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INTEGRATED DISEASE MANAGEMENT OF QUICK WILT (FOOT ROT) OF BLACK PEPPER (PIPER NIGRUM L.) CAUSED BY PHYTOPHTHORA PALMIVORA 'MF4' (P. CAPSICI)*

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Quick wilt or foot-rot disease is a major constraint in black pepper production in the pepper growing countries like India, Indonesia and Malaysia etc. The estimated global loss due to this disease is about $ 4.5-7.5 million per annum. A recent survey carried out by National Research Centre for Spices in Calicut and Cannanore districts of Kerala showed 2.5 and 9.5% vine death annually, resulting in a loss of 120 and 908 metric tonnes of black pepper respectively.

ETIOLOGY AND EPIDEMIOLOGY

The disease is caused by 'Phytophthora palmivora' *MF4* (P. capsici), *(morphological form 4) which is soil-borne and is distinctly different from* Phytophthora *spp. infecting rubber, arecanut, coconut and cardamom. All parts of black pepper are prone to infection. Disease is generally noticed during May-August period coinciding with South-West monsoon. Disease incidence and spread are positively correlated with rainfall. Low temperature (22.5-29.6°C), shorter duration of sunshine hours (2.4-3.5 h/day), high and well distributed rainfall (15.8-25.0 mm/day) and high relative humidity (81-99%) are highly conducive for the disease development. The disease is a compound interest type and shows non-random type of spread around the previously infected plants. The fungus can survive in the soil for about 19*

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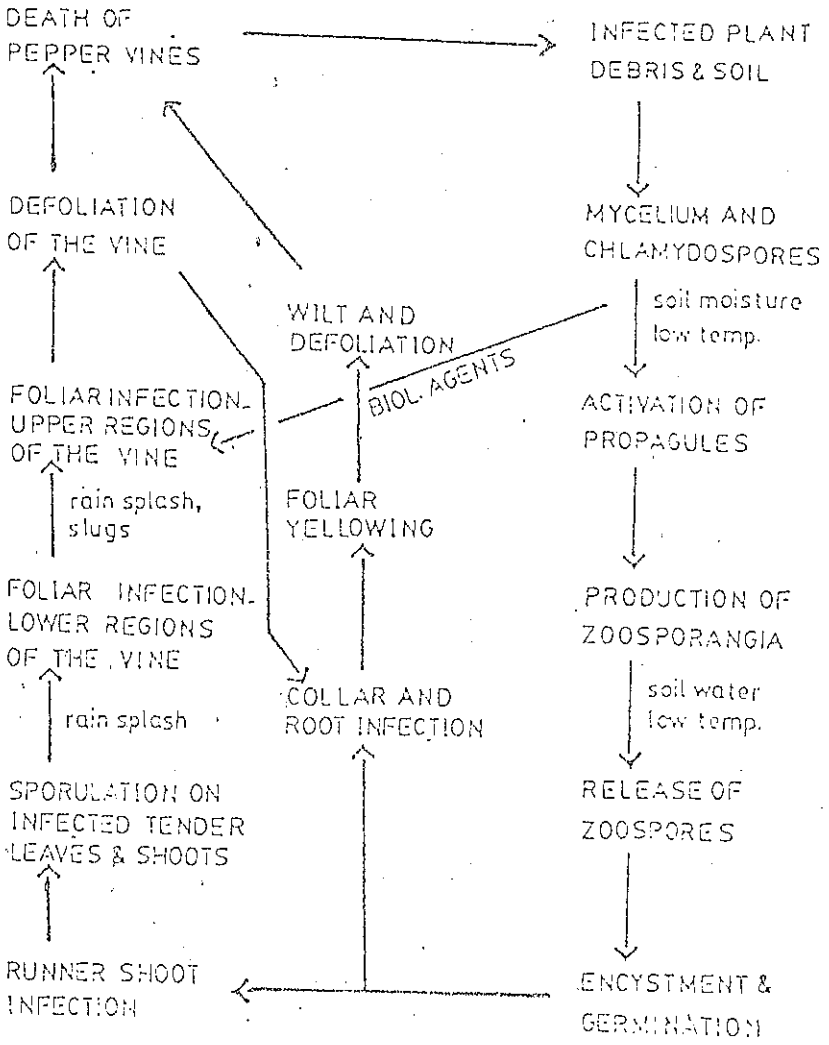
months and so can perennate in the plantation from season to season. Infected and dead vines and soil with infected plant debris serve as the primary source of inoculum. The inoculum build up in a given site depends on the type of soil, its moisture holding capacity and prevailing micro climate. The disease mainly spreads through soil water and also aerially through rain splashes. However, passive transportation, though less important practically, can also occur through slugs and termites. The micro-environmental conditions in a given area determine the foliar infection and its severity. In majority of the areca-black pepper mixed crop stands and also in pure pepper plantations, the infections are initially noticed with the onset of monsoon during May-June period, on tender runner shoots spreading on the ground. The infected tender stems or leaves rot and promote abundant sporulation. With constant rain splashes, the pathogen spreads first to the leaves of the lower region of the bush and then gradually to the upper region in a stepwise fashion and causes defoliation. The infected plant debris helps in survival and perennation of the pathogen (Fig. 1).

