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Changes in crop canopy architecture on the incidence of major foliar diseases of betelvine (*Piper betle* L.)

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Abstract

Betelvine (*Piper betle* L.) is a perennial dioecious creeper-belonging to the family Piperaceae usually grown under artificially erected structurals known as baroj that provides high moist and humid conditions favouring several diseases that in turn are major deterrents to good harvest. Betelvine suffers from many root and aerial diseases of which leaf rot caused by *Phytophthora parasitica* (Dastur) and leaf spot caused by *Colletotrichum capsici* Syd. (Butler and Bisby) are most important and are included in these studies for assessment. The extent of losses may vary from 20-40% for leaf rot and 10-20% for leaf spot, leading to almost total crop failure (Dasgupta and Sen, 1999). As the betel leaf is directly chewed immediately after harvest, it is not feasible to apply any pesticides that may cause toxic hazards to human being. An experiment was conducted for two consecutive years to study the effect of different crop canopy by maintaining three different plant to plant spacing (*viz.*, 11.1, 9.53 and 8.3 cm.) on leaf yield, disease incidence and keeping quality (days to 50% rotting) of betelvine. With the above plant to plant spacing and standard row to row spacing (60cm), the plant population was maintained as 1.50, 1.75 and 2.00 lakh ha^{-1}. The results revealed that when crop canopy was increased by reducing the plant to plant spacing from 11.1 cm to 8.3 cm there were significant increases in both the diseases under investigation (rot disease 19.76 to 22.30%; leaf spot disease 22.68 to 25.42%). Significant increase in yield (26.29 to 33.63 lakh $ha^{-1}year^{-1}$), decrease in fresh weight of 100 leaves (460.85 to 432.35g) and decrease in keeping quality of leaves (13.14 days to 10.28 days) were recorded when crop canopy was increased by reduction in plant to plant spacing from 11.1 cm to 8.3 cm. From these results it can be concluded that shifts in microclimate resulting from increase in canopy by reducing the plant spacing aggravated the spread and infection of disease.

Key words: Crop canopy, betelvine, *Phytophthora parasitica, Colletotrichum capsici*

Introduction

Betelvine is grown under artificially erected structurals known as 'baroj' or 'bareja' or 'bheet' made up bamboo poles, sticks, khari, jute sticks, paddy straw, ulu straw or coconut, arecanut leaves that provide highly moist and humid conditions favouring good harvest. However, these conditions also favour several diseases that detrimentally affect the growth and yield parameters. Betelvine suffers from many root and aerial diseases of which leaf rot caused by *Phytophthora parasitica* (Dastur) and leaf spot caused by *Colletotrichum capsici* Syd. (Butler and Bisby) are most important. The extent of losses may vary from 20-40% in case of leaf rot and 10-20% in case of leaf spot, leading to almost total crop failure (Dasgupta and Sen, 1999).

There is a large volume of literature available for the management of leaf rot and leaf spot with chemicals starting from the early works of pioneers like Dastur, 1931, 1935; McRae, 1934; Hector, 1930; Chowdhury, 1944 to present day. These have been recorded from time to time (Chattopadhyay 1967; Saksena, 1977; Sen *et al.,* 1981; Khare *et al.,* 1988; Dasgupta *et al.*, 1988; Chattopadhyay and Maiti, 1990; Dasgupta 1993; Dasgupta and Sen, 1996; Maiti and Shivshankar, 1998; Dasgupta and Sen, 1999 and Dasgupta *et al.,* 2000) and the consensus that emerges is that no efficient method of controlling the above two diseases of betelvine are available yet *i.e.,* effective as well as safe. Moreover, a tiny amount of pesticide carried by the leaf would be hazardous to human health due to the residual toxicity of the pesticide as they are non-biodegradable and as the leaves are chewed directly, immediately after harvest (Bhattacharya *et al.*, 1988; 1989 and 1992; Guha *et al.*, 1990; Kar *et al.*,1995). Moreover microclimate inside the baroj favours plant diseases which depend upon the canopy structure of the baroj.

