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Organic management of disease complex of betelvine caused by fungus, *Colletotrichum capsici* and bacterium, *Xanthomonas axonopodis* Pv. *betlicola*

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Abstract
Field trial on organic management of complex disease of betelvine, caused by fungus, *Colletotrichum capsici* and bacterium, *Xanthomonas axonopodis* Pv. *betlicola* was carried out at experimental farm, AAU, Jorhat, Assam. Seven treatment combinations were tried *viz.,* T1:Spraying with *Org-Trichojal* @5 ml/litre, T2: Spraying with bio-agent, *Bacillus subtilis* @ 5 ml/litre, T3: T1 + T2, T4: Spraying with Bordeaux mixture @5000 ppm ,T5: Spraying with Streptomycin sulphate@ 400ppm, T6: Spraying with Bordeaux mixture @5000 ppm + Streptomycin sulphate@ 400ppm, T7: Absolute control. Observation on plant disease incidence and growth parameters were recorded. Result showed that lowest disease incidence (17.50%) of complex disease of betelvine, caused by fungus, *C. Capsici* and bacterium, *X. axonopodis* Pv. *betlicola* was observed when spraying with Bordeaux mixture @ 5000 ppm + Streptomycin sulphate @ 400ppm was done with 74.49% of reduction of the disease over control. Spraying with Bordeaux mixture @ 5000 ppm causes disease reduction upto 72.81%. This was followed by spraying with Streptomycin sulphate @ 400ppm with disease reduction of 69.90%. But plant growth parameters like plant height and leaf size and no. of leaves per plants were recorded highest in T3 where spraying was done with *Org-Trichojal*@5 ml/litre and *B. subtilis* @ 5 ml/litre.

Keywords: Disease complex, *Colletotrichum capsici, Xanthomonas axonopodis* Pv. *betlicola, Piper betle, Trichoderma harzianum, Bacillus subtilis*

Introduction
Betelvine (*Piper betle*) commonly known as paan, is a vine belonging to the family *piperaceae*. It is an important cash crop of India mainly cultivated for its leaves which is used for mastication along with arecanut due to its stimulatory aromatic taste. In India and Srilanka, a sheaf of betel leaves is traditionally offered as a mark of respect and auspicious beginnings. The betel plant is an evergreen perennial plant, with glossy heart shaped leaves and white catkin. The betel plant originated in South East Asia, particularly Malaysia.

It is used in rituals and in Indian system of medicine as cure for many diseases such as congestion, constipation, rheumatism etc. The antioxidant properties of betel leaves is due to presence of phenols especially hydroxychavicol (Dwivedi and Tripathi, 2014) [6]. The chief component of betel leaf is essential oil (0.08-0.2%) called betel oil (Guha, 2006) [7] which also possess antibacterial and antifungal properties. Betelvine cultivation offers perennial source of employment to about 20 million Indian population. The betel leaf is cultivated mostly in South and Southeast Asia, from Madagascar to Papua New Guinea. Total area under production in India is 53,539 ha (Ray, 2008) [11] with annual income of INR 9000 million and in Assam total area under production is 3,763 ha with net annual income of about INR 1767.7 million (Directorate of Economics and Statistics, Assam, 2004-05) [1].

Betelvine is highly susceptible to various diseases and pests which is aggravated by the moist and shady conditions of the plantation, that is prerequisite for good harvest. The diseases of serious proportion includes basal rot (*Sclerotium rolfsii*), foot rot (*Phytophthora parasitica*), wilt, disease complex of betelvine (*Colletotrichum capsici, Xanthomonas axonopodis pv. betlicola*). Leaf spot caused by fungus *Colletotrichum* (Maiti and Sen, 1979) [8] has much similarity to that caused by *Xanthomonas axonopodis* (Patel *et al.,* 1951) and thus is difficult to diagnose in field condition.

In leaf spot caused by *Colletotrichum*, lesions are brownish black surrounded by yellow halo. The only difference with the bacterial disease is the water soaked slimy band on the advancing margin of lesion detected on the leaf surface. The disease complex have been found to be effectively controlled by chemicals such as 0.5% Bordeaux mixture or 0.1% copper oxychloride (Yadav *et al.*, 1993) [15], Streptocycline @ 500ppm but copper containing compounds have residual effect on plants and antibiotics are costlier, thus are not affordable by the farmers.

Thus, organic disease management modules have been evaluated with objectives such as a) to develop effective organic disease management practices for disease complex in betelvine. b) to determine its effect on various plant growth parameters of betelvine.

Materials and Methods

The experiment was carried out at experimental farm, Department of Horticulture, AAU, Jorhat, Assam with seven treatments *viz*., T1:Spraying with bio-agent, *Org-Trichojal* @5 ml/litre, T2: Spraying with bio-agent, *Bacillus subtilis* @ 5 ml/litre, T3: T1 + T2, T4: Spraying with Bordeaux mixture @ 5000 ppm, T5: Spraying with Streptomycin sulphate@ 400ppm, T6: Spraying with Bordeaux mixture @ 5000 ppm + Streptomycin sulphate @400ppm,T7: Absolute control. All the treatments were replicated thrice. Elite planting materials of betelvine were collected from farmers field in Nagajanka area, located in Mariani Tehsil of Jorhat district, Assam, India. Fresh, healthy vines were planted in plot size of 2x2 m^2 with 3 rows and 24 plants in each plot.