SYMPTOMS OF THE DISEASE

Aerial infections are noticed on leaves, stems and spikes. On leaves, infection starts as dark brown water soaked spots that expands rapidly with an advancing fimbriate margin and often showing concentric zonations. Under highly humid and continuous wet conditions these zonations are not seen. Alternate wet and dry conditions produce zonate spots. On the stem, infection starts as dark brown lesions which enlarge gradually causing rotting of the stem. This results in defoliation and death beyond the point of infection. Immature spikes are also infected at the stalk region or at any other portion of the spike. The infected stalk or the berries rot and drop off. Foliar infection once noticed spreads to the entire height of the bush due to spread by rain splashes. Foliar infection is more severe in areca-black pepper mixed cropping system because of the highly favourable micro-climate than in pure crop.

DISEASE CYCLE OF QUICK WILT OF BLACK PEPPER (PHYTOPHTHORA PALMIVORA)



FOOT ROT/ROOT ROT

When infection occurs at the basal portion of the main stem of the vine (foot) at the soil level or on the root system it is fatal and results in death of the vine within a period of 10-15 days and hence the name 'quick wilt'. Infection starts as a discoloured wet patch which becomes slimy. The infection spreads deeper in to tissues and extends to the considerable length of the stem and rots emitting foul smell. Foliar infection also occurs when runner shoot infection reaches the main stem. This gradually spreads to the roots. However, infection starting from the root system and extending to the main stem is also noticed occasionally. The foot rot or root rot infected vines in early stages show foliar yellowing, which intensifies with the progress of the disease. In advanced stages, the leaves become flaccid and fall down. The stems break off at nodal regions and gradually the whole vine collapses. Foliar infection and collar infection may occur alone or in combination depending on the micro-climate in the garden.

DISEASE MANAGEMENT

Integrated disease management involving chemical, cultural and biological methods besides host resistance is perhaps the most ideal strategy to combat any plant disease. The measures to check the Phytophthora infection in black pepper are detailed below :

Clean Nursery Stock

Whenever a new plantation is started, it is essential to start with disease free rooted cuttings. This reduces the spread of the pathogen and subsequent inoculum build up in the garden. Where conventional method of raising three noded rooted cuttings is adopted, collection of runner shoots from an infected garden should be avoided. It is desirable to raise the rooted cuttings in fumigated nursery mixture.

CULTURAL PRACTICES

Phytosanitation : In a soil-borne disease of this type strict phyto-

sanitary practices are of pivotal importance to reduce the chances of infection. The dead and dried up vines in the plantation should be systematically removed and burnt. Soil at the spots from where the dead vines are removed should be drenched with 5-10 l of copper oxychloride solution (0.2%). Replanting in these places may be avoided for atleast an year.

Microclimate is the deciding factor in the incidence of quick wilt and practices that reduce or alter such conditions should be adopted. Lopping of the branches of the shade trees in a plantation, ensures enough sunlight penetration and reduces humidity within the garden.

