

Management of foot rot of betelvine (*Piper betle* L.) caused by *Phytophthora parasitica* Dastur

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ABSTRACT

The experiment was carried out during 2006 and 2007 to study the incidence of foot rot of betelvine caused by *Phytophthora parasitica* and growth, yield, and keeping quality of betelvine by applying *Trichoderma harzianum* (bio-agent). *T. harzianum* inoculated in 500 kg oil cake ha⁻¹ was applied once at pre-monsoon, two times during pre and post monsoon and four times at quarterly intervals. Bordeaux mixture was used to compare the treatments in preventing the intensity of foot rot. The results revealed that the minimum foot rot disease was recorded where four drenching and eight sprayings of Bordeaux mixture at monthly and fortnightly intervals respectively were applied in 2006, 2007 and pooled analysis of two years data. The maximum foot rot disease was recorded in control treatment in 2006, 2007 and pooled analysis of two years data. The maximum growth, yield parameters like vine elongation, fresh weight of 100 leaves, leaf yield and keeping quality was recorded in treatment where four drenching and eight sprayings of Bordeaux mixture at monthly and fortnightly intervals respectively were applied during 2006, 2007 and pooled analysis of two years data. Highest cost : benefit ratio was recorded where *T. harzianum* were applied at pre monsoon and lowest cost : benefit was recorded where Bordeaux mixture were applied.

Key words: Biocontrol, *Phytophthora parasitica*, *Piper betle*, *Trichoderma harzianum*

Cultivation of betel vine is highly risky and returns are uncertain because of its proneness to several diseases, aggravated by the moist and humid conditions of the plantation, that in turn are prerequisites for good harvest. Obviously the major constraint to cultivation of betelvine is its diseases that severally damage foot, stem, root and foliage. *Phytophthora* spp. (*P. parasitica*, *P. nicotianae* var. *parasitica*, *P. palmivora*, *P. capsici*), a perpetual menace to the crop of betelvine, causes foot rot and leaf rot of betelvine. The extent of losses varies from 5-90 percent (Dasgupta and Sen, 1999; Dasgupta *et al.*, 2008). Low temperature, high humidity and diffused light that prevail inside the baroj favours vine growth and are also congenial for the growth of the pathogen.

The foot rot caused by *P. parasitica* was claimed to be ameliorated by soil application of Bordeaux mixture (BM) (Dastur, 1935; Dasgupta, 1993; Dasgupta and Sen, 1999; Dasgupta *et al.*, 2008 and Dasgupta and Maiti, 2008). The foot rot was completely checked when cuttings were dipped in streptomycin solution and the plants were sprayed with BM (1%) twice a month (Saksena, 1977). Dasgupta *et al.*, 1988 and Mohanty and Dasgupta, 2008 showed that fosetyl-Al and Bordeaux mixture were effective in controlling *Phytophthora* leaf rot of betelvine. However, to reduce toxic hazards of human being as the betel leaves are directly chewed immediately after harvest, attempts were made by many workers to replace application of fungicides with biological control. Earlier work on biocontrol of foot rot of betelvine (Tiwari and Mehrotra, 1968; Mehrotra and Tiwari, 1976) showed that dipping of cutting in a *Trichoderma viride* cell suspension effectively reduced the disease. Similarly use of corn straw and til oil cake also reduced disease (Mehrotra

and Tiwari, 1976). D'Souza *et al.* (2001) reported significant reduction of disease with the use of an isolate of *Trichoderma harzianum*. Anonymous (1992-1997) reported significant reduction of rots of betelvine with an isolates of *T. harzianum*. However, the results were not at par with those obtained from Bordeaux Mixture. Mohanty *et al.* (2000) confirmed the above findings.

The present investigation was carried out to study the effect of *T. harzianum* in the management of foot rot of betelvine in comparison with the traditional application of Bordeaux mixture.

MATERIALS AND METHODS

The experiments were carried out in Randomized Block Design for consecutive two years (2006 and 2007) with six treatments and four replications for each treatment. Before the start of the experiment all the infected plants in treatment rows were removed. Two rows containing 200-250 vines were considered as treatment. Each treatment was separated by a buffer row.

