Int.J.Curr.Microbiol.App.Sci (2018) Special Issue-7: 4610-4616

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Special Issue-7 pp. 4610-4616**
Journal homepage: http://www.ijcmas.com

Original Research Article

Epidemiological Factors Affecting Phytophthora Leaf rot and Anthracnose Leaf Spot Diseases of Betelvine (*Piper betle*) and their Control

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A B S T R A C T

Betelvine (*Piper betle*) is an important cash crop of India for livelihood security in rural area particularly small as well as marginal betel growers of "chaurasia community". Phtyophthora leaf rot and Anthracnose leaf spot is the major constraint in production and market value of betel leaf production. A study was undertaken during three consecutive years (2013, 2014 and 2015) to find out the influence of rainfall, relative humidity and minimum temperature on the development of Phytophthora leaf rot and Anthracnose leaf spot disease of betel vine. Leaf rot Disease severity of Phytophthora leaf rot was found maximum in month of August which was due to high rainfall. Whereas, disease severity of Anthracnose leaf spot was found maximum in the month of December, when atmospheric relative humidity was attained maximum. It indicated positive and significant role of the weather factors on both leaf rot and leaf spot disease development in betelvine. The efficacy of different fungicide ingredients in two concentrations were tested separately for both diseases. The significant results were obtained in different fungicide ingredients but non-significant results were obtained between different doses of same fungicide. So, lower doses can be recommended for control of both diseases. 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.

Keywords

Anthracnose leaf spot, Betelvine, Magahi Paan, Phytophthora leaf rot

Introduction

Betelvine (*Piper betle* L.) is an important cash crop of India belonging to the family Piperaceae. India is the largest producer of betel leaves in the world (Arulmozhiyan *et al.*, 2005). It is cultivated in India on about 75,000 ha area with an annual production worth about Rs. 1000 million (Dasgupta, 2011; Vijayakumar and Arumugam, 2012). In Bihar, the crop is cultivated in area, about 4000 under artificial conservatory known as '*Baroj or Baretha'* that permitted little light and retains maximum moisture conditions. Betelvine is considered as highly labour intensive crop and provides employment throughout the year in the farming and marketing. It provides livelihoods to about 20.8 lakh people in the states (Das *et al.*, 2017). There are about a hundred cultivars

of betelvine grown across the world, of which about 40 are found in India. In Bihar, Magahi is the native cultivar of the state and other cultivars are also grown like Bangla, Deshi, Pila Pata etc. (Kumar and Pandey, 2014).

The Phytophthora leaf rot and Anthracnose leaf spot are serious diseases of betelvine. Leaf rot can damage the crop within a week when it attacks the vine. Secondary spread is carried from vine to vine by disseminated sporangia and zoospores through irrigation water and rains accompanied by wind (Rangaswami and Mahadevan, 2006). The extent of losses may vary from 30-100% in case of foot rot and leaf rot leading to almost total crop failure (Maiti and Sen, 1979; Maiti and Sen, 1982; Das gupta *et al.*, 2000). Whereas, Anthracnose leaf spot may cause 10-60% yield loss and also reduce market value of the crop (Singh and Joshi, 1971; Maiti and Sen, 1982).

Environmental factors play an important role on the development of disease as they help the pathogen for growth, dissemination and infection as well as influences on expression of susceptibility/ resistance of the host plant after infection (Walker 1965).

In India, weather conditions are varied from one agro-climatic condition to others. Epidemiological information on development of leaf rot and leaf spot of the crop in Cv. *Magahi Paan* is yet to study. But it is well known fact that study on the factors affecting epidemic development of the disease is important for successful and economic management of disease.

Therefore, the present investigation entitled "Epidemiological Factors Affecting Phytophthora Leaf rot and Anthracnose Leaf Spot Diseases of Betelvine (*Piper betle*) and Their Control" was carried out.