Farmers are growing betelvine in rows on ridge with different plant to plant spacing (*viz.*, 11.1 cm. 9.53 cm. and 8.3 cm.) and standard row to row spacing (60cm). With the above plant to plant spacing and standard row to row spacing (60cm), the plant population was maintained as 1.50, 1.75 and 2.00 lakh ha^{-1}. The present investigations were carried out to study the effect of different crop canopy (by maintaining three different plant to plant spacing) on leaf yield, disease incidence and keeping quality (days to 50% rotting) of betelvine.

Materials and methods

The experiment was carried out in a randomized block design with seven replications in a boroj situated at Plant Virus Research Farm, Kalyani, Bidhan Chandra Krishi Viswavidyalaya. Soil of the plot was sandy loam alluvial soil (Entisol) with pH 7.4 and having 0.54% organic carbon, 0.06% total N, 55 kg ha^{-1} of available P_2O_5 and 100 kg ha^{-1} of K_2O respectively. The experiment was conducted in first week of July to last week of October, for two consecutive years, *i.e.* 2013 and 2014. The variety of crop was Simurali Bhabna. The treatments for the experiment were as follows:

Treatments details	Spacing between	
	Row	Plant (approx)
T_1 = 1.50 lakh ha^{-1} plant population	60 cm	11 cm
T_2 = 1.75 lakh ha^{-1} plant population	60 cm	9.5 cm
T_3 = 2.00 lakh ha^{-1} plant population	60 cm	8 cm

The crop was fertilized @ 200 kg N in the form of (MOC + Urea 1 : 1) in four equal splits at an interval of 30 days, 100 kg P_2O_5 as single super phosphate and 100 kg K_2O as muriate of Potash ha^{-1} year^{-1}. P_2O_5 and K_2O were applied along with first application of nitrogenous fertilizer, *i.e.* at the onset of monsoon.

Before conducting the experiment all the infected leaves and diseased plants in treatment rows were removed. The vine elongations, fresh weight of 100 leaves, leaf yield, keeping quality, percent disease incidence were recorded. The percent disease incidence was calculated by the formula (Townsend and HeuBerger, 1943) as follows:

$$\text{Percent disease incidence} = \frac{\text{Number of infected leaves}}{\text{Total number of leaves}} \times 100$$

Results and discussion

Vine elongation month^{-1} (cm): The results (Table 1) showed that the maximum and minimum vine elongation per month was recorded in T_3 treatment (57.99 cm month^{-1}) and T_1 treatment (53.22 cm month^{-1}), respectively in 2013. In 2014, the maximum and minimum vine elongation per month was recorded in T_2 treatment (57.82 cm month^{-1}) and in T_3 treatment (52.07 cm month^{-1}), respectively. In Pooled analysis of two years data revealed that the maximum and minimum vine elongation per month was recorded in T_2 treatment (55.85 cm month^{-1}) and in T_1 treatment (53.45 cm month^{-1}), respectively. The results of vine elongation month^{-1} (cm) with regard to results of different spacing treatments showed in the following order: T_2, $T_3 > T_1$ (Pooled).

The result therefore indicated that vine elongation was increased with increasing plant population or decreasing plant spacing. These results confirmed the observations of AICRP on betelvine reports that vine elongation increased with increase in the plant population from 1.5 to 2.0 lakh (Anonymous, 2001-02).

