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# REVIEW ON WILT DISEASE COMPLEX OF BETELVINE FROM INDIA

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***Abstract:*** *Betelvine (Piper betle) is a perennial dioecious creeper cultivated in India for its leaf since time immemorial. It is one among the important high remunerative plantation crops from the point of higher annual income per year and for its wide utility. Plant parasitic nematodes are found in all agricultural regions of the world and betelvine is likely to suffer damage from these parasites causing 3.9 to 40.28 per cent loss in yield. At present, thirty-nine species of plants parasitic nematodes belonging to 15 genera have been reported to be associated with rhizosphere soil of betelvine crop from different regions in India. However, the most common and serious nematode, Meloidogyne incognita (root-knot nematode), is present in almost all the states followed closely by R. reniformis (reniform nematode) and Hoplolaimus indicus (lance nematode). The root knot nematode (M. incognita) alone has been reported to result in 26-38 per cent yield losses. The association of plant parasitic nematodes with other microorganisms like fungi and bacteria often results in disease complexes where damage expression on crop may be additive, neutral or synergistic. The nematodes have been found important and vital in the development of wilt and root rot diseases caused by fungi and bacteria. Hence in the present manuscript considering the importance of betelvine as a commercial crop and also the importance of fungal and nematode disease complex causing much loss to this crop, a thorough review was written on the survey for incidence, pathogens associated and interaction studies involving these pathogens and integrated disease management studies on wilt disease complex of betelvine.*

***Key words:*** *Betel vine, wilt, root rot disease, nematode.*

## Introduction:

Betelvine is important plantation crop grown in India for its green leaves having aromatic, carminative, antiseptic, astringent, madly stimulant, expectorant and exhalent in nature. Besides, betelvine is supposed to act tonic for brain, liver and heart. It clears mouth and throat and helps in digestion by encouraging salivation and neutralizing the excess of acid by lime which is eaten with it. In India, it is grown over an area of more than 55,000 hectares with an approximate annual turnover of about Rs.9,000 million (Das et al., 2016). It is an important cash crop of Andhra Pradesh, Arunachal Pradesh, Assam, Bihar, Karnataka, Kerala, Madya Pradesh etc. Though the crop is highly remunerative, the area under its cultivation has either remained content or is diminishing due to pathogenic fungal, bacterial and nematode parasites besides insects.

Soil and root samples collected from various locations in India have revealed the presence of nematodes like *Meloidogyne incognita, Rotylenchulus reniformis* and *Hoplolaimus indicus* in different states of (Sivakumar and Marimuthu, 1984). So far, 39 species within 15 genera of plant parasitic nematodes have been reported to be in association with betelvine crop from many parts of the country. Among the different nemic diseases of betelvine at present, the root knot disease caused by *M. incognita* seems to be a major problem prevalent in most of the plantations having sandly loam soil, at times causing heavy loss to the farmers. The avoidable yield losses due to *M.incognita* are estimated to be 38 per cent in Tamil Nadu (Jonathan et.al., 1990). Plant parasitic nematodes interact with different groups of plant pathogens, viz. fungi, bacteria, viruses and other nematodes. However of all the interactions of pathogens with nematodes, none is more damaging

to the crops worldwide as the combined effects of wilt causing fungi and plant parasitic nematodes (Francl and Wheeler, 1993). The roots of nematode-infested vines are also found to be affected with other soil borne plant pathogenic fungi, viz. *Sclerotium rolfsii*, *Rhizoctonia solani* and *Fusarium solani*. The higher density of nematodes especially, *M. incognita* predispose the betal roots for the entry of soil borne plant pathogens, which may lead to the wilt syndrome (Jonathan et.al., 1994). Considering the heavy economic loss the nematode and fungus cause on betelvine, this review written on the major aspects of wilt disease complex of betelvine viz., fungi and nematodes associated and their interaction and management.

