Annexe VI

ROOT ROT AND STEM BLIGHT ON BLACK PEPPER IN BRAZIL.

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INTRODUCTION

Black pepper (*Piper nigrum*, L.) is affected by a wide range of diseases, but it is root rot and stem blight also known as Fusariose, Mal de Mariquita and lately also as *Fusarium* wilt due to symptoms on infected plants in late stage of infection that has become the most important disease. It is caused by *Nectria hæmatococca* f. sp. *piperis* (anamorph *Fusarium solani* f. sp. *piperis*). This pathogen, to date, is restricted to Brazil and has caused severe losses since 1957 when it was isolated for the first time from roots of infected plants (Albuquerque, 1961).

Once infected, black pepper plants decline and die, More than 5,000.000 plant have been lost in total corresponding to a loss of about 9,4 million dollars assuming the present price of US$ 1,250.00 per tonne and an average production of 1,5 kg/vine. However, the loss is higher if one takes into account the reduction in yield per unit area and the present low price per tonne in the international market.

Since the pathogen was first isolated from black pepper tissues in late 1957 many attempts have been made to control the disease.

In the 1960s efforts were concentrated towards developing resistant rootstocks from within the wild pepper population to control root infection. At that time, several species were tested . *Piper colubrinum*, Link was chosen due to its high compatibility, over 80%, with black pepper tissues (Albuquerque, 1968 a). Although ingrafted plants have shown vigorous growth and production higher than non ingrafted ones, after four years they begin to die due to late incompatibility (Albuquerque & Condurú, 1971; Albuquerque, 1968 b)

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When the outbreak of stem blight occurred in pepper plantations in 1968 in Tomé-Açú, the most productive area, research aims had to be reassessed and directed towards the control of this new form of Fusarium infection. Soon, the role played by infected stem cuttings in spreading the disease was noticed due to records of it in different areas far from Tomé-Açú, which correlated with the movement of both, people and planting material.

As the most efficient fungicides like benomyl, carbendazin, thiabendazole and captafol had only a fungistatic effect against the pathogen, the brazilian government has initiated an alternative strategy of germplasm diversification through exchange with overseas countries....., mainly India, the centre of origin of black pepper.

Germplasm introductions began after 1970 from Mayaguez, Puerto Rico through the United States Department of Agriculture (USDA). Brazil now has a germplasm collection which holds the following materials:' cultivars of black pepper, Balankotta, Belantung, Bragantina (ecotype of Panniyur-1), Chumala, Guajarina (ecotype of Arkulan Munda), Iaçará-1 and Iaçará-2 (promising lines originating from open pollination), Karimunda, Kottanadan-1 and Kottanadan-2, Kuching, Kuthiravally, Perumkodi and Trang; wild species, *Piper aduncum*, *P. attenuatum*, *P. betle*, *P. cariconnectivum*, *P. hirsutum* and *P. colubrinum*.

SYMPTOMS AND AETIOLOGY

Root rot and stem blight as referred to as Fusarium wilt, both caused by *Nectria hæmatococca* f. sp. *piperis* (anamorph *Fusarium solani* f. sp. *piperis*) are the major problem of pepper cultivation, each causing greatly reduce productivity.

Fusarium infection may start either on roots or aerial parts If root infection occurs the leaves become yellowish and flaccid, falling prematurely. As consequence of a decrease in turgor pressure the internodes turn yellow and die back to a lower node.This progressive loss of branches leads to total desiccation. There is an absence of rootlets and as the disease progresses most of the root system become necrotic. Frequently necrosis may extend up to 30 cm above ground and in this case plants appears weak, and make little growth (Albuquerque, 1961, 1964, 1980).

The first sign of aerial infection is the occurrence of yellow branches in an otherwise vigorous plant. Dark lesions, initially covering one or two nodes spread rapidly causing a blight of several stems of the whole plant. In an advanced stage a brilliant black exudate appears at the base of the stem (Albuquerque & Duarte, 1972, 1977a; Fukutomi *et al.*, 1981c).

In the sexual stage the fungus produces perithecia globose, firstly red, later light brown. The asci are cylindrical and later they become clavate originating internally eight ellipsoid to obovate ascospore, hyaline, slightly constricted at the single central septum with longitudinal striation.

The anamorph stage produces elliptical and hyaline microconidia clustered in heads. Macroconidia are hyaline, varying from 32 µm - 61 µm X 4 µm - 10 µm with 3 to 6 septa. Chlamydospores are globose, smooth walled formed intercalarily or terminally, originating from modifications of mycelia and spores.

