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BIOLOGICAL CONTROL OF BLACK PEPPER DISEASES

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ABSTRACT

In black pepper (Pipe nigrum *L) Phytophthora caused diseases are severe especially during south west monsoon season. In the aerial phase* P. capsici *infects leaves, spikes and branches causing defoliation and in the soil phase infection of roots lead to slow decline. Infection of collar leads to sudden collapse of the vine. To control both aerial and soil phase an integrated approach involving cultural, chemical and biological methods is advocated. Antagonistic fungi such as Gliocladium virens and Trichoderma spp. are used to suppress soil populations of* P. capsici *along with chemicals for the control of aerial phase.*

One of the major constraints in black pepper production is the crop losses due to foot-rot or quick wilt disease caused by the soil borne fungus Phytophthora capsici. This disease is weather dependent and occurs during south west monsoon period. Although the fungus is a wet weather pathogen, the damage caused to the underground parts of the plant are expressed after the cessation of rains when soil moisture depletes. The fungus *P. capsici* affects all part of the vine and the nature and extent of damage depends upon the site of infection.

Infection of above ground parts

Black pepper vines produce new foliage after the premonsoon showers during May and the peak production of foliage is attained during July. After the onset of rains the soil moisture increases and temperature comes down. Phytophthora capsici being a wet weather pathogen remains dormant in the soil and act as latest infection, on the roots during intermonsoonal dry period. It becomes active during the favourable weather which occurs during monsoon period. Among the aerial parts, the runner shoots which are produced at the base of the vines and trail on the ground get infected first. The infected tender shoots and leaves produce abundant sporangia which are dispersed by rain splashes to other parts of the vine. Thus the infection spreads from the trailing runner shoots to the entire height of the vine in a gradual hopping pattern. The infection on the leaves are characterised by dark spots with a fimbriate advancing margins of lesions. In each leaf one or more spots appear, which later enlarge and coalese resulting in defoliation. Spikes when infected are shed. Besides foliage aerial stems are also infected causing severe defoliation and spike shedding. The aerial phase of the disease is severe and influenced by the following weather conditions. A daily rainfall of 15.8-23.0 mm, r.h. 81-99% temperature range of 22.7-29.6°C and sunshine hours of 2.8 to 3.5/day. These conditions are invariably achieved during peak monsoon period every year.

Infection of below ground parts

Infection of below ground parts includes root system and collar. When the feeder roots are infected, it results in slow decline, the symptoms being, yellowing, defoliation and reduction in canopy size. Feeder root infection gradually leads to infection of entire root system which culminates in foot-rot. In black pepper roots are arranged in 2 or more tiers. If the infection spreads from the tier closer to the soil at the collar, the vine succumbs to infection within a few days hence referred to as 'quick wilt'. If the infection spreads from the roots of the lower tier of roots death of vines are preceded by yellowing. As long as the main underground stem is intact, new roots are produced and the vine survives albeit with reduced canopy. Thus Phytophthora infection in black pepper is serious and causes severe economic losses.

Use of biocontrol measures

Many of the soil borne diseases are amenable to control by soil inhibiting antogonistic microorganisms which include fungi, bacteria and actinomycetes. The mode of action of these organisms are varied and broadly ciassified into competition, antibiosis and predation.

Competition: Microorganism in the soil compete for nutrients such as carbon and nitrogen. Some bacteria produce siderophones which chelates with iron and thus deprives the competing microorganisms the availability of iron, which is required by aerobic microbes for electron transport system during respiration.

Antibiosis: Several antagonistic microorganisms produce antibiotics which inhibit several pathogenic organisms by antibiosis or by producing fungistatic compounds.

Predation: Some of the antagonistic fungi are endowed with cellulolytic cell wall degrading enzymes which makes them possible to be hyper parasites. Fungi belonging to the genera *Coniothyrium, Gliocladium, Laetisaria, Penicillium, Sporidesmium* and *Trichoderma* are known hyper parasites.

