ECO-FRIENDLY DISEASE MANAGEMENT STRATEGIES IN SPICE CROPS

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Disease problems are serious in spice crops and have been recognised as major production constrains. *Phytophthora* foot rot and slow decline in black pepper, capsule rot ('Azhukal') and clump rot in cardamom, rhizome rot in ginger and turmeric and fusarial wilts in cumin and coriander are serious soil borne diseases that take a heavy toll of the crops incurring heavy losses. High degree of host resistance is not available in any of these crops. Chemical control though to some extent reduce the disease, it is not cost effective in many cases. Spices being export oriented even traces of pesticide residues would affect the trade. Besides, the agro-chemicals applied are prone for leaching due to heavy rainfall. Many of these diseases being soil borne, the targetability of the fungicides to the pathogens which lie in deeper layers of soil is a limiting factor.

In view of these factors, biocontrol programmes to manage these diseases have been intensified. Biocontrol becomes an important component of integrated disease management. This being eco-friendly and slow in action compared to agrochemicals, it is essential to strictly adhere to cultural practices that would reduce the disease incidence, in order to realise optimum results.

Ecology of biocontrol agents (BCA's)

Biological control agents (BCA's) are present in native soils and specially in the rhizosphere and rhizoplane of the host plants. Their population level in the soil is also correlated to the health of the plants. It is desirable to test the native isolates and select the efficient ones. Since they are present in low population, further augmentation/boosting up their population to reach a higher stability through artificial application is the present strategy in biocontrol. Potentiating the efficacy of the biocontrol agents through biotechnological approaches is being tried in various labs.

MODE OF ACTION

Trichoderma spp. and *Gliocladium* :

Suppression of Pathogen populations by one or many of the following methods viz., competition, antagonism, antibiosis, predation and hyperparasitism, are the recognised modes of action of these biocontrol agents. *Trichoderma* and *Gliocladium* are known to produce both voltatile and non-volatile antibiotics which are inhibitory to majority of the target pathogens. Besides they also infect the pathogen (mycoparatism/hyper paratism). *Trichoderma* spp. are known to cause lysis of host hyphae through production of *glucanases* cellulases and chintinases and thus disentergrating the pathogen.

Vesicular arbuscular mycorrhiza (VAM)

VAM acts indirectly in disease suppression. VAM increases root regeneration and consequently increase the uptake of phosphorous and other nutrients. Besides, they also alter the host metabolism in such a way that the plants develop defence mechanism. Negative effects of VAM in disease suppression also have been reported in some cases.

Flurescent pseudomonads

Pseudomonas fluorescens is known to produce a *siderophore pseudobactin* that deprives the pathogens of iron. Besides, it is also known to produce antibiotics like chlorinated pyrole that are inhibitiory to pathogens like *Pythium*. *Bacilus subtilis* another biocontrol bacterium is also known to produce antibiotics that are deleterious to plant pathogens.

NURSERY MANAGEMENT

Trichoderma spp. *Gliocladium virens* and *glomus faciculatum* (VAM) are highly effective in suppressing the pathogen in black pepper nursery. Plants treated with theme were found to be healthy and robust and their establisment in the field was above

90 per cent. Soil application of these organisms either to nursery beds or to the nursery mixture is simple and cost effective. In the case of cardamom and ginger seed treatment was found to be effective. *Glomus fasciculatum* suppressed root rot caused by *P. capsici*, and nematodes by *R. similis* and *M. incognita* in black pepper.

PREPLANT TREATMENT

Application of biocontrol inoculum to the planting pit along with FYM or compost resulted in good field establishment of black pepper and the plants were robust and healthy. Pretreatment of nursery beds with the biocontrol inoculum resulted in recovery of as high as 70-93 per cent plantable vigorous seedlings in cardamom.

FIELD APPLICATION

Biocontrol agents raised in the carrier media can be applied to the field specially in the case of black pepper, cardamom and ginger. The rate of application depends on their inoculum load in the carrier media. Similarly field application of *T. harzianum* raised in coffee husk has been reported to be highly effective in checking capsule and clump rot of cardamom, rhizome rot in ginger and root rot in black pepper.

Soil amendments like neem/pongamia/maroti cakes would further help in enhancing the population of the biocontrol agents specially of *Trichoderma* and *Gliocladium*.

