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PHYTOSANITARY CONDITIONS OF BLACK PEPPER CULTIVARS CROP IN BRAZIL

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INTRODUCTION

The search for new black pepper cultivar (*Piper nigrum* L.) came from the need of controlling the root rot disease caused by *Nectria haematococca* f. sp. *piperis* (anamorph: *Fusarium solani* f. sp. *piperis*). As India is the centre of origin of black pepper and in the absence of a formal exchange of black pepper germplasm between both countries, Embrapa used an alternate strategy via Asian consultant to introduce new acessions in order to form a base collection to be tested in infested areas by the pathogen and have recorded their productivity in order to recommend the more promising acessions to the pepper farmers.

Between the date of introduction and the availability to pepper growers has taken about 8 to 20 years, because the introduced stem cuttings were weak or came from thief branches. Before those genotypes being planted in the field they have to be cloned several times until being selected for foliage architecture and production.

Pioneers and enthusiastic pepper growers were invited to test the new cultivars, under their farm conditions, recording growth rate, precocity, disease incidence and productivity until the fourth or fifth year of age when the more productive cultivars were recommended.

From 1982 to 2001 six cultivars viz. Bragantina (Panniyur-1 ecotype), Guajarina (Arkulan Munda ecotype), Kottanadan-1, Iaçara-1, Kuthiravally and Apra, were recommended. Among 33 introduced genotypes resistance source to *F. solani* f. sp. *piperis* has never found. However, several cultivars showed resistance to *Fusarium oxysporum*, causal agent of yellow wilt, a new disease that is affecting cultivar Guajarina (Arkulan Munda ecotype), only.

BLACK PEPPER CULTIVARS CROPPED IN BRAZIL

Brazil has a germplasm collection that holds 33 acessions (Poltronieri *et al.*, 2001). The first accession was introduced in the 17th century, during Portuguese colonisation, while the last one occurred in 1994. Only seven out of 33 accessions have been planted by pepper holders and, although no resistance source against *Fusarium solani* f. sp. *piperis* has been found those cultivars have shown high yield, about 2.5 ton/ha black pepper. The major objective of cropping different cultivars is to broad genetic variability in

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order to reduce the losses caused by soil-borne pathogens.

Brazilian black pepper production comes from the following cultivars:

a) Singapore (Kuching ecotype) – Introduced in 1933 by Japanese imigrants in the municipality of Tomé Açu. More than 80% of Brazilian black pepper production come from Singapore cultivar. It has narrow leaf and show orthotropic branches with short internodes and outgrowth from the base. Plagiotropic branches slightly slope, forming a 45° angle with the main branch. Bisexual, it grows vigorously when adequate fertilizer quantities are applied and reaches 2.30 m height in the first year growth. In soils with medium contents of macro and micronutrients yields 2.0 to 3.0 kg black pepper per vine. It is susceptible to root rot caused by *F. solani* f. sp. *piperis* but show high resistance to yellow wilt (*F. oxysporum*).

b) Bragantina (Panniyur-1 ecotype) – Introduced in 1977 from Kerala, India. After sucessive cloning, plants from one-node stem cuttings with well formed architecture and large number of productive branches (plagiotropic), were selected after experimental tests in 15 municipalities. Plants are bisexual, producing long spikes set with large heavy berries. Leaves show cordiform shape with light green shoots, characteristic of this cultivar. Orthotropic branches show long internodes, decumbent plagiotropic branches If a balanced fertilizer quantity is applied it responds with production of 3.0 kg black pepper per vine (Embrapa...1982). This cultivar is susceptible to root rot disease but it shows a good resistance to yellow wilt.

