J. Mycopathol. Res. 46(1) : 81-84 (2008)

Management of foot rot and leaf rot of betelvine (*Piper betle*) caused by *Phytophthora parasitica* by using safer fungicides

BIBEKANANDA MOHANTY AND B. DASGUPTA
Department of Plant Pathology, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur 741252, Nadia, W. B.

A field trial was conducted for two consecutive years for the management of foot rot and leaf rot of betelvine caused by *Phytophthora parasitica* using four fungicides (Chlorothalonil, Fosetyl-Al, Mancozeb and Bordeaux mixture) and a growth stimulant formulation, Phosphorus acid (Akomin) as soil drench at monthly and bi-monthly intervals for four and two times respectively starting from June except that Bordeaux mixture was applied at monthly interval for four times. The results of pooled analysis of two consecutive years showed that application of Bordeaux mixture at monthly interval led to the lowest foot rot (8.19 %) and leaf rot (10.74 %) disease incidence. The second best treatment was application of Fosetyl-Al at monthly interval. Highest foot rot and leaf rot incidence (24.66 % and 28.13 % respectively) were recorded in control treatment and it was statistically superior to all other treatments. Highest leaf yield and fresh weight of 100 leaves were obtained with Bordeaux mixture application. Bordeaux mixture application also recorded highly remunerative and it differed significantly from other treatments.

Key words : Foot rot, Leaf rot, betelvine, *Phytophthora parasitica*, safer fungicides

INTRODUCTION

The cultivation of betelvine (*Piper betle* L.) 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. The serious diseases reported include a foot rot syndrome produced by a number of pathogens including *Phytophthora parasitica* var. *piperina*, *Phytophthora nicotianae* var. *parasitica*, species of *Rhizoctonia*, *Pythium* and *Sclerotium rolfsii* Sacc, and foliage diseases like leaf rot by *Phytophthora parasitica*, *Phytophthora palmivora*, leaf spot and stem anthracnose caused by *Colletotrichum capsici* and bacterial leaf spot and stem rot caused by *Xanthomonas campestries* pv. *betlicola*. Among the pathogens, *Phytophthora* sp. perhaps ranks first in its destructiveness under both field and storage conditions. The extent of losses may vary from 30 – 100 % in case of foot rot and 20 – 40 % in case of leaf rot, leading to almost total crop failure (Dasgupta *et al.*, 2000).

To manage the diseases caused by *Phytophthora* sp, use of safe fungicides and judicious timing of fungicides application are of major importance for this crop. There is a much greater volume of literature on field trials starting from the early works of pioneers like Dastur, McRae, Hector, Chowdhury to present day. These have been recorded from time to time (Saxena, 1977; Mehrotra, 1981, 1984; Sen *et al.*, 1981; Khare *et al.*, 1988) and the consensus that emerges is that no efficient method of controlling the *Phytophthora* diseases of betelvine is available yet *i.e.*, effective as well as safe as the betel leaves are directly chewed immediately after harvest. The present investigation has been undertaken to develop a suitable management strategy for foot rot and leaf rot of betelvine caused by *Phytophthora parasitica* by using safer fungicides.

MATERIALS AND METHODS

A field trail was conducted at the bareja situated at Plant Virus Research Farm, Kalyani for two cosecutive years. The variety used was Simurali Bangla, of fairly susceptible host variety (Anonymous, 1989-90). The fungicides evaluated