Use of biocontrol agents against black pepper pathogen

Among several isolates of antagonistic fungi tried against P.*capsici, Trichoderma* spp and *Gliocladium virens* were found to be effective both *in vitro* and in field trials. For mass multiplication and application in the field several organic wastes are tried. Partially decomposed coffee husk, neem cake etc. were found to be good carriers. These antagonistic fungi being secondary colonizers, partially decomposed coffee husk form a good base for multiplication.

Another group of microorganisms which form a potential biocontrol agents are the Vesicular Arbuscular Mycorrhiza (VAM). These obligate symbiotic microorganisms were found to enhance growth of plants by increased uptake of water and nutrients. In black pepper incorporation of VAM in nursery mixture has shown to increase rooting of cuttings and enhanced growth and dry matter production. VAM colonization of black pepper roots prior to challenge by three pathogens viz. *Phytophthora capsici, Radopholus similis* and *Meloidogyne incognita* either alone or in combination offered better protection of root system than uninoculated plants.

Both the *P. capsici* and *M. incognita* prefer the zone of elongation of rootlets. If this portion is already colonized by VAM it prevents pathogen entry. Secondly the altered physiology of colonized roots prevent the moulting of second stage larva of *M. incognita* into adult thereby reducing the chance of gall formation. In case of *R. similis* the protection is by enhanced production of roots, thereby the root damage caused by *R. similis* is compensated by enhanced production of roots.

Integration of biocontrol in the management strategy of black pepper diseases

The management of *Phytophthora* diseases of black pepper involves integration of cultural, chemical and biological control measures besides growing of disease tolerant lines. The integrated approach aims at reducing pathogen population by modifying the environment to disfavour pathogens and increase resistance of hosts.

Cultural method/Ecological method

Infected plant material forms a major source of inoculum in a black pepper garden. Sanitation is one way to reduce pathogen population. Secondly modifying the microclimate in a black pepper canopy by lopping of branches of shade trees/standards which facilitates penetration of light and reduction of humidity which favours pathogen multiplication. Minimum disturbance to the soil by avoiding digging of inter spaces and covering the basins with mulch also reduce the change of soil splashes. It was observed that spread- of foot-rot disease is rapid in plots where weeds are removed completely, than the plots where grass/ weed cover was maintained. Soils with good drainage had less incidence than ill-drained soils. So, maintenance of grass cover in the interspaces and provision of adequate drainage would reduce the incidence of disease.

Cultivation of mixture of cultivars

In black pepper monocropping with a single high yielding variety like Karimunda which is highly susceptible must be avoided. Although there is no variety or cultivar which is resistant some cultivars like Narayakodi, Kalluvally are some what field tolerant. Application of organic cakes like neem cake @ 1kg/vine/year is suggested. This besides serving as nutrient, supports soil microflora especially *Trichoderma* spp and the neem oil has nematicidal property.

Chemical control

Since the fungus is capable of infecting all parts of the vine, the ecological control measures suggested reduces the soil population of pathogens. To prevent the aerial infection prophylactic sprays with 1% Bordeaux mixture or 100 ppm metalaxyl or 2000 ppm phosphoric acid is suggested.

Biological control organisms

Trichoderma spp and *Gliocladium virens* were found to suppress *P. capasici.* These organisms are multiplied on sorphum grains and mixed with neem cake and applied to the soil. Application of biocontrol agents along with the forementioned measures would minimise the incidence of *Phytophthora* diseases on black pepper. Another important factor is raising of plantation from disease free seedlings. The black pepper cuttings must be raised from pathogen free soils after fumigation. VAM cultures may be incorporated to enhance rooting and growth. These cuttings when planted to the field, wherein biocontrol agents such as *Trichoderma* spp and *Gliocladium virens* are added to the pits.

Among the diseases of black pepper, *phytophthora* incited ones are most severe. The soil phase of the disease may be controlled by modifying the soil environment by addition of organics and biocontrol agents. To prevent aerial phase infection still chemicals have to be used. Thus, an integration of all the methods suggested above will go a long way in minimising the crop losses caused by this fungus.