Fig. 1 – Guajarina genotype (Arkulan Munda ecotype) cultivated in yellow latosol, in Bujaru, State of Pará, Brazil (Photo: M. L. R. Duarte)

c) Guajarina (Arkulan Munda ecotype) – Introduced in 1977 from Kerala, India. After sucessive cloning through one-node stem cutting, plants with good architecture were selected to be tested in different areas in the Amazon region. It has large and dark green leaves, with orthotropic branches showing several outgrowth and long internodes. Bisexual with medium spike fully set with large green berries. Plagiotropic branches almost erects. If well balanced fertilizer quantity is applied it can produce 3.0 kg black pepper per vine (Fig. 1). It is susceptible to root rot (*F. solani* f. sp. *piperis*) and yellow wilt (*F. oxysporum*).

d) Iaçará-1 (from open pollination) – Introduced in 1981 from Kerala, India. The productivity and resistance to main diseases were assessed in field experiments conducted in Tomé Açu and Capitão Poço, State of Pará, from 1987 to 1994. When cultivated under the sun lined up on wood posts it shows a cylindrical architecture. The main branch show strong adventitious roots but in the first two year growth the number of productive branches is smaller than in Singapore. It has narrow leaves, bisexual and shows medium size spikes (9.0 cm long) fully set with large berries under favourable climate conditions. If balanced fertilizer quanities are applied it produces 2.0 ton/ha black pepper. Berry skin is thicker than in Singapore being more recommended for processing black pepper than white pepper. It is susceptible to root rot disease but show a high resistance to yellow wilt.

e) Kottanadan-1 – It was introduced in 1981 from Kerala, India and tested as for productivity and disease resistance along with 13 more cultivars in field experiments, carried out in Tomé Açu and Capitão Poço. It shows a cylindrical architecture at three years of age. From the nodes emerge strong adventitious roots that helps to tied it up to the wood posts. If plants are pruning new shoots are slow growing. It has to large leaves. Bisexual with medium size spikes (10.13 cm long) fully set with pale green berries. This cultivar can produce 2.2 ton/ha black pepper depending on a balanced fertlizer quantity. Plants are susceptible to root rot disease but highly resistant to yellow wilt.

f) Apra – Originated from open pollination, it was introduced mistakenly as Uthirankotta from Kerala, India, in 1972. It is a large leaf cultivar (13.8 cm x 8.88 cm), bbisexual with long spikes (12.43 cm long) set with pale green berries. Berries reach maturity one month later (Sep – Nov) and even ripen, berries remain tide to the spikes. Plants are highly resistant to yellow wilt and susceptible to root rot disease.

g) Kuthiravally – This broad leaf (10.12 wwidth and 15.77 long)and bisexual cultivar produces long spikes assumig shape of a horse-tail with a bend at the stalk end. Berries are closely set on the spike, large and elliptical in shape. It is late ripen (Sep-Nov), remaind berries tied to spikes. As well fertilized yields 2.7 kg black pepper per vine. It is resistant to yellow wilt and susceptible to root rot disease.

RISKS OF INFORMAL INTRODUCTION OF BLACK PEPPER CULTIVARS

The resistance to free exchange of black pepper genotypes among producer coutries has encouraged informal introductions of new cultivars having as consequence, the introduction of exotic diseases. *Piper* Yellow Mottle Virus (PYMV) was introduced in Brazil in, at least, one accession brought from India in

1994 but only recorded in 1999 (Duarte et al., 2000). As those plant materials were in processing of cloning and selection under experimental conditions, the prompt eradication of infected plants and control of vector insect (*Pseudococcus elisae*) prevented the disease to be established in the main producer areas.

RESPONSE OF BLACK PEPPER CULTIVARS TO ROOT AND FOLIAR DISEASES

The promising cultivars were tested in infested areas in the municipality of Castanhal, Capitão Poço and Tomé Açu, State of Pará, from 1991 to 1996.

The disease incidence was more severe in Castanhal, where the inoculum density was higher due to a large host population, about 30,000 pepper plants, nearby experimental field. In Capitão Poço and Tomé Açu where the new cultivars were planted far from other pepper plants the percentage of dead plants by *Fusarium* disease was low (Albuquerqueet al., 1997). Cultivars Apra, Bragantina, Chumala, Guajarina, Iaçara-1, Iaçara-2, Karimunda, Kottanadan-1, Kottanadan-2, Kuching, Kuthiravally e Perumkodi behave as susceptible to *F. solani* f. sp. *piperis* under field conditions. In highly infested areas as Castanhal, from the fourth to the fifth year, Kuching and Kottanadan-1 showed higher index of root rot disease. And, in all fields, Kottanadan-1, Kuthiravally and Apra were the most productive, even in Castanhal where severe epidemics of *Fusarium* disease were observed.