against foot rot and leaf rot caused by *Phytophthora parasitica* appeared naturally and extensively with the onset of monsoon. Four fungicides and a growth stimulant formulation, phosphorus acid (Akomin) were used with two doses except Bordeaux mixture where only one dose was used. The treatments were : Tr_1 = Phosphorus acid at 0.08 % a.i. (4 mL/L) formulation of Akomin) as soil drench at bi-monthly interval (2 drenches – June, August) ; Tr_2 = Phosphorus acid at 0.08 % a.i. (4 mL/L) formulation of Akomin) as soil drench at monthly interval (4 drenches – June, July, August and September) ; Tr_3 = Chlorothalonil at 0.18 % a.i. (2.5 g/L formulation of Kavach) as soil drench at bi-monthly interval (2 drenches – June and August) ; Tr_4 = Chlorothalonil at 0.18 % a.i. (2.5 g/L formulation of Kavach) as soil drench at monthly interval (4 drenches – June, July, August and September) ; Tr_5 = Fosetyl – AL 0.24 % a.i. (3 g/L formulation of Aliette) as soil drench at bi-monthly interval (2 drenches – June and August) ; Tr_6 = Fosetyl – AL 0.24 % a.i. (3 g/L formulation of Aliette) as soil drench at monthly interval (4 drenches – June July, August and September) ; Tr_7 = Mancozeb @ 2.5 g/L formulation, as soil drench at bi-monthly interval (2 drenches – June and August) ; Tr_8 = Mancozeb @ 2.5 g/L formulation on as soil drench at monthly interval (4 drenches – June, July, August and September) ; Tr_9 = Bordeaux Mixture at 1 % as soil drench at monthly interval (4 drenches – June, July, August and September) and Tr_{10} = Control (no drenching with fungicide).

Drenching was done as per treatment schedule. Before starting the experiment all the infected plants in treatment rows were removed. Each treatment was separated by a buffer row and each replication was separated by 2 buffer rows. The mortality of vines were recorded 30 days after last application of fungicides *i.e.* in the month of October. For leaf rot disease the number of infected and healthy leaves in treatments were counted. Per cent disease incidence (PDI) was calculated by the formula of Townsend and Heuberger (1943).

Fresh weight 100-leaves and yield per hectare of each treatment were recorded and cost : benefit ratio was also calculated. The results obtained were subject to analysis of variance.

RESULTS AND DISCUSSION

Foot rot

The results showed that in 1st year, application of 1 % BM at monthly interval provided the lowest foot rot incidence (8.69 %) though it was statistically at par with the application of Fosetyl-Al, 2D (Tr_5); Fosetyl-Al, 4D (Tr_6); Phosphorus acid, 2D (Tr_1); Chlorothalonil, 4D (Tr_4); Mancozeb, 4D (Tr_8); Phosphorus acid, 4D (Tr_2) and Chlorothalonil, 2D (Tr_3). Tr_{10} (control) showed the highest foot rot incidence (22.85 %). The intermediary result was obtained in Tr_7 (DM-45 at bi-monthly interval).

In 2nd year, the highest foot rot incidence was recorded in control treatment (Tr_{10}) which was statistically superior to all other treatments, followed by Tr_7 (DM-45 at bimonthly interval). The most effective treatment was Tr_9 which was statistically at per with Tr_5 (Fosetyl-Al, 2D) and Tr_6 (Fosetyl-Al, 4D). Application of Phosphorus acid, 2D (Tr_1); Chlorothalonil, 4D (Tr_4); Mancozeb, 4D (Tr_8); Chlorothalonil, 2D (Tr_3); and Phosphorus acid, 4D (Tr_2) showed the intermediary foot rot incidence and these treatments were statistically at par with each other.

Pooled analysis of two years data revealed that the highest foot rot incidence was recorded in the control treatment and which was statistically superior to all other treatments. The lowest foot rot incidence was recorded in Tr_9 (1% BM at monthly interval) and which was statistically at par with Tr_5 (Fosetyl-Al, 2D); Tr_6 (Fosetyl-Al, 4D); Tr_1 (Phosphorus acid, 2D) and Tr_4 (Chlorothalonil, 4D). All other treatments showed the intermediary foot rot incidence.