For field testing chemicals used were Bordeaux mixture @5000 ppm, Streptomycin sulphate @400 ppm and liquid bio formulations *viz*., *Org-Trichojal* and bacterial biocontrol agents *B. subtilis* were used in the experiment. Before spraying bio formulations were diluted @ 5ml/l of water and applied thrice at an interval of 45 days. The observations on percent disease incidence, percent disease reduction over control, and plant growth parameters after treatment were recorded for each treatment and best disease management module was assessed. Observation on pest associated with betelvine were also recorded during the experimentation.

Results and Discussion

The results for percent disease incidence revealed that the minimum disease complex incidence((17.50%) was recorded in T6 treatment where Bordeaux mixture @ 5000 ppm + Streptomycinsulphate @ 400 ppm was sprayed (3 sprays at 45 days interval) followed by T4 (18.65%) where Bordeaux mixture @5000 ppm was sprayed (3 sprays at 45 days interval) (Table 1). The maximum disease incidence (68.60%) was observed in control where neither chemical nor bioformulation was applied. The percent disease reduction over control was recorded for each treatment and observed that the maximum disease reduction (74.49%) over control was reported in T6 treatment This was followed by treatment T4 (72.81%). The minimum disease reduction (58.53%) was found in control (Table 1). The effect of different treatments of plant growth parameter was observed and the results showed maximum plant height (120cm) in T3 where *T. harzianum* (*Org-Trichojal*) and *B. subtilis* @ 5 ml/ litre was sprayed. This was followed by T1(117 cm) where *T. harzianum* (*Org-Trichojal*) was sprayed @ 5ml/l of water. Minimum Plant height (97.3 cm) was observed in treatment Control. Similarly, for total number of leaves per plant, maximum result was obtained in treatment T 3 (avg. 21.4 nos.) followed by treatment T1(16.7 nos.) where *T. harzianum* (*Org-Trichojal*) was sprayed @ 5 ml/ l of water and lowest number of leaves (12.5 nos.) per plant was observed in treatment T7 (Control). Maximum internodal length (13.4 cm) was found in treatment T3 (Table 2). This was followed by T1treatment (11.6 cm). Minimum internodal length (9.20 cm) was found in T7 treatment.

Higher plant growth parameter observed in bioformulations like *Org-Trichojal* and *Bacillus subtilis* (T3) applied betelvine plot with significantly reduced disease complex may be due to the disease suppression by fungal and bacterial biocontrol agents by production of growth inhibitory secondary metabolites, siderophores, hydrolytic enzymes, like chitinase, glucanases, and proteases, competition, predation and/or induction of host resistance (Pal and Gardener 2006). Many plant associated organism are known to produce auxins and exhibit phosphate solubilization and ACC deaminase activity that promote plant growth by improving root development, thereby eliciting effective nutrient assimilation, soluble phosphate availability and relieving ethylene stress, respectively (Shuai *et al.* 2009) [13]. Furthermore, strain used in the bioformulation used in the present study may also induced IAA activity. These additional characteristics of the strain make it a good candidate for growth promotion of crop plants.

Thus, the present study showed that for organic management of the disease complex of betelvine, spraying of *Org-Trichojal* and *B. subtilis* bioformulations can be done which can also give the better plant growth parameter.

Table 1: Field trial on management of complex disease of betelvine.

Treatment	PDI	Per cent disease reduction over control
T1: Spraying with bioformulation,*Org-Trichojal*@5 ml/litre	28.45 (32.234)	58.53
T2: Spraying with bio-agent, *Bacillus subtilis* @ 5 ml/l	24.65 (29.767)	64.07
T3 : T1 + T2	23.45 (28.963)	65.82
T4 : Spraying with Bordeaux mixture @ 5000 ppm	18.65 (25.585)	72.81
T5: Spraying with Streptomycin sulphate @ 400ppm	20.65 (27.027)	69.90
T6 : Spraying with Bordeaux mixture @ 5000 ppm + Streptomycin sulphate @ 400ppm	17.50 (24.729)	74.49
T7: Absolute control	68.60 (55.919)	-
CD (p=0.05)	4.78	

Table 2: Effect of treatment on plant growth parameters

Treatment	Plant height (cm)	Total number of leaf	Internodal length (cm)
T1: Spraying with bioformulation,*Org-Trichojal*@5 ml/litre	117.0	16.7	11.6
T2: Spraying with bio-agent, *Bacillus subtilis* @ 5 ml/l	114.6	16.4	11.3
T3: T1 + T2	120.0	21.4	13.4
T4 : Spraying with Bordeaux mixture @ 5000 ppm	106.0	12.8	10.7
T5 :Spraying with Streptomycin sulphate @ 400ppm	107.6	14.0	10.9
T6: Spraying with Bordeaux mixture@5000ppm+Streptomycin sulphate @400ppm	98.0	13.5	10.9
T7 : Absolute Control	97.3	12.4	09.2
CD (p=0.05)	1.45	2.34	1.12

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