After seven years cultivation *Fusarium* disease incidence increased in some cultivars. However, data obtained in Tomé Açu and Capitão Poço showed some differences probably due to the irregular inoculum density during favourable time for establishment of infections (Table 1).

Table 1 Productivity and incidence of root rot caused by *Fusarium solani* f. sp. *piperis* on 13 black pepper cultivars after seven year planting, in Tomé Açu and Capitão Poço, State of Pará. (Mean of five replicates).

Cultivar	Capitão Poço		Tomé Açu	
	Pepper (kg/ha)	Disease (%)	Pepper (kg/ha)	Disease (%)
Singapore (Kuching)	1,269.3	26.6	1,431.3	16.6
Bragantina (Panniyur-1)	1,162.6	16.6	1,433.8	23.3
Guajarina (Arkulan Munda)	1,701.3	30.0	1,425.2	36.6
Kottanadan-1	2,280.0	40.0	2,235.0	26.6
Kottanadan-2	2,070..6	50.0	2,354.4	20.0
Iaçará-1	2,204.0	13.3	1,641.8	13.3
Iaçará-2	1,502.6	23.3	1,080.6	30.0
Kuthiravally	1,933.3	26.6	1,041.8	26.6
Apra	1,621.3	46.6	1,937.2	16.6
Karimunda	1,477.3	23.3	360.6	40.0
Perumkodi	794.6	10.0	71.3	40.0
Chumala	-	-	777.3	20.0
Kuching	784.0	43.3	-	-

Time of planting: March, 1987

The incidence of yellow wilt (*Fusarium oxysporum*) in 1997, caused serious concerns as for the future of pepper crops in Brazil because this pathogen remains for a long time in the soil as chlamidospore. It infects pepper plants throughout the year invading the vessels and causing death of plants in a short time. As *F. oxysporum* has been detected in Guajarina cultivar, only, experiments were conducted in order to find resistance sources within black pepper germplasm collection at Embrapa for Eastern Amazon.

Young plants of 28 cultivars were inoculated by immersion in a spore suspension (3.7 x 10^6 cfu/ml) and evaluated 30 days after inoculation considering the external symptoms and the extent of vascular invasion (Duarte *et al.*, 2001a).

Resistance sources to *F. oxysporum* were found. Apra, Balankotta, Belantung, Djambi, Karimunda-2, Karinkotta, Kudaravally, Kottanadan-2, Kuthiravally, Panniyur-2 e Panniyur-3 were the most resistant. Although Singapore (Kuching ecotype) and Bragantina (Panniyur-1 ecotype) show resistant response in the field, under experimental conditions the pathogen was able to invade vascular tissues of both cultivars (Duarte *et al.*, 2001a).

The new cultivars are also infected by other pathogens, which infect the foliage and spikes. Thread blight caused by *Koleroga noxia* (= *Pellicularia koleroga*) is an endemic disease that occurs during rainy season (January-May). There are no genotypes resistant to this disease. Very poor caring pepper crop are more predisposed to infection than those very well managed. The incidence of anthracnose caused by *Colletotrichum gloeosporioides* is associated to Potassium deficiency in mature plants. In young plants it causes leaf blight in nurseries very wet and under the shade. This pathogen can infect spikes in early stage of development causing necrosis and fall of young berries mainly in cultivar Bragantina. Black berry disease (*Cephaleuros virescens*) has caused black spot in leaves and berries of Bragantina and Singapore cultivars (Duarte et al., 2001b).

INTEGRATED DISEASE MANAGEMENT

Several cultural practices associated to efficient fungicides have been used to control root rot and yellow wilt diseases. The use of fungicides is restricted to desinfec soils to be used as substrate. preventative treatment of stem cuttings and, to protect pepper plants in clonal gardens.

