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Evaluation of different modules for control of wilt complex disease in betel vine

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Abstract
An experiment was conducted in farmer's fields of Kakol, Ranebennur and Medleri villages of Haveri district during 2017 and 2018 in ten farmers field to evaluate four different modules (Package of Practice module, Biological module, Chemical module and Adoptive module) for control of wilt complex disease in beetle vine. Extremely lower incidence of wilt disease (15.55 %) was recorded in adoptive module. Higher leaves production per plant was recorded in Medleri (5000 to 8000) as compared to Kakol (3000 to 6000) and Ranebennur (3000 to 7000) villages. The leaf yield and pendi (bundle) per hectare were also higher in adoptive module (49.29 lakh leaves and 485 pendi, respectively) followed by other modules. All the parameters (disease incidence, yield, cost of cultivation, returns and BC ratio) were found to be higher and significantly superior with adoptive module where, four applications were taken up to the root zone of vines. The BC ratio was higher with adoptive module (9.45) followed by POP module (9.43) but significantly superior over chemical (9.00) and biological modules (7.10).

Keywords: Betel vine wilt, integrated disease management, biological agents, neem cake, chemicals

Introduction
Among perennial climbers Betel vine is cultivated in India since ages (Guha, 2006) [3]. It is native to Central and Eastern Malaysia. Chewing of pan (betel vine) is an age-old practice in India and Asia. The pan is prepared by spreading a layer of slaked lime on leaf, mixed with areca nut bits and used for chewing. The pan has some medicinal properties also. It is used for curing indigestion, fewer, cough, headache and few others. One vine can yield about 5000 leaves and these are sold in pendies (bundles of 10000 leaves, wrapped in banana leaf sheaths). The leaf yield from one acre is about 300-700 pendies, which varies due to disease 'wilt complex'. The cultivation of betel vine in Karnataka is to the tune of 7000 ha and in India is about 50,000 ha. In Haveri district it is being cultivated in about 1500 ha (Anonymous, 2010; Suryanarayana *et al*., 2015; Anonymous, 2017; Sateesh *et al*., 2017) [1, 4, 5, 6] and crop is suffering from wilt disease (confirmed through diagnostic field visits). The control measures recommended by the horticultural persons in the area is used by the farmers and it is not so effective. However, there is a need to find out more feasible eco-friendly technology to manage this wilt complex. In view of this an experiment was conducted to evaluate different modules for control of wilt complex disease in betel vine.

Materials and Methods
An experiment was conducted to evaluate different modules for control of wilt complex disease in betel vine at three locations in (betel vine existing) ten farmer's field (i.e. Kakol and Ranebennur, Haveri district) during 2017 and 2018. The four different modules were used to manage wilt complex disease in betel vine and they are Package of Practice module, Biological module, Chemical module and Adoptive module and compared with control (no treatment). In Package of practice module (UHS, Bagalkot), drenching of Bordeaux mixture @1% was done twice at 15 days interval after the incidence of the disease. In biological module (Divya Bharati, 2018) [2] the *Pseudomonas fluorescens* @10g/l was drenched initially. Second drenching was done after 15 days of first drenching with Garlic (10g) + Black tulsi (20 g) +Turmeric (10 g) crush filtrate @15ml/l. Third drenching was done after 15 days of second drenching with *Trichoderma Harzianum** @10g/*l*. Finally fourth drenching was done after 15 days of third drenching with *Pseudomonas Fluorescens* @10g/*l*. In chemical module (Divya Bharati, 2018) [2] the Propiconazole (Tilt 25EC) @2 ml/l was drenched initially. Second application was done after 15 days of first drenching with Carbofuran 3G (Furadan) @ 100g/vine.

Third drenching was done 15 days after second drenching with Carbendazim 12% + Mancozeb 63% (SAAF 75%WP) @2g/l. Finally, fourth drenching was done 15 days after third drenching with Captan 70% + Hexaconazole 5% (Taqat 75% WP) @ 2g/l. In adoptive module (Divya Bharati, 2018) [2] the vines are applied with neem cake and Trichoderma enriched FYM @ 1.0 kg/vine (FYM 1.0 kg + *T. harzianum 20g* + Neem cake @ 250 g/vine). The drenching was done after 15 days of first application with Thiram 37.5 + Carboxin 37.5 (Vitavax power) @ 2.5g/l. Third application was done after 15 days with neem cake and Trichoderma enriched FYM @ 1.0 kg/vine (FYM 1.0 kg + *T. harzianum 20 g* + Neem cake @ 250 g/vine). Finally fourth application was done after 15 days of third application with Carbofuran 3G (Furadan) @ 100g /vine.

The plant observations were recorded for per cent disease incidence and control (%), leaf yield (number per plant and per ha) and number of pendi (bundle of 10000 leaves) per hectare. Economics was worked out based on expenditure made for cultivation of beetle vine and net returns were calculated.

