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Management of wilt disease complex of betelvine incited by *Meloidogyne incognita* and *Sclerotium rolfsii*

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Abstract
Wilt complex is an important disease of betelvine (*Piper betel* L.) caused by the association of nematode *Meloidogyne incognita* and *Sclerotium rolfsii*. An integrated approach was carried out for the management of betelvine wilt complex disease. The result revealed that, the lowest wilt incidence was observed in combined application of fungicide vitavax power (carboxin 37.5% + thiram 37.5%) at 0.2 per cent and neem cake at 1 kg/ plant with 33.33% and 23.33% respectively. Whereas the higest wilt incidence with 66.67 and 83.33% respectively was recorded in untreated control.

Keywords: disease incidence, management, *Meloidogyne incognita, Sclerotium rolfsii,* wilt complex

Introduction
Betelvine (*Piper betle* Linn.) is a perennial, shade loving evergreen creeper commercially cultivated in many parts of the world especially in tropical and sub-tropical countries. Every part of the vine has high medicinal value, the presence of phenolic compound hydroxyl-chavicol, with anti-carcinogenic property has also been identified in betel leaves [1].
Soil borne pathogens are important in the context of betelvine production as they cause heavy yield losses. Various plant parasitic nematodes are known to cause a reduction in crop yields among the plant parasitic nematodes the root knot nematode (*Meloidogyne incognita*) and reniform nematode (*Rotylenchus reniformis*) are the most destructive in all the betelvine growing areas. The roots of nematode infested vines are very much prone to other soil borne plant pathogen infection *viz.*, *Sclerotium rolfsii*, *Colletotrichum capsici*, *Phytophthora palmivora*, *Rhizoctonia solani*, *Fusarium solani* and *Xanthomonas campestris* pv. *betlicola*. The higher density of nematodes especially, *M. incognita* and *R. reniformis* helps in the easy entry of soil-borne plant pathogens, which may further lead to the wilt complex. The extent of loss due to the association of wilt causing fungi with root knot nematode *M. incognita* is up to100 per cent [2].
In recent years, the possibilities of managing soil-borne diseases by the integration of several methods have been the subject of extensive research. Integrated management denotes the rational use of all available control measures which need to be considered, especially for a crop that is infected simultaneously by various types of pathogens. It does offer the possibility of making up for the deficiencies of any single method [3]. Hence, the present investigation was carried out with the integration of chemicals and bioagents for managing soil-borne diseases that have been considered as a novel approach, as it requires low amounts of chemicals thereby reducing the cost of management as well as soil and groundwater pollutions, with minimum interference to biological equilibrium.

Material and Methods
A field experiment was carried out in a naturally infected betelvine wilt disease complex garden at Belludi village of Harihara taluk in relation to managing the wilt complex of betelvine. The experiment was laid out in a randomized complete block design that included 10 treatments, with three replications each treatment was having 10 vines and the local variety kariyele was used for the study. Treatment and experimental details are given in Table 1

Table 1: Details of the treatment and experiment

Treatments	Concentration
T1: *Trichoderma harzianum* (2x10^8 cfu)	20 g/plant
T2: *Paecilomyces lilacinus* (2x10^8 cfu)	20 g/plant
T3: *Pseudomonas fluorescens* (2x10^8 cfu)	20 g/plant
T4: Thiram 37.5% + Carboxin 37.5% (Vitavax power)	0.2% drenching.
T5: Carbofuran 3G	0.3 g a.i./plant
T6: Tebuconazole50%+ trifloxystrobin 25% (Nativo)	0.2% drenching.
T7: Mancozeb + *Trichoderma harzianum*	0.2% drenching + 20 g/ plant .
T8: Carbendazim	0.2% drenching.
T9: Thiram 37.5% + Carboxin 37.5% (Vitavax power) + Neem cake	(0.2% drenching.) +1000 g/plant
T10: Untreated Check	

Experimental details

Design	RCBD
Treatment	10
Replication	3
Spacing	0.8 X 1.5 m
No. of vines per treatment	10
Variety	Kariyele
Location	Belludi
Age of the vine	5 yrs

Results and Discussion

The field experiment was conducted in a farmer's field at Belludi village of Harihara taluk with nine treatments and one untreated control. Integration of different chemicals, bioagents, and in combination was applied to soil for the management of the wilt complex of betelvine. The observation on initial nematode population, wilt incidence, root knot index, and final nematode population was recorded at 90 and 180 days respectively after treatment imposition and the results are presented in Table 2.

Per cent wilt incidence

Results of the experiment recorded that, the incidence of the disease before treatment application was non-significant and almost uniform in the garden and significant differences among the treatment were obtained at 90 and 180 days after treatment.

At 90 days treatment combination of (Carboxin 37.5% + thiram 37.5%) vitavax power + neem cake recorded the lowest per cent wilt incidence (33.33%) which is significantly superior over other treatments, followed by vitavax power (40%). Maximum wilt incidence of 66.67 per cent recorded in the untreated control. Whereas, the bioagents alone application were found to be least effective in the management of wilt complex.