**Symptoms**

The specific symptoms of damage exhibited by root knot nematodes (*M. incognita*, *M. arenaria*, *M. incognita* var. *acrita*) on betelvine are described by Dhande and sulaiman (1961) and Subba Rao et al. (1993). In general, nematode infested vines are stunted in their growth, show yellow coloured small sized leaves with each vine bearing a few leaves. The aerial roots are swollen and sometimes, form in clusters. When the infested plants are up rooted, deformed roots with prominent galls of varying sizes are noticed. The average size of the root galls developed on varieties grown in Tamil Nadu state ranged from 2-10 mm (Anon., 1984) whereas in Guntur district of Andhra Pradesh, which is one of the major betelvine growing areas, largest Knots (2 to 3 mm x 7 to 25 mm) with a mean of 4x9 mm were observed in the roots developed from the nodes of lowered vines in the second and third year old gardens, planted with local clone, Tellaku (Anon., 1984). Association of burrowing nematode *Radophlus similis* with the yellow disease of betelvine was also reported from the chickmagalur area of Karnataka state (Sundararaju and Suja, 1986; Eapen *et al.*, 1987). The nematode infestation showed prominent symptoms of yellowing of leaves, root lesions and wilting.

**Economic importance**

Because of the worldwide distribution, extensive host range and involvement with fungi, bacteria and viruses in disease complexes, root-knot nematodes rank first among the top ten damaging genera of plant parasitic nematodes affecting the world's food supply (Sasser, 1989). Even though several nematode species have been reported in betelvine, *Meloidogyne* spp. are the most widespread and most damaging plant parasitic group. In India M. *incognita* and *M. jauanica* are reported to attack more than 141 and 232 plant genera respectively. These species prefer hot weather and cause serious problems in regions where, summers are long and winters are short and mild. However severe damage also occurred in north India (Grew and Sharma, 1990). Unlike other crops loss estimates in betelvine are based on leaf yields. In multilocational yield loss trials conducted under the auspices of the All India Co-ordinated Research Project on Betelvine in different State Agricultural University (SAU) centers losses in leaf yield (by weight), due to M. *incognita* ranged from 16.8 to 50.2 per cent (Anon, 1991).

**Plant pathogenic fungi**

Betelvine is subjected to attack by several plant pathogens. The important ones, in terms of direct yield loss, are foot rots due to *Phytophthora parasitica* var. *piperina, F. solani, S. rolfsii, R. solani* and *R. bataticola* and leaf spots due to bacterial pathogens. In addition several fungi are responsible for leaf rotting which can also cause damage in transit and storage. *Phytophthora* rot has been the main pathological problem wherever betelvine is grown, so much so that untrained or inexperienced person tends to ascribe all type of root-rots to *Phytophthora*. However in recent times, association of other fungi in such root-rot disease has been established in many places. *Rhizoctonia* (Chowdhury, 1944), *Fusarium* (Sulladamath et al, 1977) and *Sclerotium* wilts (Palakshappa *et al.,* 1988; Parameshwari and Lingaraju, 2003) and have been the main problems in certain pockets of India.

**Plant parasitic nematode-fungal disease complex**

Venkata Rao *et al.* (1973) observed the manifestation of wilt incidence in a large magnitude at the beginning of the second year of crop growth, along with root-knot nematode symptoms which indicates the possibility of the nematode predisposing the vines to fungal attack. Survey conducted in different districts of Tamil Nadu revealed that the parasitic nematodes are widely prevalent, especially the root knot nematode species such as M. *incognita* which predispose betelvine for *Phytophthora* attack leading to wilt (Anon., 1985). Sitaramaiah and Parvathi Devi (1994) investigated the nematode population, soil micro organisms in relation to betelvine wilt disease caused by *Phytophthora capsici* under field conditions. The results revealed that as the soil microflora (total fungi, total bacteria, total actinomycetes) increased, the per cent change in wilt disease incidence was also increased. The population of root knot nematodes M. incognita was positively correlated with per cent change in wilt disease incidence. A survey conducted in different districts of Orissa showed that the fungus *Colletotrichum* spp. and R. *solani* were found to be associated with betelvine roots infested with root knot nematode, M. *incognita* (Anon., 1995).

**Interaction of nematodes with wilt inducing fungi**

Plant parasitic nematodes are capable of producing recognizable disease in their hosts on their own, Mammen (1974) found that the root knot nematode M. *incognita* is capable of causing betelvine wilt disease in Kerala state. The roots of nematodes infested vines are also found to be affected with soil borne plant pathogenic fungi, *viz. S. rolfsii, C. capsici, P. palmivora, R. solani* and *F. solani* and the bacterium *X. campestris* pv. *betlicola*.