Leaf rot

In 1st year, control treatment recorded the highest leaf rot disease incidence (26.73 %) which was statistically superior to all other treatments. Bordeaux mixture (Tr_9) treatment gave the lowest disease incidence (10.56 %) although it was not statistically different from disease level recorded from application of Fosetyl-Al 2D and 4D (Tr_5 & Tr_6). Against leaf rot disease, highly effective fungicides were BM and Fosetyl-Al. Other chemicals i.e., Phosphorus acid, Mancozeb, and Chlorothalonil gave the moderate response to leaf rot disease incidence of betelvine.

In 2nd year, with respect to leaf rot disease reduction, the highly effective fungicide was Bordeaux mixture (Tr_9). Mancozeb had no significant effect against leaf rot of betelvine. The control treatment (Tr_{10}) recorded the highest leaf rot incidence (29.53 %).

Table 1 : Management of foot and leaf rot of betelvine by using safer fungicides

Treatment	Foot rot (PDI)*			Leaf rot (PDI)*			Yield (lakh ha^{-1})			Fresh weight of 100-leaves (g)			Cost : benefit ratio		
	1999	2000	Pooled	1999	2000	Pooled	1999	2000	Pooled	1999	2000	Pooled	1999	2000	Pooled
Tr_1	11.33 (19.67)	13.81 (21.82)	12.57 (20.77)	15.23 (22.97)	15.75 (23.38)	15.49 (23.19)	32.32	27.46	29.89	286.59	276.23	278.91	1: 0.29	1: 0.22	1: 0.26
Tr_2	12.57 (20.77)	15.63 (23.29)	14.10 (22.06)	16.58 (24.03)	19.29 (16.05)	17.94 (25.06)	31.85	27.18	29.56	283.37	272.14	275.26	1: 0.26	1: 0.95	1: 0.61
Tr_3	12.73 (20.90)	15.47 (23.16)	14.10 (22.06)	16.94 (24.30)	20.57 (26.97)	18.76 (25.66)	36.43	29.28	32.86	287.72	278.17	280.45	1: 1.29	1: 0.73	1: 1.01
Tr_4	11.47 (19.80)	14.21 (22.18)	12.84 (21.00)	15.87 (23.48)	18.03 (25.13)	16.95 (24.31)	39.23	37.76	38.50	307.14	301.57	303.86	1: 0.99	1: 1.23	1: 1.11
Tr_5	10.21 (18.63)	12.54 (20.74)	11.38 (19.71)	13.14 (21.25)	15.08 (22.85)	14.11 (22.06)	37.57	34.12	35.85	296.58	288.64	290.11	1: 0.87	1: 1.10	1: 0.96
Tr_6	9.05 (17.51)	9.75 (18.19)	9.40 (17.85)	12.32 (20.55)	14.59 (22.46)	13.46 (21.52)	38.42	35.53	36.98	299.57	296.24	295.41	1: 0.49	1: 0.78	1: 0.64
Tr_7	14.57 (22.43)	19.23 (26.01)	16.90 (24.27)	18.14 (25.21)	21.46 (27.60)	19.08 (26.42)	35.49	28.12	31.81	281.18	272.83	273.51	1: 2.79	1: 1.03	1: 1.91
Tr_8	12.33 (20.56)	14.53 (22.40)	13.43 (21.50)	16.26 (23.78)	19.12 (25.93)	17.69 (24.87)	36.85	32.81	34.83	293.46	283.49	285.48	1: 1.84	1: 1.91	1: 1.88
Tr_9	8.69 (17.14)	9.12 (17.58)	8.91 (17.36)	10.56 (18.96)	10.92 (19.30)	10.74 (19.13)	40.52	38.43	39.48	317.73	310.58	313.16	1: 2.57	1: 3.14	1: 2.86
Tr_{10}	22.85 (28.56)	26.47 (30.96)	24.66 (29.77)	26.73 (31.13)	29.53 (32.92)	28.13 (32.03)	31.25	26.89	29.07	263.32	256.45	257.39	1: 1	1: 1	1: 1
SEm (±)	1.36	1.17	1.25	0.94	0.91	0.92	1.78	1.45	1.62	2.56	1.97	2.09	0.37	0.17	0.05
C.D.(0.05)	4.04	3.33	3.71	2.79	2.70	2.72	5.28	4.31	4.81	7.61	5.51	5.64	1.11	0.51	0.16