Materials and Methods

The field experiment was conducted under state plan project at Betelvine Research Centre. Islampur, Nalanda, Bihar which is under administrative control of Bihar Agricultural University, Sabour, Bhagalpur. This centre was situated in agro-climatic Zone III B of Bihar at latitude and longitude (25.147012, 85.200789) and GPS coordinates (25° 8' 49.2432" N85° 12' 2.8404" E). The Betelvine crop (Cultivar- *Magahi Paan*) was grown under baroj (Artificial conservatory for betelvine cultivation) in month of June during three consecutive years (2013, 2014 and 2015). Young cutting of vine from two years old vine was used as planting material. The cuttings were planted in 2.4 m x 4.0 m for each treatment plot size, maintaining 80 cm row to row, 10 cm plant to plant. After establishment of the cutting the field was fertilized with only mustard oil cake at the rate of 5 tons per hectare per year. The oil cake was applied into three equal. The field experiment was laid out in a randomized block design with three replications. The disease severity of Phytophthora foot rot and Anthracnose leaf spot was recorded during diseases occurrence periods for three year and also noticed symptom types. The efficacy of different fungicides was tested under natural disease occurrence periods. Two sprays of each fungicide in two concentrations (Listed in Table 3) were tested at 15 days of interval separately for both diseases ensuring minimum 10% disease severity occurred naturally in each replication. The disease severity of Phytophthora leaf rot was recorded using 0-5 scoring scale from 30 vines taken randomly from each replications as described by Goswami *el al.* (2002) for Phytophthora leaf rot; 0 = Healthy leaf, 1 = Up to 5% leaf area covered, 2 = 6-15% leaf area covered, 3 = 16-30% leaf area covered,

4 = 31-50% leaf area covered and 5 = above 50% leaf area covered. Whereas, the disease severity of Anthracnose leaf rot was recorded using 0-5 scoring scale described by Goswami *et al.*, (1993); 0 = no or a few lesion on leaf, 1= Up to 10% leaf area affected,2 = 11-25% leaf area affected, 3 = 26-50% leaf area affected, 4 = 51-75% leaf area affected and 5 = above75 %leaf area affected. The Percent Disease Index was computed based on the formula as described below by Wheeler (1969).

PDI = (Sum of numerical values / No. of plant parts observed) x (100 / Maximum disease rating)

Disease data were correlated with the meteorological data to find out the critical weather condition for the epidemiology of the disease (Srivastava and Singh, 1994). Meteorological data were collected from the nearest Meteorological Centre (ICAR-RCER, Patna).

Results and Discussion

Epidemiological factor affecting Phytophthota leaf rot and Anthracnose leaf Rot

Pooled mean of three year data (2013, 2014 and 2015) showed that Phytophthora leaf rot severity was found maximum (40.4%) during the month of August and this month received high rainfall (311.0 mm) as compared to other month of disease severity period (Table 1). So, management or control of leaf rot strategies should make before August. Anthracnose leaf spot severity was reported maximum (28.0%) during the month of December (Table 3). In this month, the average low temperature was 10.6 ^{0}C which was lowest temperature as compared to other month of disease severity and relative humidity was high (92.0 %). Therefore, Management or control of Anthracnose leaf spot strategy should be applied in month before December. Similar type of result was also reported by Das Gupta and Sen (1985) who found that 92.0% relative humidity is critical moisture level for severe leaf spotting and heavy losses of betel vine and Goswami *et al.*, (2002) reported three weather factors viz. temperature, relative humidity and rainfall greatly influenced the severity of leaf spot in betelvine. The correlation matrix (Table 2) between disease severity of Phytophthora leaf spot and weather factors represented positively correlated with average rainfall received in month and average minimum temperature, in other hand negatively correlated with relative humidity. Huq (2011) also reported influence of high atmospheric humidity and rainfall on Leaf rot disease of betel leaf. On the other hand, incidence of leaf spot increased with less humidity gradient. Whereas, disease severity of Anthracnose leaf spot was positively correlated with Relative humidity in month of disease occurrence (Table 2).

Efficacy of fungicides for management of diseases

For Phytophthora leaf spot, each fungicide treatment was sprayed when the percent disease index (PDI) varied between, 10.0—24.0, 15.0—27.7, 17.7—29.0 % during 2013, 2014 and 2015, respectively under natural disease conditions at the 4th week July. Two sprays were applied at 15 days of interval. All treatments reduced the Phytophthora leaf rot over the control (Table 3). Pooled Analysis of three years data (2013 to 2015) revealed that the treatment (T_4)- Metalaxyl 8% + Mancozeb 64% WPingredient of fungicide at 0.2% concentration significantly superior as compared to all other treatment followed by treatment (T_{10})- Bordeaux mixture (0.5%) controlled the disease severity by 76.2% and 49.1% disease, respectively.

