Summary

Betelvine (*Piper betle.* L.) is an important Commercial crops of Karnataka. This crop supports more than 1.5 million people for their livelihood especially in rural areas, this crop plays an important role in rural economy and rural employment. Since the betelvine cultivation is a labor intensive job, it provides employment throughout the year. The cultivation needs considerable investment and intensive care. Due to heavy investment and intensive care the crop is generally cultivated by small and marginal farmers in small land holdings. A major portion of betel leaves cultivated in India are consumed in the domestic market, only small quantity is exported to U.K. Canada, Kenya, Kuwait, Pakistan and Nepal. The annual turnover of betel leaves is estimated to the worth Rs.800 crore in the stastical year 2000 and it has a good potential of becoming a foreign exchange earner. No such crop is there where the produce can be harvested from the same plant for more than five to six times in a year, but we can do it for the betelvine and hence it is also known as "All Time Yielding" (ATY) crop. So it plays an important role in rural economy and rural employment and hence growing this crop is very economical either as monocrop or as intercrop. Betelvine is mostly cultivated by small farmers, since it is a cash crop plays a major role in "Rural economy". The seventy percent of the crop failure is mainly due to the fungal diseases, since this is a very delicate crop and is easily subjected to wide variety of diseases.

The yield loss due to the disease results in economic decline of rural farmers and also increases rural unemployment. Fungal diseases were the main limiting factors in the betel leaves production, resulting in heavy loss to cultivators, often they were forced to abandon their plantations.

Among the diseases of betelvine the diseases due to soil borne fungi are more destructive and damaging to the crop, where the visible symptoms appears

only after a considerable damage to the plant, where there will be little time to take any measures to combat disease.

From the field studies and isolation studies it was found that the soil borne pathogens like *Phytophthora parasitica, Pythium vexans, Fusarium oxysporum, Rhizoctonia solani* and *Sclerotium rolfsii* always showed their activity throughout the pre-monsoon and monsoon seasons of the year 2000 - 2002 (Table 3.4) (Fig 4.7 to 4.18). The scattered diagram for the paired values of Percentage Disease Incidence (PDI) for wilt caused by the soil borne fungal pathogens of betelvine and the Recovery Percent (RP) during pre-monsoon and monsoon seasons, for *Phytophthora, Pythium, Fusarium, Rhizoctonia solani* and *Sclerotium rolfsii* was shown in Fig 4.19 to 4.28 reveals that the PDI and RP were in the side of positive correlation.

Phytophthora parasitica, Pythium vexans, Fusarium oxysporum, Rhizoctonia solani and *Sclerotium rolfsii* grow well in all these three PDA, HEPDA and SEPDA nutrient medium very well but in PDA they showed very active growth rate followed by HEPDA and SEPDA (Table 4.7) (Fig 4.36).

The pathogenecity studies revealed that the isolated soil borne fungi of betelvine in the study area (Tarikere) were found to be pathogenic and are causing disease, the same were isolated from the diseased plants, thus proving Koch's postulates. The disease symptom due to *Phytophthora parasitica* on the test plant was shown in the Figures 4.30, 4.34, 4.37, 4.56 and 4.59. The disease symptom due to *Pythium vexans* on the test plant was shown in the Figures 4.38, 4.55 and 4.62. The disease symptom due to *Fusarium oxysporum* on the test plant was shown in the Figures 4.43, 4.60 and 4.61. The disease symptoms due to *Rhizoctonia solani* on the test plant was shown in the Figures 4.46, 4.52 and 4.63. The disease symptom due to *Sclerotium rolfsii* on the test plant was shown in the Figures 4.53, 4.64 and 4.65. When these fungal propagules were artificially inoculated they will transmit the disease to healthy host plant.

The plant extracts of *Allium sativum* (Garlic) and *Azadirachta indica* (Neem) were showing antifungal activity against the isolated soil borne fungi of betelvine like *Phytophthora parasitica, Pythium vexans, Fusarium oxysporum, Rhizoctonia solani* and *Sclerotium rolfsii* was given in Tables 5.1 to 5.5 and Figures 4.67 to 4.76.

Both the plant extracts of *Allium sativum* and *Azadirachta indica* were showing antifungal activity at the said concentrations (Tables 5.1 to 5.6), but the overall performance of *Allium sativum* was more than *Azadirachta indica* under in-vitro condition

The Table 4.7 reveals that the soil borne pathogens of betelvine were capable of surviving on the 'non-host' plant residues and showed continued activity throughout the season (Table 3.4) (Fig 4.7 to 4.18). The disease control and management can be chemical, biological and agronomical practices. Though the control of diseases by systemic fungicides are quite promising but the frequent and indiscriminate use of fungicides often leads to atmospheric pollution and development of fungicide resistance in pathogens.In this context, biological control is coming up as an alternative strategy for disease management, which is also environment friendly.

The native isolate *Trichoderma harzianum* was found to be a successful and potential biocontrol agent, as it has parasitised all the isolates of soil borne fungi of betelvine like *Phytophthora parasitica, Pythium vexans, Fusarium oxysporum, Rhizoctonia solani* and *Sclerotium rolfsii* (Fig 4.91, 4.92 and 4.93).