Tr_1 = Phosphorus acid (2 D); Tr_2 = Phosphorus acid (4D); Tr_3 = Chlorothalonil (2D); Tr_4 = Chlorothalonil (4D); Tr_5 = Fosetyl–AL (2D); Tr_6 = Fosetyl–AL (4D); Tr_7 = Mancozeb (2D); Tr_8 = Mancozeb (4D); Tr_9 = BM (4D) and Tr_{10} (Control), D = drenching.
Figures in parentheses are angular transformed value * Average of 4 replications

Pooled data of the two years revealed that lowest disease incidence was recorded with the application of Bordeaux Mixture (Tr_9), closely followed by Fosetyl-Al (Tr_5) and both of them were statistically at par. Against leaf rot disease Tr_6 (Fosetyl-Al- 4D), Tr_1 (Phosphorus acid – 2D) and Tr_4 (Chlorothalonil – 4D) gave the moderate effect and they were statistically at par with each other. Tr_{10} (control) recorded the highest leaf rot incidence (28.13 %) which was statistically superior to all other treatments.

Leaf yield

With respect to yield of leaves (lakh ha^{-1}), in both the years, Tr_9 provided the highest leaf yield where Bordeaux mixture (1 %) was applied as soil drench for 4 times at an interval of one month though it was statistically at par with the treatments where Chlorothalonil was applied 4 times at one month interval, Fosetyl-Al was applied 4 times at monthly interval and two times at bi-monthly interval and Mancozeb was applied 4 times at monthly interval in 1st year and statistically at par with TR_4 in 2nd year. The lowest leaf yield was recorded in control treatment (Tr_{10}) in both the years.

Pooled analysis of two years data on leaf yield revealed that highest yield was obtained in BM treatment (Tr_9) and it was statistically at par with Tr_4, Tr_6, Tr_5 and Tr_8. The control treatment (Tr_{10}) where no drenching with fungicides were made, resulted the lowest leaf yield (29.07 lakh ha^{-1}) and was statistically at par with rest of the treatments.

Fresh weight of 100 leaves

Fresh weight of 100 leaves was recorded highest in Tr_9 (application of BM) in both the years and it was statistically superior to all other treatments. The lowest fresh weight was observed in treatment Tr_{10} (control).

When pooled data were analysed it was found that application of Bordeaux mixture was most effective (Tr_9) followed by Tr_4 (Chlorothalonil 4D). Application of Fosetyl-Al (2D and 4D) showed more or less similar results and they were at par with each other. Tr_1 (Phosphorus acid,2D),Tr_2 (Phosphorus acid 4D) and Tr_7 (Mancozeb, 2D) were at par. The lowest fresh weight of 100 leaves was found in Tr_{10} (Control).

Cost : benefit ratio

In both the years and pooled of both years, the

highest cost : benefit ratio was recorded in Tr_9 where BM was applied 4 times at monthly interval and when Phosphorus acid was applied 4 times with monthly interval it recorded the lowest cost : benefit ratio.

Overall the above results showed that application of Bordeaux mixture led to the lowest disease incidence of both the diseases. Soil drenching of Bordeaux mixture cofirmed the findings of Dastur (1931, 1935); Subramanian and Venkatrao (1970) and Mahanty *et al.* (2000). Fosetyl-Al treatment reduced foot rot and leaf rot to a great extent though less effective than Bordeaux mixture. Fosetyl-Al was also reported to be highly effective against *Phytophthora* of betelvine by different workers (Dasgupta *et al.*, 1998; Maiti and Shivshankar, 1998; Dasgupta and Sen, 1999). Efficacy of Chlorothalonil reported by earlier workers (Dasgupta and Sen, 1999; Nag *et al.*,1993) did not prove effective. As Bordeaux mixture application in betelvine was also effective against other major diseases of betelvine like leaf spot due to *Colletotrichum capsici* and bacterial leaf spot due to *Xanthomonas campestris pv. betlicola,* it may be recommended for management of *Phytophthora* foot rot and leaf rot of betelvine as well as other major diseases of betelvine.