Results and Discussion

Among different locations the per cent incidence of wilt disease was more in Medleri village as compared to Kakol and Ranebennur (Table -1). The per cent wilt disease incidence (after 4th application or after 75 days of evaluation) was significantly higher in control (no treatment) fields. Whereas, the incidence was significantly lower in different modules as compared to control. However, extremely lower incidence of wilt disease (15.55 %) was recorded in adoptive module where four applications were done, first with neem cake and *Trichoderma* enriched FYM @ 1.0 kg/vine (FYM 1.0 kg + *T. harzianum 20g* + Neem cake @ 250 g/vine). Second application was done after 15 days of first application with Thiram 37.5 + Carboxin 37.5 (Vitavax power) @ 2.5g/l. Third application was done after 15 days with neem cake and Trichoderma enriched FYM @ 1.0 kg/vine (FYM 1.0 kg + *T. harzianum 20 g* + Neem cake @ 250 g/vine). Finally fourth application was done after 15 days of third application with Carbofuran 3G (Furadan) @ 100g /vine. It was followed by chemical module (20.84 %), POP module (22.49 %) and biological module (29.99 %). Similar results were also recorded by Ashish kumar Tripathi (2015) [7].

Table 1: Effect of different modules on incidence of wilt complex of betel vine (Pooled data of three locations)

Module	Per cent Disease incidence (after 4th drench or after 75 days)			Pooled	
	Location 1 (2017) (Kakol)	Location 2 (2017) (Ranebennur)	Location 3 (2018) 10 farmers (Medleri)	Mean	Per cent Reduction over control
Package of practice	20.83 (27.11)*	19.98 (26.49)	26.66 (31.07)	22.49 (28.22)	56.70
Biological module	29.99 (33.14)	28.32 (32.05)	31.66 (34.23)	29.99 (33.14)	42.26
Chemical module	19.99 (26.49)	18.31 (25.30)	24.16 (29.40)	20.83 (27.06)	59.89
Adoptive module	15.82 (23.41)	13.33 (21.38)	17.50 (24.64)	15.55 (23.14)	70.06
Control	50.83 (45.47)	47.49 (43.55)	57.50 (49.32)	51.94 (46.11)	-
S. Em. ±	1.17	1.25	0.95	1.12	-
C.D. @ 5%	3.52	3.73	2.84	3.36	-

Table 2: Effect of different modules on leaf yield of betel vine (Pooled data of 3 locations)

Module	leaf yield (000' leaves)				Leaf yield (lakh leaves/ ha)				No. of pindi per hectare			
	Location 1 (2017) (Kakol)	Location 2 (2017) (Ranebennur)	Location 3 (2018) (Medleri)	Pooled	Location 1 (2017) (Kakol)	Location 2 (2017) (Ranebennur)	Location 3 (2018) (Medleri)	Pooled	Location 1 (2017) (Kakol)	Location 2 (2017) (Ranebennur)	Location 3 (2018) (Medleri)	Pooled
Package of practice	4.73	5.10	5.74	5.19	34.58	37.03	45.28	38.96	288.20	308.62	377.32	324.71
Biological module	3.32	3.02	3.59	3.31	27.53	29.30	30.49	29.11	229.41	244.14	254.08	242.54
Chemical module	5.53	5.85	7.48	6.29	40.02	41.48	57.19	46.23	333.53	345.66	476.60	385.26
Adoptive module	6.29	6.96	8.04	7.10	43.24	46.43	58.20	49.29	360.33	386.88	484.98	410.73
Control	1.5	1.77	1.52	1.60	17.87	19.61	18.88	18.79	148.96	163.41	157.37	156.58
S. Em. ±	0.09	0.18	0.20	0.15	1.11	2.33	1.71	1.72	9.39	19.39	14.26	14.35
C.D. @ 5%	0.38	0.53	0.59	0.50	3.33	6.98	5.13	5.15	28.14	58.14	42.74	43.01

Table 3: Effect of different modules on gross returns per hectare of betel vine (Pooled data of 3 locations)

Module	Gross returns (Rs in lakhs/ha)				Net returns (Rs in lakhs/ha)			
	Location 1 (2017) (Kakol)	Location 2 (2017) (Ranebennur)	Location 3 (2018) (Medleri)	Pooled	Location 1 (2017) (Kakol)	Location 2 (2017) (Ranebennur)	Location 3 (2018) (Medleri)	Pooled
Package of practice	14.41	15.43	18.87	16.24	12.69	13.71	17.14	14.51
Biological module	11.47	12.21	12.70	12.13	9.76	10.50	11.00	10.42
Chemical module	16.68	17.28	23.83	19.26	14.54	15.14	21.69	17.12
Adoptive module	18.02	19.34	24.25	20.54	15.84	17.17	22.08	18.36
Control	7.45	8.17	7.87	7.83	5.94	6.66	6.36	6.32
S. Em. ±				1.39				1.33
C.D.@5%				4.17				3.99

Table 4: Economics of different modules as a component of integrated management of betel vine wilt complex disease (Pooled data)