SOLARISATION

Soil solarisation increases the efficacy of biocontrol agents. Soil solarisation involves tarping the moist seed beds in the field with transparent polythene sheets and sealing it on all the sides. This would ensure build up of soil temperature as high as 50°C. This high temperature would kill many of the soil-borne pathogens besides suppressing weed growth. Nursery mixture can also be solarised. Field application of biocontrol agents or fortification of nursery mixture with these were found effective in suppression of rhizome rot of ginger and also root rot in black pepper nurseries.

COMPATIBILITY OF BCA's WITH AGROCHEMICALS

In general copper fungicides and some of the dithiocarbamates are

Table 1 : Important diseases of spices, their pathogens and potential biocontrol agents

Crop	Disease	Pathogen	Candidate Biocontrol agent
Black pepper	*Phytophthora* foot rot	*Phytophthora capsici*	*Trichoderma* spp. *Gliocladium* spp.
	Slow decline	*Radopholus similis*	*Vesicular arbuscular mycorrzhia* (VAM)
		Meloidogyne incognita	*Flourescent pseudomonads* *Paeciliomyces lilacinus* (VAM)
Small cardamom	Capsule rot	*Phytophthora meadii*	*Trichoderma harzianum* *Bacillus subtilis*
	Clump rot	*Pythium vexas* *Rhizoctonia solani*	*Lateisera avavlis* *Trichoderma* spp. *Gliocladium virens*
Ginger	Rhizome rot	*Pythium aphanidermatum* *P. myriotylum* + *Fusarium solani*	*Trichoderma viridae* *T. vi[illegible]ae* *T. hamatum*
		F. oxysporum f.sp. *Zingiberi*	*G. virens* *Pythium acanthophoron*
Turmeric	Rhizome rot	*P. graminicolum* *P. aphanidermatum*	Not tested but above BCA's would be effective.

inhibitory to Trichodermas and Gliocladiums and also to VAM. However, fungicides like metalaxyl and potassium phosphonates are not inhibitory to these. These can be effectively utilised in integrated disease management.

MULTIPLICATION OF BIOCONTROL AGENTS (BCA's)

Trichoderma and *Gliocladium*

Locally available low cost organics can be made use of for their multiplication. These two fungi can be multiplied on sorghum seed, coffee husk, coir husk or saw dust. The wet media can be taken in poly propylene bags of convenient size, sterlised and inoculated with BCAs. The fungi will grow in the carrier media vigorously in 10-15 days. Coir husk supplimented with coconut water gave good growth and sporulation. Recent studies have shown that coconut water supported good growth and sporulation of *Trichoderma/Gliocladium*.

Vesicular Arbuscular Mycorrhiza (VAM)

This is a symbiotic fungus that lives on the roots and is not amenable for culturing on artificial media. The association of VAM on black pepper, ginger and cardamom and many of the plantation crops has been established. *Glomus fasciculatum. Gigaspora margarita* and *Acaulospora laevis* are some of the VAM fungi associated with spice crops. At present these can be multiplied on the five roots of graminaceous hosts. At Indian Institute of Spices Research (IISR), VAM is multiplied on sorghum roots. For this sorghum is sown in sterile soil in earthern pots. Later the spore inoculum can be added to the pots. The plants can be grown for about three months. Later the tops are removed and roots are cut into bits. The root bits along with soil becomes VAM inoculum. Efforts are in progress in various labs to mass multiply them on axenic root culture and also in artifical media.

Initial inoculum can be obtained by isolating the spores from the soil and roots through wet sieving. Subsequently the individual spore of each species can be picked up and multiplied on grass to raise the base cultures.

Several commercial organisation are now marketing the biocontrol products. Department of Biotechnology, Government of India, New Delhi, has taken up a Mission Mode Project in popularising biocontrol programmes in the country. At present, this programme is in operation at IISR, Calicut for the control of soil-borne disease of spice crops.

Biocontrol definitely is a viable proposition in checking the soil-borne diseases specially under low disease pressure. Like agrochemicals these are to be applied periodically to maintain their population stable that would ensure their suppressive ability of the pathogen. However, under high disease pressure specially during heavy monsoon the results would not be impressive. Hence, integrating biocontrol with compatible agrochemicals would be a viable proposition in a long run.

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