For field testing the selected biocontrol agents were grown in oil cake medium for mass production and incubated at 28 ± 1 °C for 30 days. They were mixed with mustard oil cake previously soaked in water for 7days in the ratio of 1 : 10 and kept for another seven days after covering it with Polyethylene sheet. The antagonists were then applied within the rows of vines and lightly covered with the soil. The treatments were as follows:

T₁ = One application of *T. harzianum* inoculated in 500 kg oil cake ha⁻¹ at pre-monsoon + three application of uninoculated oil cake at 500 kg ha⁻¹ per application at quarterly intervals.

T₂ = Two applications of *T. harzianum* inoculated in 500 kg oil cake ha⁻¹ at pre and post monsoon +

two application of uninoculated oil cake at 500 kg ha⁻¹ per application at quarterly intervals.

T₄ = Bordeaux mixture (4 drenches + 8 sprays at monthly and fortnightly intervals (respectively) + four split doses of uninoculated oil cake at 500 kg split⁻¹ha⁻¹ at quarterly intervals.

T₅ = Farmer's practice (application of Bordeaux mixture as and when required).

The mortality of vines, fresh weight of 100-leaves and yield per hectare in each treatment were recorded 30 days after last application of bioagents. The disease incidence and mortality of vines were calculated by using McKinney's (1923) formula. The results obtained were subject to the analysis of variance and pooled for two years.

RESULTS AND DISCUSSION

Percent disease incidence

The results (Table 1) showed that the minimum foot rot disease was recorded in T₄ treatment (12.64, 6.30, 9.47 %) where Bordeaux mixture (4 drenches + 8 sprays at monthly and fortnightly intervals respectively) + four split doses of uninoculated MOC at 500 kg split⁻¹ha⁻¹ at quarterly intervals were applied and it was statistically superior to all other treatments in 2006, 2007 and pooled analysis of two years data. The maximum foot rot disease was recorded in T₅ treatment (38.30, 20.41, 29.35 %) (Control) where four split doses of MOC at 500 kg split⁻¹ha⁻¹ at two quarterly intervals were applied and it was statistically inferior to all the treatments in 2006, 2007 and pooled analysis of two years data.

The results in foot rot disease (*C.O. P. parasitica*) of betelvine at different treatments of bio-agent showed the following order; T₅ > T₁ > T₂ > T₃ > T₄.

Bio-agent like *Trichoderma* application in betelvine plots reduced the foot rot of betelvine as compared to untreated control. This trend was noticed in both the years and also in pooled mean. In comparison between Bordeaux mixture and bio-agent application it was noticed that Bordeaux mixture was superior than bio-agent in respect to reduction in foot rot of betelvine. Different dose and time of application of *Trichoderma* revealed that reduction of foot rot was maximum in T₃ treatment (21.42, 11.76, 16.59 %) when *Trichoderma* was applied at quarterly intervals. Similar result was also observed by Dasgupta *et al.* (2003). Dutta *et al.* (1996) also reported that Bordeaux mixture was effective for control of foot rot of betelvine caused by *Phytophthora* sp. Roy *et al.* (2005) also reported that chemical fungicide like Bordeaux mixture was superior over bio-agent like *Trichoderma* in reducing disease incidence of betelvine.

T₃ = Four applications of *T. harzianum* inoculated in 500 kg oil cake ha⁻¹ at quarterly intervals.

Vine elongation month⁻¹

Maximum vine elongation per month (Table 1) was recorded in the treatment T₁ (34.46 cm) (one application of *Trichoderma* inoculated in 500 kg MOC ha⁻¹ at pre-monsoon + three application of uninoculated oil-cake at 500 kg ha⁻¹ per application at quarterly intervals) and it was statistically at par with the treatments T₂ (33.12 cm) and T₄ (34.04 cm) where two application of *Trichoderma* inoculated in 500 kg MOC ha⁻¹ at pre and post monsoon + two application of uninoculated oil-cake at 500 kg ha⁻¹ per application at quarterly intervals and Bordeaux mixture (4 drenches + 8 sprays at monthly and fortnightly intervals (respectively) + four split doses of uninoculated MOC at 500 kg split⁻¹ha⁻¹ at quarterly intervals were applied in 2006. Similar trends were recorded in 2007 and pooled analysis of two years data revealed that the maximum vine elongation per month was recorded in T₄ treatment (43.38, 38.71 cm) where Bordeaux mixture (4 drenches + 8 sprays at monthly and fortnightly intervals (respectively) + four split doses of uninoculated MOC at 500 kg split⁻¹ha⁻¹ at quarterly intervals were applied and it was statistically superior to all the treatments. The minimum vine elongation per month was recorded in T₅ treatment (29.00, 29.23, 29.11 cm) (control).