Pruning of runner shoots: In a known infected garden runner shoots are prone to infection during May-June. Such infected runner shoots form the main sources of secondary spread. Hence runner shoots should be tied back to the main bush or pruned off before the onset of monsoon. The basins should be covered with a thick dried leaf mulch so as to prevent the new runner shoots coming in contact with soil.

Since water stagnation favours the disease better drainage in a plantation has to be ensured.

Disease spread is rapid in plantations where clean cultivation (without a grass cover) is practiced compared to plantation where grass or legume cover crop is retained. In view of this, it is advisable to have a cover crop in the garden. Cover crop might be reducing the soil splashing and the movement of disease propagules. It is also possible that the build up of microbial population suppressive to Phytophthora *might be responsible for the lower disease incidence under the cover crop conditions.*

Movement of personnel from diseased to healthy garden and usage of the same farm implements used in the diseased garden should be avoided in healthy garden unless they are cleaned with a disinfectant.

Minimum tillage is an important concept in pepper. Digging

operation should be minimum because injury to the root system will enhance the chances of infection. In areca-black pepper plantations, digging is a regular practice. To reduce the chances of injury to pepper root system, digging operation should be avoided in the portion/sector where maximum pepper root system is distributed. Hence utmost care should be exercised during this operation to avoid any injury to the underground parts of the vines.

CHEMICAL CONTROL

Application of Bordeaux paste (10% mixture) to the collar, drenching the soil at the base of the vines with 2-5 l of 0.2% copper oxychloride, and spraying the foliage with 1% Bordeaux mixture, once during May-June (pre-monsoon treatment) and again during August-September period (post-monsoon treatment) as a prophylactic measure, is essential to reduce the disease incidence. New flush starts emerging with the fresh monsoon showers. It is desirable to apply the first round of spray after first 2-3 monsoon showers in order to cover the maximum amount of new foliage. The new flushes emerging after the first round of the spray remain vulnerable to infection. As such the timing of the spray should coincide with maximum emergence of new flush, and this differs from place to place especially in the plains and high ranges.

In view of the heavy rainfall during South-West monsoon and consequent leaching off of the contact fungicides like Bordeaux mixture, systemic fungicides with selective action on Phytophthora, *and with high efficacy in disease control were tested. Among the three systemic fungicides namely metalaxyl (Ridomil), fosetyl-Al (Aliette) and Terrazole both as foliar spray as well as soil drench, metalaxyl-ziram and Aliette were found to be highly effective in checking the disease incidence under field conditions. Besides, soil application of granular formulations of metalaxyl (Ridomil 5G) @ 20 g/vine was equally effective. Application of the systemic fungicide is recommended only once or twice in the season and can't be used indiscriminately to avoid development of fungicide resistances by* P. palmivora. *Once the commercial formulations are available in the market, this fungicide becomes*

an important component in the integrated disease management programmes.

DISEASE RESISTANCE

Based on the studies carried out at NRCS, the cultivars Narayakodi, Kalluvally, Uthirankotta and Balankotta were found to be comparatively tolerant to the disease. Besides some of the progenies from open pollinated cultivars and a few hybrids found to be tolerant to Phytophthora *are now under field evaluation. Intensive screening programmes to identify types with high degree of resistance coupled with high yield are in progress. The diseaes resistance forms a major component of the integrated disease management programme.*

FUTURE OUTLOOK

The plant parasitic nematodes viz., Radopholus similis *and* Meloidogyne incognita *are found to play a major role in the slow wilt disease of black pepper. However, their role and their interaction with* Phytophthora *are little understood. Similarly studies on the interaction of VAM associated with black pepper and* Phytophthora *needs to be studied. Identification of cultivars with horizontal resistance and high productivity, organic amendments that support optimum microbial population that supress* Phytophthora, *exploiting hypovirulence if any in* Phytophthora *for disease control are some of the priority programmes. Isolation and field testing of potential antagonists of* Phytophthora *and standardising cheap and cost effective agronomic practices that ensure optimum health and productivity of black pepper are the lines of work that hold promise.*