Module	Per cent Disease incidence	Yield (pendi/ha)	Treatment cost (Rs in lakh/ha)	Total cost of Cultivation (Rs in lakh/ha)	Gross returns (Rs in lakh/ha)	Net returns (Rs in lakh/ha)	B:C ratio
Package of practice	22.49 (28.22)*	324.71	0.21	1.72	16.24	14.51	9.43
Biological module	29.99 (33.14)*	242.54	0.19	1.70	12.13	10.42	7.10
Chemical module	20.83 (27.06)*	385.26	0.63	2.14	19.26	17.12	9.00
Adoptive module	15.55 (23.14)*	410.73	0.66	2.17	20.54	18.36	9.45

Control	51.94 (46.11)*	156.58	-	1.51	7.83	6.32	5.18
S. Em. ±	1.12	0.15	1.72	14.35	0.52	1.12	0.15
C.D. @ 5%	3.36	0.50	5.15	43.01	1.56	3.36	0.50

* Figures in parenthesis indicate arcsine transformed values

Table 5: Per cent survival of betel vine plants after imposition of treatment

Module	Per cent survival of plants			
	Location 1 (Kakol) 2017	Location 2 (Ranebennur) 2017	Location 3 (Medleri) 2018	Pooled
Package of practice	79.17 (62.89)*	80.00 (63.50)	73.33 (58.92)	77.50 (61.77)
Biological module	70.00 (56.86) *	71.67 (57.94)	68.33 (55.77)	70.00 (56.86)
Chemical module	80.00 (63.50) *	80.83 (64.07)	75.83 (60.60)	78.89 (62.72)
Adoptive module	84.17 (66.58) *	86.67 (68.62)	80.00 (63.46)	83.61 (66.22)
Untreated control	49.17 (44.52) *	52.50 (46.45)	46.66 (43.09)	49.44 (44.69)
S. Em.±	1.17	1.32	0.64	1.04
C.D. @ 5%	3.52	3.95	1.93	3.13

Figures in parenthesis indicate the number of plants survived

The data on leaf yield (Table -2) indicated that, higher leaves production per plant was in Medleri (5000 to 8000) as compared to Kakol (3000 to 6000) and Ranebennur (3000 to 7000) respectively. The pooled data over locations indicated that, leaf yield was significantly higher (7100 per plant) in adoptive module followed by chemical module which were significantly superior over POP module and biological module. The leaf yield and pendi per hectare were also higher in adoptive module (49.29 lakh leaves and 485 pendi, respectively) followed by other modules in the trend as said above.

The cost of cultivation, gross returns, net returns and BC ratio was worked out based on the existing costs and prices (Table-3 and 4). Among the three locations farmer's of Medleri obtained more returns (gross – Rs.12-24 lakhs / ha and net – Rs.11-22 lakhs per ha) as compared to Kakol and Ranebennur locations. Among the four modules, adoptive module yielded more gross returns (Rs.24.25 lakhs / ha) and net returns (Rs.18.36 lakhs / ha) followed by chemical module and POP module. The biological module yielded significantly lower gross and net returns however, it was superior over control. All the parameters (per cent disease incidence, yield, cost of cultivation, returns and BC ratio) were found to be higher and significantly superior with adoptive module where four applications of different bio-agents in combination with chemicals was taken up. The BC ratio was higher with adoptive module (9.45) followed by POP module (9.43) but significantly superior over chemical (9.00) and biological modules (7.10).

NIPHM Recommendations for wilt disease management in Betelvine (Satyagopal *et al*., 2015)	
Phytophthora foot rot, Sclerotial wilt or collar rot and Fusarial wilt	Follow common cultural, mechanical and biological practices • For resistant/tolerant varieties consult ICAR Institute/KVK's/SAU's. • Cultural control: • Removal and destruction of dead vines along with root system from the garden is essential as this reduces the build up of inoculum (fungal population). • Planting material must be collected from disease free gardens and the nursery preferably raised in fumigated or solarized soil. • Adequate drainage should be provided to reduce water stagnation. • Injury to the root system due to cultural practices such as digging should be avoided. • The freshly emerging runner shoots should not be allowed to trail on the ground. They must either be tied back to the standard or pruned off. • The branches of support trees must be pruned at the onset of monsoon to avoid build up of humidity and for better penetration of sunlight. • Reduced humidity and presence of sunlight reduces the intensity of leaf infection. • Chemical control (for foot rot): • Copper oxychloride 50% WP @ 1 Kg in 300-400 l of water/acre

The highest number of plants survived (Table-5) in adoptive module (83.61%) followed by chemical module (78.89%), package of practices (77.50%) compared to untreated control (49.44). These results are in line with Divya Bharati (2018) [2] indicating that, among different modules adaptive module fund to be superior over other modules.

The incidence of wilt complex is known to reduce the leaf yield in betel vine. Though there is package of practices for management of wilt complex, farmer's are unable control its incidence to a greater extent. Alternatively chemical and biological methods are also available for management of the disease. An adoptive module was designed through an experiment and it (where *Trichoderma* and chemicals application to roots area of the vines four times at 15 days interval) can be recommended for the management of the disease with higher yield and returns.

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