The formation of perithecia and macroconidia is promoted by sunlight and artificial daylight. Perithecia are not formed in darkness.The species is heterothallic and perithecium formation requires the presence of two mating types, strain A or (-) and strain a or (+).

There is some evidence of variation in pathogenicity within the natural population of *F. solani* f. sp. *piperis*, notably the existence of three physiological types characterized by different pigmentations in culture and the induction of different intensity of symptoms on inoculated stem cuttings. Type III isolates which are the most virulent, import a dark red colour to culture media and cause large lesions and profuse sporulation seven days after inoculation (Duarte & Albuquerque, 1979 a).

EPIDEMIOLOGY

F. solani f. sp. *piperis* was known as a pathogen only of different cultivars of Piper nigrum, but recently it was detected infecting roots of *P. aduncum* different localities in the state of Pará and in the Dominican Republic.

In humid environments masses of conidia formed on infected tissues of the roots and stem bases are dispersed by water to health organs of other plants. In stems the infection may start after germination and penetration of spores or from growth of latent mycelium into plant tissues. Colonization starts from the base of the plants moving towards the top. At that stage, a gelatinous substance is formed blocking vessels, thus affecting translocation of water and minerals. Spore formed on infected stems are disseminated by wind, agricultural machinery and pepper growers during harvesting, initiating secondary infections (Duarte & Albuquerque, 1986)

Infections of the root system and organs above soil occur during the rain season (December-May), although during that period plants retain green leaves without any visible symptoms.In the dry season the number of visibly infected plants increases progressively. Ascospore dispersal of the fungus plays an important role in the incidence of the disease for they are easily carried to upper parts of the vines on air current and can invade tissues through the nodes (Hamada *et al.*, 1988)..

In poorly drained soils the disease appears in plantations of three to four years old and may cause losses mainly in crops managed without additional effort going into its cultivation. Improving drainage of heavy wet soils is important, as is the breaking up of light soils that have impermeable layers close to surface. Suppressive soils have not yet been detected nor has it been possible to select organic materials for bending with mineral fertilizers or of acting as a disease suppressive soil amendment.

INTEGRATED DISEASE CONTROL

Pesticide usage

Chemical control is achieved by treatment of stem cuttings, nursery soil and by field spraying. Among several fungicides tested benomyl, carbendazin and thiabendazole have all efficiently controlled the pathogen (Silva *et al.*, 1973; Duarte & Albuquerque, 1979b, 1980). Stem cuttings collected from infected plants may show up to 84% infection when grown from mature stems and 10% when grown from herbaceous ones. This results supports the recommendation for chemical treatment of stem cuttings by immersion in aqueous solution of benomyl (0,05%), carbendazin (0.06%) and thiabendazole (0.06%) for 30 minutes before planting(Duarte & Albuquerque, 1984).

In field these products are mostly preventative and fortnightly reapplication is necessary to control the disease. When the disease reaches 15% within a plantation, even spraying with efficient fungicides like benomyl or thiabendazole, ceases to be effective and most plants eventually die. Strains of fungicide-resistant *Fusarium* have not yet been found in the native pathogen population. If infection starts trough the root system diseased plants are best eradicated.

Cultural practices

The extent to which infection is affected by application of chemical or organic fertilizers is not clear. It has been suggested that minor nutrient deficiencies such as those of zinc, iron and boron and the lack of equilibrium between potassium and phosphorus in relation to calcium and magnesium can contribute to enhanced infection rates.

Mulching of pepper using grass leaves, rice hulls and sawdust can increase soil moisture in the rainy season as well as infection rates, allowing a rapid establishment of disease epidemics once plants reach an age of steady production after about four or six years (Albuquerque, 1968c). To avoid a rapid spread of the disease but yet retain the advantage of mulching on growth and production, a partial protection of the soil with grass leaves is recommended.

Resistance

One approach to *Fusarium* disease control is to diversify the genetic base of the material in Brazilian pepper plantations. Hitherto neither resistant nor tolerant germplasm has been found among P. nigrum cultivars although it occurs among wild species such P. colubrinum which show high levels of resistance. Wild species have been used as rootstocks but plants generally die after four years due to a late tissue incompatibility. For this reason grafting as an agricultural practice was abandoned but it is still used for conservation of highly susceptible germplasm. Although new germplasm has recently been introduced, the population obtained has not shown resistance to the pathogen *F. solani* f. sp. *piperis*.

Despite the availability of 18 different genotypes this is a very small population with which to start a breeding programme. Farming system which rely on vegetative propagation prevent increases in genetic variability. To increase this variability pepper must be grown from seeds but for that, time is required and the resultant population is heterogeneous and late into production.

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