Acharya *et al.* (1987) reported that maximum reduction in height and weight of shoot and root of betelvine cv. Godibangla was observed in simultaneous inoculations with M. *incognita* (1000 juveniles/2 kg of soil), S. *rolfsii* (0.25 per cent Mycelial mat/2 kg of soil) and also with the bacterium *Xanthomonas campestris* pv. *betlicola* (0.25% O.D/2 kg of soil). The incidence of root rot was noticed in all the combined inoculations. Inoculation of potted P. *betle* plants with P. *palmivora,* alone reduced plant height, root length, shoot and root weight and number of leaves/vine. It was concluded that the nematode can predispose the vine to P. *palmivora* which is able to infect through wounds caused by *M. incognita* (Marimuthu, 1991). Ray *et al.* (1993) reported that *M. incognita* interacts with *Colletotrichum* spp. increasing the speed of development and severity of wilt disease of betelvine. Maximum disease occurred when the nematode was inoculated first, followed 15 days later by *Colletotrichum,* or when, both were inoculated simultaneously. It was concluded that M. incognita initiates the disease, providing sites for infection by the *Colletotrichum* spp.

Jonathan *et al.* (1996) reported that combined pathogenic effects of *M. incognita* (5000 juveniles/pot) and P. *palmivora* (50 ml sporangial suspension/pot) on betelvine cv. Karpoori were greater than independent effects of either. Synergistic interactions occurred between the nematode and fungal pathogens on the crop, both in concomitant and sequential inoculations. An increase in vine mortality was observed when the nematode inoculation preceded the fungus. *R. reniformis* (5000 /pot) and *P. palmivora* (50 ml sporangial suspension/pot) were shown to interact synergistically on betelvine cv. Karpoori. The incidence of wilt disease as measured in terms of root rot index was significantly higher when the nematode and fungus were inoculated concomitantly or sequentially. Vine mortality increased significantly both when nematode inoculation preceded fungal inoculation and when both pathogens were inoculated concomitantly (Jonathan *etal,* 1997).

The studies conducted through various centers of AICRP (Betelvine) revealed that root knot nematode alone can bring about losses in leaf yield from 16.8 to 50.2 per cent and with S. *rolfsii,* twig mortality upto 84 per cent as against only 64 per cent due to fungus alone in different locations (Ray,

1998). Reniform nematode has been also shown to act synergistically with *C. capsici* in bringing about root necrosis and rotting upto 40 per cent as against only 20 per cent by the fungus (Ray, 1998).

**Integrated management of nematode fungal disease complex**

A field experiment was conducted to study the effect of organic amendments, nematicide, fungicide and their combination on the crop yield, wilt and root knot diseases of betelvine. The results revealed that maximum yield (13.81 kg = 4270 leaves) was obtained in the beds treated with carbofuran @ 1.5 kg ai/ha + neem cake urea @ 50 + 50 N/ha + 0.5 per cent Bordeaux mixture. The wilt percentage and root rot index were minimum in the two treatments *viz.,* carbofuran and aldicarb @ 1.5 kg ai/ha both with the combination of neem cake and 0.5 per cent Bordeaux mixture. A significant yield reduction, increase in wilt percentage and root knot index were noticed in the untreated control (Anon., 1984).

Integrated control of plant parasitic nematodes including the combined application of neem cake @ 0.5 t/ha along with carbofuran (3G) @ 0.75 kg ai/ha before planting of vines was found to be the best in controlling the root knot incidence in betelvine (Anon., 1987). Application of oil cakes (500 kg/ha) with soil drench of carbofuran (0.1%) and three applications of *P. lilacinus* inoculated oil cakes 500 kg/ha) were at par with carbofuran (1.5 kg/ai/ha) in Assam Agricultural University; Jawaharlal Nehru Krishi Vishwa Vidyalaya; Tamil Nadu Agricultural University, Rajendra Agricultural University and Orissa University of Agriculture and Technology Centers with respect to root knot index and leaf yield of betelvine (Maiti *et al.,* 1998).

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