Field observations have shown that root rot incidence is related to hydric stress. Pepper plants that show symptoms of root rot during dry season seem to recover during the next rainy season. The use of mulching applied in the end of rainy season (May) and irrigation by dripping of pepper plants during dry season have contributed to reduce hydric stress and incidence of root rot, in the field. Pepper growers that use these cultural practices have enlarge the productive cycle in more than five years. Plant eradication by rouging should not be neglected in order to reduce the disease spread in pepper plantations.

In case of yellow wilt, besides soil desinfestation, preventative treatment of stem cuttings with fungicides, sprays of clonal gardens and mulching, the use of dolomite lime, the replacement of Arkulam Munda (Guajarina) by resistant cultivars like Kuthiravally, Kottaanadan-1, Apra, Singapore and Panniyur-1 (Bragantina) are also recommended. Leaf and berries diseases are controlled by sprays with efficient fungicides. Thread blight is efficiently controlled by eliminating all infected leaves spraying all plants with copper fungicides (1.5 g a.i./L) monceren (1 g/L); anthracnose and black berry disease are controlled with benomyl sprays (1 g i. a./L) (Duarte et al., 2001b)

CONCLUDING REMARKS

The climate of Amazon region, characterised by higher temperatures and air humidity favours the occurrence of diseases, which cause significant losses to the pepper farmers.

The introduction of new black pepper genotypes aiming to control root rot disease has only had parcial success because all acessions in the germplasm collection are susceptible to *Fusarium solani* f. sp. *piperis*. However, the identification of highly productive cultivars have contributed to increase the benefit margins allowing to pepper farmers to get good yields.

The risks of introducing new diseases in a free area through planting materials is iminent. Pests like *Radopholus similis*, phytoplasm-like organism (Phyllody), branch weevil (*Lophobaris* sp) and *Colletotrichum piperis* do not occurr in Brazil.A technical co-operation agreement aiming exchange genetic material among producer countries should be encouraged by the International Pepper Community in order to diversify genetic variability in black pepper population.

On the other hand, the occurrence of new diseases like yellow wilt, as well, increases in severity of diseases considered of secondary importance have been concerning pepper farmers, Fortunately, in the case of yellow wilt there are sources of resistance to the pathogen. The high susceptibility of Guajarina the preferred cultivar by pepper producer due to its good production characteristics, has resulted in the replacement of Guajarina by more resistant cultivars as Singapore and Bragantina.

In spite of showing high susceptibility to soil-borne pathogens, mainly root rot caused by *Fusarium solani* f. sp. *piperis* the tradition and enthusiasm of pepper growers have contributed to increase the planted area and black pepper production, estimate in 45 thousands hectares and 45 metric tonnes, in 2002 (IPC,...2001).

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HARNESS THE POTENTIAL FOR DIVERSIFIED USES OF BLACK PEPPER (*Piper nigrum* L.)

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Black pepper enjoys the rare distinction of 'King of Spices' for its varied uses and dominance in the global spice trade. It is the most oldest and widely used spice in the world, occupying a position that is supreme and unique. It is the lure of this spice that brought the western world to the Indian sub-continent, centuries back.

Though the origin of this precious spice was in the forests of Western Ghats of India, pepper is today a foreign exchange earner for India, Indonesia, Malaysia and Brazil. Of late, Vietnam has also emerged as a major pepper producing country. Black pepper continues to be one of the major items of international spices trade. It accounts for 48 per cent of the total area and 27 per cent of the total production of spices in the world.

Black Pepper, the "black gold" is valued for its multiple uses. It occupies a pivotal position in food, pharmaceuticals, perfumery and cosmetic industries. In the modern world, black pepper has wide applications and new uses, which are under investigation, have to be scientifically validated.

With the development of modern science & technology and with awareness among people about the use of natural products, both in food & pharmaceuticals, what is needed is a thorough re-evaluation of indigenous traditions of science and technology as a part of our present day search for alternatives.

Black pepper in traditional medicine

Black pepper is esteemed because of the analgesic, antinflamatory, antimicrobial and antineoplastic properties, which can be directly attributed to the secondary metabolites and the major alkaloids present in the spice.