REFERENCES

Annonymous, 1989-90. Annual Report. All India Co-ordinated Research Project on Betelvine. National Research Centre for Medicinal and Aromatic Plants. Pp. 46-47.

Dasgupta, B. and Sen, C. 1999. Assessment of *Phytophthora* root rot of betelvine and its management using chemicals. *J. Mycol. Plant Pathol.*, **29** : 91-95.

Dasgupta, B.; Roy, J. K. and Sen, C. 2000. Two major fungal diseases of betelvine. In : *Diseases of Plantation Crops, Spices, Betelvine and Mulberry* (Ed. M. K. Dasgupta) 133-137.

Dasgupta, B; Jha, S. and Sen, C. 1999. Betelvine in Tropical Horticulture (T.K.Bose *et al* Eds.). Naya Prakash Publication, Calcutta.

Dastur, J. R. 1931. Control of the foot rot disease of pan (*Piper betle*) in the Central Provinces. *Agric. And Livestock in India,* **1**(1) : 26-31.

Dastur, J. R. 1935. Disease of pan (*Piper betle*) in the Central Provinces. *Proc. Indian Acad. Sci.,* **1**(11) : 26-31.

Khare, M. N. and Vyas, S. C. 1988. Effect of systemic fungicides on Phylloplane Mycoflora. *In Progress in Microbial Ecology*, Ed. K. G. Mukherjee, V. P. Agnihuotri and R. P. Singh, 133-144.

Maiti, S. and Shivasankar, K. C. 1998. Betelvine Research Highlights (1981-1997), ICAR, AICRP on betelvine, IIHR, Bangalore.

Mehrotra, R. S. 1981. Fungal diseases of betelvine and their control. In Proc. Group Discussion Improvement of Betelvine Cultivation. NIBRI, Lucknow, 3-12.

Mehrotra, R. S. 1984. Fungal diseases of betelvine and their control. In : Proc. Improvement of Betelvine cultivation (Eds. S. D. Khanduja, VR Balasubrahmanyam) NBRI, Lucknow, 3-12.

Mahanty. B., J. K. Roy, B. Dasgupta and Chitreshwar Sen .2000. Relative efficacy of promissing fungicides and biocontrol agents *Trichoderma* in the management of foot rot of betelvine. *Journal of Plantation Crops.* **28**(3): 179-184.

Nag, S. K.; Chowdhury, A.; Das, A. K. and Dasgupta, B. 1993. Potentials of Chlorothalonil in management of major diseases of betelvine, its persistence and residue levels on foliage. *Pestology,* **17**(1) : 37-43.

Saksena, S. B. 1977. *Phytophthora parasitica*, the scourge of 'pan'. *Indian Phytopathol.*, **30** : 1-16.

Sen, C.; Maiti, S. and Khatua, D. C. 1981. Control of rot and foot rot diseases of betelvine caused by fungal pathogens. Proceedings Improvement of Betelvine Cultivation, NBRI, Lucknow, Feb. 27-28, 33.

Subrahmanian, K. S. and Venkata Rao, A. 1970. Some experiments on betelvine wilt at Pathanur in Tamil Nadu. *Indian Phytopathol.*, **73** : 603-605.

Townsend, G. R. and Heuberger, J. W. 1943. Methods for estimating losses caused by diseases in fungicidal treatments. Plant Dis. Reptr., **27** : 340-42.

(Accepted for publication November 21, 2007)