaf fall (0.20/vine) was observed in Nov, Dec, Jan, Feb, March when the treatment comprised with soil application of Consortium (PGPR) capsule @5 capsules/ha along with sanitation and raised beds with drip irrigation was superior in controlling the foot rot disease in betel vine (Table 1, 2). All the remaining treatments viz. application of *Trichoderma harzianum*@ 5kg/ha (Oct-Dec) in FYM + Neemcake @500 kg/ha in 3 splits at monthly interval (Oct-Dec.), spraying of Fosetyl AL @ 0.2% + Drenching of Potassium Phosphonate @ 0.3%, soil application of *Bacillus subtilis* @ 5kg/ha (enumeration of antagonistic bacteria after mass multiplication), soil application of Consortium (IIHR) @ 12.5kg/ha. in 1250kg FYM/ha, soil drenching with Bordeaux mixture (1%) 4 times at monthly intervals and soil application of *Trichoderma harzianum* @ 5kg/ha + foliar spray of Potassium Phosphonate @ 0.3% was also found effective in controlling the disease when compared to control.

Dasgupta *et al*., (2003) revealed that biological control approach was at par to chemical control in terms of per cent disease control. Sengupta (2011) noted that *Trichoderma harzianum* and Bordeaux mixture spray were effective in managing the foot rot disease in betel vine. Mohanty *et al.,* (2011) reviewed and the results showed that integrated use of sanitation, Bordeaux mixture and *T. harzianum* gave the best control of foot rot and leaf rot of betel vine and the treatment yielded maximum leaf production (3.448 million ha^{-1} $year^{-1}$) and the highest fresh weight of 100 leaves (351.85 g). The economic analysis showed that application of bordeaux mixture along with *T. harzianum* and sanitation may be useful to obtain satisfactory control of both the diseases and economic benefit showing BCR of 1.48:1. Dasgupta *et al.,* (2008) studied about the varietal resistance, in vitro and in vivo effect of chemicals on foot rot disease management.

Table 1: Foot rot incidence in integrated disease management in Betel vine.

Treatments	Nov	Dec	Jan	Feb	Mar
T_1	1.18 (6.23)	2.54 (09.17)	4.59 (12.37)	6.74 (15.04)	9.28 (17.72)
T_2	1.95 (8.02)	3.24 (12.35)	6.39 (14.64)	8.26 (16.70)	10.88 (19.25)
T_3	1.56 (7.17)	4.58 (12.35)	5.75 (13.87)	7.45 (15.83)	11.45 (19.77)
T_4	1.28 (6.49)	3.85 (11.31)	5.34 (13.36)	7.05 (15.39)	8.28 (16.72)
T_5	1.11 (6.05)	3.06(10.07)	5.13 (13.09)	6.85 (15.17)	7.74 (16.15)
T_6	1.05 (5.88)	5.55 (13.62)	6.87 (15.19)	9.15 (17.60)	11.86 (20.14)
T_7	2.44 (8.98)	12.24(20.47)	14.84(22.65)	19.66 (26.31)	23.55 (29.02)
SEm	0.21	0.52	0.57	0.45	0.77
CD at 5 %	0.63	1.55	1.69	1.34	2.30
CV %	14.23	12.93	14.57	8.31	11.36

Table 2: Leaf rot disease index and leaf fall in Integrated management of foot rot in Betel vine.

	Leaf rot disease index					
Treatments	Nov.	Dec.	Jan.	Feb.	Mar.	Leaf fall
T_1	1.12 (6.07)	2.24 (8.60)	6.05 (14.23)	7.25 (15.61)	9.56 (18.00)	0.75 (4.97)
T_2	1.05 (5.88)	1.98 (8.09)	5.24 (13.23)	6.16 (14.37)	8.95 (17.40)	1.66 (7.40)
T_3	1.36 (6.69)	3.26 (10.40)	6.98 (15.31)	7.83 (16.24)	9.95 (18.38)	2.53 (9.15)
T_4	1.12 (6.07)	1.55 (7.15)	4.35 (12.03)	5.76 (13.88)	7.86 (16.28)	0.26 (2.92)
T_5	0.98 (5.68)	1.05 (5.88)	4.06 (11.62)	5.76 (13.88)	7.65 (16.05)	0.20 (2.56)
T_6	0.66 (4.66)	2.05 (8.23)	6.05 (14.23)	7.05 (15.39)	9.54 (17.98)	1.85 (7.81)
T_7	2.65 (9.37)	5.25 (13.24)	14.85 (22.66)	18.35 (25.35)	35.28 (36.43)	5.55 (13.62)
SEm ±	0.29	0.22	0.83	0.54	0.46	0.24
CD@ 5 %	0.86	0.65	2.50	1.61	1.37	0.71
CV (%)	18.41	15.19	21.27	11.19	6.32	22.53

Singh *et al.,* (2003), reported that Collar rot disease of betel vine (*Piper betle* L.) caused by *Sclerotium rolfsii* is difficult to control by conventional means by use of chemicals; therefore, use of biocontrol agents is desirable. In the present study, 186 bacterial strains of different morphological types were screened for their biocontrol activity against *S. rolfsii* under in vitro conditions. Two strains, *Pseudomonas fluorescens* NBRI-N6 and *P. fluorescens* NBRI-N, were selected for further studies because of their ability to inhibit the mycelial growth of the pathogen significantly. Spontaneous rifampicin-resistant (Rif) derivatives of *P. fluorescens* NBRI-N6 and *P. fluorescens* NBRI-N showing growth rate and membrane protein composition comparable to the wild type were selected to facilitate their monitoring in the rhizosphere. Field trials demonstrated that strain *P. fluorescens* NBRI-N6 was better than *P. fluorescens* NBRI-N in increasing the yield of betel vine significantly, whereas a consortium of the two strains controlled the disease more than either of the strains. The screening method should prove useful in identifying rhizosphere bacteria with the greatest potential for controlling diseases caused by phytopathogenic fungi.