Fresh weight of 100 leaves (g): Maximum fresh weight of 100 leaves was recorded in T_2 treatment (418.57, 460.85 g), where 1.75 lakh ha^{-1} plant population was maintained and it was found statistically superior to all the other treatments in the year 2013 and pooled analysis of two years data. In 2014 the maximum fresh weight of 100 leaves was recorded in T_3 treatment (522.71 g) where 2.00 lakh ha^{-1} plant population was maintained and it was statistically superior to all the other treatments. The minimum fresh weight of 100 leaves was recorded in T_3 treatment (360.71 g) where a 2.00 lakh ha^{-1} plant population was maintained in the year 2013. In 2014 the minimum fresh weight of 100 leaves was recorded in T_1 treatment (495.71 g). The pooled analysis of two years data revealed that the minimum fresh weight of 100 leaves was recorded in T_1 treatment (432.35 g) (Table 1).

These results of fresh weight of 100 leaves (g) may be arranged in the following order: $T_2 > T_3$, T_1 (Pooled).

Different plant spacings (11.1 cm, 9.53 cm and 8.3 cm) were also reflected on fresh weight of 100 leaves (g) and their differences were statistically significant in both the years and also in pooled mean. The result contradicts with the result obtained in the experiment of AICRP on betelvine in the year 2001-02 that fresh weight of 100 leaves was statistically not significant with the plant spacing (Anonymous, 2001-02).

Effect of spacings on leaf yield (lakh ha^{-1} year^{-1}) of betelvine: Maximum leaf yield was recorded in T_2 treatment (31.17, 33.63 lakh ha^{-1} year^{-1} respectively) where 1.75 lakh ha^{-1} plant population was maintained in the year 2013 and pooled analysis of two years data (Table 1). Treatment T_3, where 2.00 lakh ha^{-1} plant population was maintained recorded maximum leaf yield (37.03 lakh ha^{-1} year^{-1}) in the year 2014. The minimum leaf yield (20.04, 32.55 and 26.29 lakh ha^{-1}yea^{-1} respectively) was recorded in treatment T_1 where 1.50 lakh ha^{-1} plant population (11.1cm spacing) was maintained.

The results of the leaf yield (lakh ha^{-1} year^{-1}) in different treatments showed a decreasing order like: $T_2 > T_3 > T_1$ (Pooled).

These results thus revealed that different plant spacings showed differential result in leaf yield (lakh ha^{-1} year^{-1}) in two different years and also in pooled mean and their differences were statistically significant. Similar result was also obtained by Pawar *et al.* (2006) that highest leaf yield was obtained from 50 x 10 cm spacings, the minimum spacing kept in their experiments. It indicated that with decreasing spacing there was a significant increase in leaf yield though 9.53 cm spacing gave better results.

Effect of spacing on keeping quality (days to 50% rotting) of betelvine: Keeping quality was best in T_1 and T_2 treatments (10.28 days) and the poor keeping quality was recorded in treatment T_3 (9.00 days) in 2013. In 2014 the maximum keeping quality was recorded in T_3 treatment (15.28 days) and minimum keeping quality was recorded in T_2 treatment (12.28 days). The pooled analysis data of two years revealed that the maximum keeping quality was recorded also in T_3 (12.14 days) and minimum keeping quality was also in treatment T_2 (11.28 days) (Table 1).

The results of two different years showed different results in keeping quality of betelvine leaves in different plant spacing. This result also confirms the result of AICRP on betelvine in the year 2000-01 (Anonymous, 2000-01).

Table 1. Effect of crop canopy structure on growth, fresh weight, yield and keeping quality of betelvine

Treatments (plant population)	Vine elongation Month^{-1} (cm)			Fresh weight of 100 leaves (g)			Leaf yield[1] (Lakh ha^{-1}year^{-})			Keeping quality (days to 50% rotting)		
	2013[1]	2014[1]	Pooled	2013[1]	2014[1]	Pooled	2013[1]	2014[1]	Pooled	2013[1]	2014[1]	Pooled
1.50 lakh ha^{-1}	53.22	53.67	53.45	369.00	495.71	432.35	20.04	32.55	26.29	10.28	13.00	11.64
1.75 lakh ha^{-1}	53.88	57.82	55.85	418.57	503.14	460.85	31.17	36.08	33.63	10.28	12.28	11.28
2.00 lakh ha^{-1}	57.99	52.07	55.03	360.71	522.71	441.71	24.85	37.03	30.94	9.00	15.28	12.14
SEm(±)	0.67	0.63	0.36	4.32	4.63	3.28	0.96	1.09	0.78	0.81	0.78	0.62
LSD (P=0.05)	2.05	1.94	1.10	13.30	14.27	10.12	2.95	3.36	2.41	NS	2.40	NS