Vine elongation by application of Bio-agent in different treatments showed a decreasing order like; T₄ > T₁ > T₂, T₃ > T₅.

Fresh weight of 100 leaves

The results (Table 1) showed that in T₄ (257.00, 254.00 g) treatment where Bordeaux mixture (4 drenches + 8 sprays at monthly and fortnightly intervals respectively) + four split doses of uninoculated MOC at 500 kg split⁻¹ha⁻¹ at quarterly intervals were applied, recorded highest fresh weight of 100 leaves and it was statistically superior to all treatments in 2006 and pooled analysis of two years data. In 2007 the maximum fresh weight of 100 leaves was recorded in T₃ treatment (258.60 g) where four application of *Trichoderma* inoculated in 500 kg MOC ha⁻¹ at quarterly intervals were applied and it was statistically at par with the treatment T₄ (256.00 g) where Bordeaux mixture (4 drenches + 8 sprays at monthly and fortnightly intervals (respectively) + four split doses of uninoculated MOC at 500 kg split⁻¹ha⁻¹ at quarterly intervals) were applied. The minimum fresh weight of 100 leaves was recorded in T₅ treatment (238.00, 237.00 g) (Control).

The results of fresh weight of 100 leaves (g) with regards to results of bio-agent application were showed in the following order; T₄ > T₃ > T₁ > T₂ > T₅.

Table 1: Effect of bio-agent on growth, yield, keeping quality and disease incidence of betelvine (Average of five replications)

Treatments	Vine elongation			Fresh weight of 100			Leaf yield in			Keeping quality			Foot rot			Cost : benefit ratio		
	month ⁻¹ (cm)			leaves (g)			(lakh ha ⁻¹ year ⁻¹)			(days to 50% rotting)			c.o. <i>P. parasitica</i>					
	2006	2007	Pooled	2006	2007	Pooled	2006	2007	Pooled	2006	2007	Pooled	2006	2007	Pooled	2006	2007	Pooled
T ₁	34.46	36.73	35.59	257.00	251.00	254.00	37.16	32.74	34.95	14.40	14.60	14.50	26.85	14.91	20.88	23.36	5.56	14.56
													(31.19)	(22.67)	(27.18)			
T ₂	33.12	33.12	33.12	245.00	238.20	241.60	38.32	37.20	37.76	14.60	13.40	14.00	23.59	12.02	17.81	13.23	8.74	10.98
													(29.02)	(20.22)	(24.92)			
T ₃	31.92	33.56	32.74	257.80	258.60	258.20	43.46	39.60	41.53	13.60	13.80	13.70	21.42	11.76	16.59	13.40	7.96	10.69
													(27.53)	(19.93)	(24.01)			
T ₄	34.04	43.38	38.71	277.00	256.00	266.50	49.76	47.88	48.82	16.00	15.60	15.80	12.64	6.30	9.47	4.26	3.44	3.85
													(20.74)	(14.04)	(17.89)			
T ₅	29.00	29.23	29.11	238.00	236.00	237.00	28.42	30.66	29.54	11.20	8.00	9.60	38.30	20.41	29.35	-	-	-
													(38.21)	(26.80)	(32.79)			
SEm(±)	0.562	0.711	0.449	1.766	1.631	1.146	0.596	0.949	0.666	0.320	0.363	0.258	0.718	1.308	0.591			
LSD(0.05)	1.684	2.131	1.345	5.293	4.889	3.435	1.786	2.844	1.996	0.959	1.088	0.773	2.152	3.920	1.771			
CV%	3.867	4.518	2.968	1.549	1.471	1.019	3.384	5.646	3.868	5.140	6.211	4.281	5.474	14.113	5.216			

Note: Figures in parentheses are angular transformed values of percent disease incidence