Kumar *et al.,* (2018) stated that the fungicide ingredient of Metalaxyl 8% + Mancozeb 64% WP at 0.2% was found superior as compared to all other treatment followed by Bordeaux mixture (0.5%) controlled the disease severity by 76.2% and 49.1% disease of Phytophthora leaf rot. Whereas, Carbendazim 12% + Mancozeb 63% WP ingredient of fungicide at 0.2% concentration significantly superior as compared to all other treatments followed by Tebuconazole 25 EC (2%) which reduced the diseases of Anthracnose leaf spot by 73.0% and 65.1%, respectively.

Hegde (2015) reported that *Phytophthora arecaea*, a causal agent of nut rot disease (koleroga) of areca nut (Areca catechu L.) is one of the major fungal pathogens affecting the crop in the northern Karnataka of India. The estimated loss associated with this disease extends up to 60%. In the endemic regions of India, the disease occurs immediately after the onset of the monsoon rains (June) and prevails till mid-August due to congenial weather conditions. For the effective management of this devastating disease, potassium phosphonate was tried during June and July 2013-2014 at the farmer's fields. The results revealed that potassium phosphonate applied at the rate of 6.0 ml/L has reduced the per cent disease incidence (PDI) in areca nut (PDI = 19.5%), where the results were on par ($p>0.05$) with metalaxy MZ applied at 2.0 g/L (PDI = 16.81%) and Bordeaux mixture applied at 1% (w/v; PDI = 18.84%). However, potassium phosphonate at 3.0 ml/L (PDI = 43.10%) and 4.5 ml/L (PDI=39.45%) was not effective in reducing the PDI. The maximum PDI of 52.87% was recorded in unsprayed control plots. The highest yields of 26.42 q/h were recorded from the plots sprayed with metalaxy MZ at 2.0 g/L, which is in par ($p>0.05$) with potassium phosphonate applied at 6.0 ml/L (24.76 q/ha) and Bordeaux mixture at 1% (25.12q/ha). The lowest yield (12.48 q/ha) was recorded from the control (unsprayed) plots.

Ramachandran and Sarma (1985) reported that the systemic fungicide metalaxyl (Ridomil, Matco 8-64) and Fosetyl Al (Aliette) both as foliar spray and soil drenching were effective against P. capsici in the field conditions. Similar results have been reported on the

efficacy of metalaxyl against Phytophthora infections in black pepper (Sastry 1982; Anon., 1986). This may be due to the reduced number of secondary inoculum due to the antisporulant activity of this fungicide there by restricting the rapid secondary spread of the disease.

Jahan *et al.,* (2016) reported that disease incidence and severity of foot and root rot of betel vine ranged from 24.00 to 58.00% and 17.65 to 34.75%, respectively, where the maximum disease was recorded in Mirpur and the minimum was in Khoksha in the month of July and October. Disease incidence and severity of foot and root rot of betel vine ranged from 50.00 to 58.00% and 33.25 to 34.20%, respectively in Mirpur where the maximum disease was recorded in July and the minimum was in October. In Kushtia Sadar, disease incidence and severity of foot and root rot of betel vine ranged from 27.00 to 37.00% and 18.45 to 20.39% respectively. In Bheramara, disease incidence and severity of foot and root rot of betel vine ranged from 27.00 to 37.00% and 18.30 to 20.38%, respectively. In Kumarkhali, the disease incidence and severity were 45.00 to 50.00% and 27.95 to 30.60% respectively. In Khoksha, disease incidence and severity of foot and root rot of betel vine ranged from 24.00 to 31.00% and 17.65 to 18.80% respectively. In Daulatpur, disease incidence and severity of foot and root rot of betel vine ranged from 39.00 to 46.00% and 22.30 to 24.35% respectively, considering all the locations of Kushtia District, the maximum disease was recorded in the month of July and the minimum was in October.

Prasad *et al*., (2018) studied that integrated disease management of Foot Rot Complex in Betelvine and the application of enriched FYM with *Trichoderma harzianum* (@ 2 kg/vine) + Pseudomonas fluorescens (@ 10 g/vine) or enriched FYM with *Trichoderma harzianum* (@ 2 kg/vine) + *Pseudomonas fluorescens* (@ 10 g/vine) + neemcake (@ 1 kg/vine) or Bordeaux mixture (1%) @ 2 l/vine or metalaxyl + mancozeb 78 WP (3 g/l @ 2 l/vine) recorded highest reduction of the disease with maximum yield.

Similarly, Garain *et al.,* (2021) observed that application *Trichoderma* amendment in soil along with organic manures significantly reduced the foot rot incidence in betel vine crop. Similar results were reported by Berry *et al*., 2021; Rahman *et al*., 2021).

CONCLUSION

The present study concluded that application of biological formulation along with the application organic manures significantly reducing the foot rot disease in betel vine crop. However, the Soil application of Consortium (IISR) PGPR capsule @5 capsules/ha recommended for the effective foot rot control in Rayalaseema zone of Andhra Pradesh. Therefore, the use of biological control agents is recommended for the integrated management of *Phytophthora* foot rot of betel vine for sustainable leaf production as well as to avoid the possibility of health risks due to consumption of betel leaf polluted with the fungicides.

FUTURE SCOPE

Since the conclusions are based on study conducted over a single season in Rayalaseema region of Andhra Pradesh, further trials may be needed before it can be considered a recommendation.

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Conflict of Interest. Nil.

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