At 180 days treatment combination of (Carboxin 37.5% + thiram 37.5%) vitavax power + neem cake recorded lowest per cent wilt incidence (23.33%) which is significantly superior over other treatments, followed by vitavax power (36.67%) and tebuconazole 50% + trifloxystrobin 25% (nativo) (40.0%) which were on par with mancozeb + *Trichoderma harzianum* (43.33%). Whereas, untreated check has recorded a maximum wilt incidence of 83.33 per cent.

Root knot index (RKI)

The treatment of *P. lilacinus* and carbofuran significantly reduced RKI which accounted to be 1.67 and 2.0 followed by the treatment (vitavax power) carboxin 37.5% + thiram 37.5% + neem cake (2.33) over control (4.33). Correspondingly, the highest RKI was recorded in carboxin + thiram, tebuconazole + trifloxystrobin, and carbendazim treatments which were found to be least effective.

Nematode population

The initial population of root knot juveniles/200 cc of soil ranged from 1020 to 1080. There was a significant reduction of soil nematode population at 90 and 180 days after treatment application in the garden. Among ten treatments less nematode population was recorded in carbofuran alone (644 and 553) and *P. lilacinus* alone (649 and 507) followed by combined application of vitavax power and neem cake (703 and 576) which were differed significantly and remained on par with each other. Whereas, maximum nematode population was recorded in the untreated control (1350 and 1744) at 90 and 180 days respectively.

The results in the present study indicated that the wilt incidence, nematode population, and root knot index were minimum in the vines enriched with neem cake 1 kg/ plant followed by the soil application of combi fungicide vitavax power (carboxin + thiram) at 0.2 per cent. The application was repeated twice.

The plots treated with *P. lilacinus* recorded the lowest nematode population and RKI followed by treatment with carbofuran these results are in conformity with Karmakar *et al*. (2002) [4] and Haseeb *et al*. (2006) [5] where plots treated with *P. lilacinus* at 4g/kg soil decreased 35 to 44 per cent population of *M. incognita* population.

Similar results were obtained in a field experiment conducted by AIRCP (Betelvine) in Tamilnadu , where wilt incidence and root knot index were minimum in a treatment involving a combination of carbofuron @1.5 kg a.i./ha + neem cake 50 qtl/ha and 0.5 per cent bordeaux mixture [6]. Brahmankar (2011) [7] reported the integrated disease management module in which *Trichoderma* at 10 kg/ha and neem cake at 2000 kg/ha with drip irrigation reduced the wilt causing fungus and nematode significantly. Krishna Rao (1994) [8] also reported the efficiency of integration of physical, chemical, and biological methods on nematode fungal complex of chickpea. Soil drenching of carboxin + thiram was found to be effective in controlling *Sclerotium* wilt [9]. Field evaluation of fungicides by several workers has shown that carboxin as soil drench was effective against, *S. rolfsi* on many crops [10, 12].

Table 2: Integrated management of wilt complex in betelvine garden

Treatments	Per cent Disease incidence		Initial nematode population	Final nematode population		Root knot indices (0-5)
	At 90 days	At 180 days		At 90 days	At 180 days	
T_1- *T. harzianum* @ 20 g/plant	53.33 (47.03)*	50.00 (45.02)	1052	786	659	3.00
T_2- *P. lilacinus* @ 20 g/plant	56.67 (48.87)	56.67 (48.87)	1057	649	507	1.67
T_3- *P. flourescens* @ 20 g/plant	60.00 (50.88)	60.00 (50.88)	1060	963	835	3.67
T_4- (Carboxin 37.5 + thiram 37.5) @ 0.2% drenching	40.00 (39.17)	36.67 (37.16)	1080	987	860	4.00
T_5- Carbofuran 3G @ 0.3 g a.i./plant	53.33 (46.95)	50.00 (45.02)	1038	644	553	2.00
T_6- (Tebuconazole 50% + trifloxystrobin 25%) @ 0.2% drenching	56.67 (48.87)	40.00 (39.17)	1020	982	855	4.00
T_7- Mancozeb @ 0.2% drenching + *T. harzianum* @ 20 g/plant	50.00 (45.02)	43.33 (41.18)	1060	816	688	3.00
T_8- Carbendazim @ 0.2% drenching	50.00 (45.02)	46.67 (43.10)	1080	866	739	4.00
T_9- (Carboxin 37.5 + thiram 37.5) @ 0.2% drenching + Neem cake 1Kg/plant	33.33 (35.24)	23.33 (28.79)	1054	703	576	2.33
T_{10}- control	66.67 (55.10)	83.33 (66.18)	1029	1350	1744	4.33
S.Em ±	3.67	3.49	NS	18.52	22.38	0.21
CD at 5%	10.90	10.36		55.03	66.48	0.64

***** Figures in the parenthesis are arcsine transformed values

Conclusion

Management of wilt complex of betelvine by the integration of different chemicals, bioagents, and organic amendments usage *in vivo* showed that the soil application of carboxin + thiram (vitavax power) with neem cake was significantly effective and recorded least wilt incidence, Root Knot Index, and final nematode population.

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