Leaf yield (lakh ha⁻¹year⁻¹)

Treatment where Bordeaux mixture (4 drenches + 8 sprays at monthly and fortnightly intervals respectively) + four split doses of uninoculated MOC at 500 kg split⁻¹ ha⁻¹ at quarterly intervals (T₄) (49.76, 47.88, 48.82 lakh ha⁻¹year⁻¹) were applied recorded the maximum leaf yield and it was statistically superior to all the treatments in 2006, 2007 and pooled mean of two years data (Table 1). The minimum leaf yield was recorded in T₅ treatment (28.42, 29.54 lakh ha⁻¹ year⁻¹) (control)

The results of leaf yield (lakh ha⁻¹year⁻¹) in different treatments by application of Bio-agent showed in the following order; T₄> T₃> T₂> T₁> T₅. Increase in growth and fresh weight of 100 leaves ultimately reflected in leaf yield of betelvine different treatments as compared to untreated control. As

Keeping quality (days to 50% rotting)

In the year 2006 and pooled analysis of two years data revealed that, the maximum keeping quality was recorded in T₄ treatment (16.00, 15.80 days) where Bordeaux mixture (4 drenches + 8 sprays at monthly and fortnightly intervals respectively) + four split doses of uninoculated MOC at 500 kg split⁻¹ ha⁻¹ at quarterly intervals were applied and it was statistically superior to all other treatments. In 2007 the maximum keeping quality was also recorded in T₄ treatment (15.60 days) and it was statistically at par with the treatment T₁ (14.60 days) where one application of *Trichoderma* inoculated in 500 kg MOC ha⁻¹ at pre-monsoon + three application of uninoculated MOC at 500 kg MOC ha⁻¹ per application at quarterly intervals were applied. T₅ treatment (11.20, 8.00, 9.60 days) (Control) recorded the minimum keeping quality and it was statistically inferior to all the treatments in 2006, 2007 and pooled analysis of two years data. (Table 1)

The results in keeping quality (days to 50% rotting) of betelvine by the application of Bio-agent of different treatments showed the following order; T₄> T₁≥T₂, T₃>T₅. Application of bio-agent also reflected in keeping quality of betelvine leaves. Different treatments increase the keeping quality of betel leaves significantly as compared to untreated

earlier result the maximum leaf yield (lakh ha⁻¹year⁻¹) was recorded in Bordeaux mixture application plot and other treatments also increase the betel leaf and compared to untreated plots.

Here also noticed that leaf yield increased significantly in different treatments as compared to untreated control. Maximum leaf yield (lakh ha⁻¹year⁻¹) was recorded in T₄ (48.82 lakh ha⁻¹year⁻¹) followed by T₃ (41.53 lakh ha⁻¹year⁻¹) and minimum in untreated in control T₅ (29.54 lakh ha⁻¹year⁻¹) followed by T₁ (34.95 lakh ha⁻¹year⁻¹) and their differences were statistically significant. Similar result was also noticed by Dasgupta *et al.* (2003) that *Trichoderma* application with MOC at quarterly interval increases the yield though less effective as compared to application of Bordeaux mixture control. This trend was noticed in both the years and also in pooled mean.

Cost: benefit ratio

Highest cost : benefit ratio was recorded where *T. harzianum* were applied at pre monsoon in the year 2006 and in pooled mean of two years data. In 2007, highest cost : benefit ratio was recorded where *T. harzianum* were applied at pre and post monsoon. Lowest cost : benefit was recorded where Bordeaux mixture were applied in the year 2006, 2007 and in pooled mean of two years data (Table 1).

These results also revealed that although biological control approach was not superior to chemical control in terms of yield, PDI and fresh weight of 100 leaves but when we consider cost : benefit ratio, biological control with *T. harzianum* at pre, pre and post monsoon and quarterly application of *T. harzianum* were superior to chemical control. Moreover, quarterly application of *T. harzianum* were statistically at par with the chemical treatment in terms of yield, PDI and fresh weight of 100 leaves.

Therefore, quarterly application of *T. harzianum* may be recommended to the farmer for the control of most dreaded disease of betelvine caused by *P. parasitica* to avoid the possibility of health hazards of pesticides application as the betel leaves are directly chewed immediately after harvest.

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