Table.1 Percent disease index (PDI) of Phytophthora leaf rot and Anthracnose leaf spot and weather factors

Month	PDI of Phytophthora leaf rot				Rain fall (mm)				Humidity (%)				Average temperature Min (^{0}C)			
	2013	**2014**	**2015**	**Mean**	**2013**	**2014**	**2015**	**Mean**	**2013**	**2014**	**2015**	**Mean**	**2013**	**2014**	**2015**	**Mean**
July	20.0	36.0	29.7	**28.6**	65.3	151.0	260.9	**159.1**	86.4	90.0	88.1	**88.2**	27.1	26.0	26.7	**26.6**
August	36.0	49.0	36.3	**40.4**	164.4	472.0	296.6	**311.0**	86.8	89.0	90.5	**88.8**	26.5	27.0	26.7	**26.7**
September	24.0	45.0	30.0	**33.0**	223.4	184.0	29.0	**145.5**	86.9	92.0	85.5	**88.1**	26.0	25.0	26.2	**25.7**
October	18.0	32.0	24.7	**24.9**	169.0	33.0	7.4	**69.8**	91.7	93.0	87.8	**90.8**	22.6	21.0	21.8	**21.8**
	PDI of Anthracnose leaf Spot															
October	22.3	21.0	17.3	**20.2**	169.0	33.0	7.4	**69.8**	91.7	93	87.7	**90.8**	22.6	22.0	21.78	**22.1**
November	27.7	24.0	21.7	**24.5**	0.0	0.0	0.0	**0.0**	91.0	93	91.2	**91.7**	14.1	14.0	16.49	**14.9**
December	30.3	30.0	23.7	**28.0**	0.0	0.2	0.0	**0.1**	92.3	93	90.7	**92.0**	11.0	10.0	10.85	**10.6**
January	11.0	13.0	28.3	**17.4**	16.8	14.3	3.4	**11.5**	93.4	92.2	90.8	**92.1**	10.6	10.5	8.72	**9.9**

Table.2 Correlation coefficient between severity of Phytophthora leaf Rot and Anthracnose leaf Spot of betelvine (Cultivar-*Magahi Paan*) and three weather factors (monthly average Rainfall, Relative humidity and minimum temperature) recorded during 2013, 2014 and 2015

	Disease Severity of PLR	Average Rainfall	Relative Humidity	Average Minimum Temperature
Disease Severity of PLR	1			
Average Rainfall	0.945393	1		
Relative Humidity	-0.50475	-0.46684	1	
Average Minimum Temperature	0.703053	0.748965	-0.91812	1

	Disease Severity of ALS	Average Rainfall	Relative Humidity	Average Minimum Temperature
Disease Severity of ALS	1			
Average Rainfall	-0.47108	1		
Relative Humidity	0.203108	-0.91281	1	
Average Minimum Temperature	-0.18651	0.867731	-0.99278	1

Table.3 Efficacy of different fungicides against Phytophthora leaf rot and Anthracnose leaf spot of betelvine