[1]Average of seven replications

Table 2. Effect of crop canopy structure on disease incidence of betelvine

Treatments (plant population)	Leaf spot : C.O.*Colletotrichum capsici*			Leaf rot : C.O. *Phytophthora* spp.		
	2013[1]	2014[1]	Pooled	2013[1]	2014[1]	Pooled
1.50 lakh ha^{-1}	16.27(23.72)*	11.48(21.45)	14.90(22.68)	13.92(21.87)	9.10(17.28)	11.51(19.76)
1.75 lakh ha^{-1}	16.84(24.15)	13.45(21.20)	15.15(22.80)	17.50(24.69)	9.84(17.99)	13.67(21.68)
2.00 lakh ha^{-1}	16.76(24.09)	20.21(26.62)	18.48(25.42)	14.39(22.26)	14.47(22.31)	14.43(22.30)
SEm(±)	0.67	1.34	0.62	0.57	1.26	0.57
LSD (P=0.05)	NS	4.14	1.91	1.74	3.87	1.74

[1]Average of seven replications.
*Figures in parenthesis represent angular transformed values.

Effect of plant spacing on disease incidence (%) of betelvine

Leaf spot: Minimum leaf spot due to *Colletotrichum capsici* (16.27 %) was recorded in treatment T_1 and maximum in T_2 treatment (16.84 %) in 2013. In 2014 the minimum leaf spot disease (11.48 %) was recorded in T_1 treatment and the maximum leaf spot was recorded in the treatment T_3 (20.21%) (Table 2). The pooled analysis of two years data revealed that the minimum leaf spot disease was recorded in treatment T_1 (14.90 %) and the maximum leaf spot was recorded in the treatment T_3 (18.48 %).

It was noticed that leaf spot disease incidence increased with decrease of plant spacing. This may be due to microclimate developed in minimum spacing helped in spread and infection of diseases.

These results of leaf spot disease of betelvine at different plant spacing showed the following order like: T_3> $T_{2,}$ T_1 (Pooled).

Leaf rot: The minimum leaf rot disease (Table 2) was recorded in T_1 treatment in 2013 and 2014 (13.92 and 9.10 %, respectively) Pooled analysis of two years data revealed that the minimum leaf rot disease was recorded in treatment T_1 (11.51 %). The maximum leaf rot disease was recorded in treatment T_2 (17.50 %) in 2013. In 2014 the maximum leaf rot disease was recorded in treatment T_3 (14.47 %). In pooled analysis of two years data revealed that the maximum leaf rot disease was recorded in treatment T_3 (14.43%) (Table 2).

The results of leaf rot disease of betelvine at different plant spacing showed the following order like: T_3, T_2>T_1 (Pooled).

The results revealed that leaf rot disease caused by *Phytophthora spp* showed different disease reaction in different plant spacing and their differences were statistically significant. With decreasing plant spacing there was a significant increase in disease incidence. The result also confirmed the result of Pawar *et al.* (2006) that minimum plant spacing harbour the leaf rot disease incidence.

From these results it was concluded that a change in microclimate occurred due to a change in plant canopy. By increasing the plant spacing, growth and yield of Betelvine was not increased but incidence of disease is reduced due to changes in micro-climate within the plant canopy.

Correlations between microclimate and incidence of diseases should be made before giving final recommendation to the farmers. However, these results give some information about the effect of plant canopy architecture on disease incidence, growth and yield of betelvine.

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