The mass production of Trichoderma inoculum was carried out by using locally available substrates which are cost effective, the substrates includes, paddy straw, saw dust and sorghum grains were used as substrate for preparation of inoculum seeds.The substrate sorghum grain yield more *cfu* ml^{-1} followed by Paddy straw and Saw dust

The significant growth was observed in the plants treated with the Trichoderma inoculum prepared in the substrate paddy straw – sorghum mixture. The cellulose based substrates like paddy straw and sorghum, availability of air pores within the culms, might have resulted in the building of increased conidial concentration of Trichoderma in the soil. The change in routine organic cultural practices, that is by amending soil with the addition of farm yard manure, new soil and the *Trichoderma harzianum* inoculum with cellulose based substrates played a significant role in the overall growth and recovery of the plant. The decomposition of organic matter in the soil was known to increase microorganism activity and suppressing root infecting pathogens (Khanna and Singh, 1974).

This is especially important in connection with root diseases because in these cases besides the interaction between host and the parasite, one factor of soil environment is the soil microbial Population. The rhizoplane and rhizosphere population intimately reacts with the disease causing fungus before it enters the root tissues.

If there were any antagonists present in these regions they will actively influence against the disease causing fungus. Weindling (1932 and1934) recorded the parasitism of Trichoderma on other species of soil fungi like *Phytophthora, Pythium, Sclerotium* and including *Rhizoctonia solani* a common soil pathogens.

Trichoderma harzianum occurs widely in nature in soil substrate and this is being commercialization because of its ability to compete with phytopathogenic fungi and produce toxins. This fungus has been recommended for the control of soil-inhabiting pathogenic fungi like *Fusarium, Rhizoctonia, Sclerotium Phytophthora* and *Pythium* (Hoitink *et al.*, 1997 and Pandey *et al.,* 1999a & 1999b).

Trichoderma harzianum competes in the soil for nutrients and rhizosphere dominance with phyto-pathogenic fungi. In presence of sufficient organic carbon it produces enzymes having lytic effect on target fungi and in contrast in adverse conditions it produces toxins which are equally harmful. *Trichoderma harzianum* is a widely distributed member of the soil microflora and exerts its effect by competing for nutrients and producing toxins against phytopathogenic species.

The *Trichoderma harzianum* was effectively used against several soil borne fungi like *Rhizoctonia solani, Sclerotium rolfsii,* and *Pythium aphanidermatum* (Hadar *et al.,* 1979; Elad *et al.,* 1980; Chet *et al.,* 1981; Elad *et al.,* 1982; Deb and Dutta, 1992; Mehrothra *et al.,*1993; Suseelendra and Schlosser, 1999). The main objective of integrated crop protection (ICP) is the co-ordination of all cultural, biological, ecological and chemical methods in such a way as to obtain the maximum total benefit and to minimize harmful side effects which is due to the excessive usage of pesticides and fungicides in agriculture (Charles, 1997).

Compost acts as suitable substrate for many microorganisms, which includes bio control agents like Trichoderma which suppresses the broad spectrum of soil borne fungal pathogens (Hoitink *et al.*, 1997). The decomposition of organic matter helps in alternation of physical, chemical and biological conditions of the soil and the altered conditions may be reducing the inoculum potential of soil- borne pathogens including *Rhizoctonia solani* and *Sclerotium rolfsii* (Singh, 1983 and Sachin *et al.,*2002). It also improves soil structure, which promots root growth of the host plant, various biochemicals like antibiotics and phenols are released in decomposition, which induces resistance in root system and increase overall growth of the plant (Sachin *et al.*,2002).

Possibilities of disease spread was observed during the field studies due to faulty agronomic practices is as follows

(a). Improper sanitation practices will influence in disease spread like using sewage water for irrigation (Fig 4.86), leaving the infected plant debris as it is on the ground surface (Fig 4.85 and 4.87), will leads to further disease spread (Sadanandan, 1989).

(b). The regular harvesting of the leaves will make sufficient wounds. When the plant grown as inter crop in areca plantation the regular agronomic practices, like weeding, soil turning and harvesting the areca nuts, in these situations, there will be an considerable damage or injury to the plant and make an easy entry through rain splash (Venkata Rao *et al.*, 1969).

Recommendations

- Soil must be evaluated before planting as well as regularly for the presence of pathogenic soil fungi for betelvine.
- Planting disease free clones.
- Regular consent of Plant pathologist is always necessary.
- Proper disposal of infected or dead plant, i.e. by burning.
- Increasing the native antagonists like regularly adding FYM.
- Using Trichoderma which was mass multiplied in paddy straw along with FYM.

- ❖ Immediate lowering of infected betelvine giving first aid to the damaged plant like removing infected part, and infected rhizosphere soil and treating the soil with Trichoderma.

Conclusion

We believe that our past approach to the pesticide and fungicides problem needs a new look. At a time when there is growing demand to do away with chemical poisons, biological control is the best alternative and offers hope for a safe method of dealing with pests and pathogens . However, the task ahead is challenging. Research is needed in order to exploit more fully the use of various forms of organic matter to enhance the biological control of soil borne fungal pathogens. One probable reason that pure cultures of specific target microorganisms may not work under field conditions is that the soil system already contains the maximum number of microbial load that it can support and hence the soil system itself needs to be altered.

The cascade of experiments were done to understand the nature of soil fungi, their behavior in outside the soil environment, since it was difficult to simulate the exact condition of soil environment that naturally exist (Saksena, 1969a and Hillocks & Waller,1997a). The isolates were found to be pathogenic to betelvine and they are potential colonizers on non-host plant parts, they are showing continued activity in the soil and in the host plant throughout the studied years. Pathogens should be controlled before they enter into the destructive phase of crop damage, for this the soil has to be vaccinating with the *Trichoderma harzianum*, which is a potential mycoparasite of soil borne fungal pathogens and this is the only available alternative for chemicals to control the soil borne fungal diseases of betelvine.