Treatment	Fungicide ingredients	#Percent reduction of disease over control			Pooled mean	#Percent reduction of disease over control			Pooled mean
		2013	2014	2015		2013	2014	2015	
T_1	Control (spray of water)	0.0	0.0	0.0	0.0 (0.0)	0	0	0	0.0 (0.0)
T_2	Carbendazim 12% + Mancozeb 63% WP (0.2%)	39.2	36.6	39.0	38.3 (38.2)	79.5	70.6	68.8	73.0 (58.7)
T_3	Carbendazim 12% + Mancozeb 63% WP (0.4 %)	41.0	38.1	42.4	40.5 (39.5)	86.9	74.7	77.1	79.6 (63.3)
T_4	Metalaxyl 8% + Mancozeb 64% WP (0.2%)	78.0	74.3	76.2	76.2 (60.8)	34.5	35.7	41.5	37.2 (37.6)
T_5	Metalaxyl 8% + Mancozeb 64% WP - (0.4%)	79.6	77.3	77.4	78.1 (61.1)	37.1	39.7	45.3	40.7 (39.6)
T_6	Fenamidone 10% + Mancozeb 50% WG (0.2%)	32.2	33.0	43.7	36.3 (36.0)	38.4	32	40.3	36.9 (37.4)
T_7	Fenamidone 10% + Mancozeb 50% WG (0.4%)	36.7	38.3	48.0	41.0 (39.8)	54.2	39.7	48.8	47.6 (43.5)
T_8	Tebuconazole 25 EC (0.2%)	37.3	34.8	38.7	36.9 (37.4)	73.4	59.8	62.1	65.1 (58.8)
T_9	Tebuconazole 25 EC (0.4%)	39.3	36.4	40.1	38.6 (38.4)	84.4	66.9	69.8	73.7 (59.4)
T_{10}	Copper Sulphate+ Calcium oxide+ water- (Bordeaux mixture)-(0.5%)	45.0	47.8	54.5	49.1 (44.5)	55.4	50.4	55.4	53.7 (47.1)
T_{11}	Copper Sulphate+ Calcium oxide+ water- (Bordeaux mixture) - (1%)	47.2	49.6	58.8	51.9 (46.0)	68.5	56.2	59.8	61.5 (51.7)
T_{12}	Mefenoxam + Mancozeb (WP) - (0.2%)	40.2	44.3	45.3	43.3(41.1)	30.8	33.1	42	35.3 (36.4)
T_{13}	Mefenoxam + Mancozeb (WP) - (0.4%)	43.7	49.0	52.4	48.4 (44.0)	33.6	38.1	43.2	38.3 (38.2)
T_{14}	Locally available plant botanical based fungicide - (0.3%)	25.4	22.9	29.7	26.0 (30.6)	36.5	16.2	24.4	25.7 (30.2)
T_{15}	Locally available plant botanical based fungicide - (0.6%)	31.5	28.68	37.2	32.5 (34.7)	25.3	23.7	33.9	27.6 (31.6)
C.D. (p=0.05)		10.8	3.5	5.0	2.8	8.7	5.3	6.7	5.5
S.E. (m ±)		3.7	1.2	1.7	0.9	3.0	1.8	2.3	1.9
C.V. (%)		16.5	5.4	7.1	4.1	12.1	8.1	9.3	7.9

#Percent reduction of disease is mean of 3 replications Angular transform value showed in parenthesis

The interaction among disease and concentrations on disease control is non-significant. So, lower doses are considered for recommendation and management of disease. The different types fungicides was also tested by different worker and they find successive control of phytophthora leaf rot (Johri *et al.*, 1984) and by spraying of 0.5% Bordeaux mixture, Peronox (0.35%), Fytolan (0.2%), Dithan Z-78 (0.2%) by (Balasubrahmanyam *et al.*, 1988; Rangaswami and Mahadevan, 2006).

For Anthracnose leaf spot, each fungicide treatment was sprayed when the percent disease index (PDI) varied between, 11.0—22.3, 10.0—20.0 and 13.0—23.7% during 2013, 2014 and 2015, respectively under natural conditions at the 4th week November. Two sprays were applied at 15 days of interval. All treatments reduced the Anthracnose leaf spot over control (Table 3). Pooled Analysis of three years data (2013 to 2015) revealed that the treatment the treatment (T_4)- 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%) controlled the disease severity 73.0% and 65.1% respectively as compared to other treatments. The interaction among disease and concentrations on disease control is non-significant. So, lower doses are considered for recommendation and management of disease. The other fungicides were also used for management of Anthracnose leaf spot by Maiti *et al.*, (1978) and Saleem (2000), they got significant result. Ahmed *et al.*, (2014) also tested different fungicide for in vitro management of Anthracnose leaf spot. This management study also help to betel growers to save the crop infected by Phytophthora leaf spot and Anthracnose leaf spot of Betelvine in the country and making strategy to control these diseases at proper time based on epidemiological factors in Betelvine particularly Cv.-*Magahi Paan* of Bihar.

Acknowledgments

Authors acknowledge the Directorate of Research, Bihar Agricultural University, Sabour for financial support under State Plan Project- SP/CP/BRC/2013-13.

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