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BROWN ROOT ROT DISEASE OF CASHEW IN WEST NUSA TENGGARA: DISTRIBUTION AND ITS CAUSAL ORGANISM

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ABSTRACT

Brown root rot disease is a major constraint on cashew plantation in Pekat District, West Nusa Tenggara. Its causal agent has not been characterized. This paper describes efforts to study the pathogen, distribution and loss. Field study was conducted in Pekat District in 2003. Laboratory experiments to isolate and test the causal agent were conducted in the Indonesian Spices and Medicinal Crops Research Institute, Bogor. Research results showed that the disease was found widespread in several villages in Pekat District, such as Pekat, Beringin Jaya, Sorinomo, and Nangamiro. Total number of died cashew trees was 1,075 equals to 5,106 kg kernel yield lost, worth Rp20.5 million. Infected trees showed leaf yellowing and defoliation leading to die. The lateral and taproots near collar were encrusted with gravel, earth, and brown mycelia sleeves. The fungus produced arthrospores and brown pigmentation on agar medium containing 0.05% gallic acid. An isolate of the fungus induced typical disease symptoms following inoculation on 5 month-old cashew seedlings. These results indicated that the causal agent of mass decline of cashew in Pekat District is *Phellinus noxius*. In field, the fungus also infects a barrier tree *(Lannea coromandelica* [Houtt.] Merr.*)* (Anacardiaceae), locally known as *kedondong pagar* or *kayu bantenan.*

[*Keywords*: *Anacardium occidentale*, root rots, *Phellinus noxius*, West Nusa Tenggara]

INTRODUCTION

Cashew *(Anacardium occidentale* L.*)* is one of the most important cash crops in eastern parts of Indonesia. Root rot disease of cashew trees was reported in Bali causing thousands of cashew trees died and many others infected. Later on the disease was also found in cashew plantations in Lombok Island (Arya and Temaja 1996). Diseased trees showed leaves yellowing and defoliation leading to plant death. The diseased collar roots and base of the stem below ground level are colonized with white mycelia mats. Arya and Temaja (1996) associated the disease with infection of a white root rot fungus *(Rigidoporus microporus).*

Cashew tree decline also occurs in Pekat District, Dompu, West Nusa Tenggara (Supriadi *et al*. 2001). Diseased trees showed discoloration of leaves and defoliation, wilt, and eventually die. These symptoms are similar to that found on infected cashew trees in Lombok and Bali. The most distinctive symptoms differentiated from diseased cashew trees in Lombok and Bali are encrustation of gravel, soil, and mycelia sleeve on lateral and taproots near the collar (Supriadi *et al*. 2002). The infected woody tissues are eventually soft and colonized with a conspicuous network of brown mycelia sleeve. On a selective agar medium containing gallic acids (Chang 1995a), white mycelia with brown plaques are consistently isolated from diseased roots (Supriadi *et al*. 2002). These characteristics are in agreement with that described for the brown root rot disease caused by *Phellinus noxius* (Chang 1995b; Ann *et al*. 2002; CPC 2002).

Efforts to induce disease symptoms on cashew seedlings by mixing growth medium with chopped of lateral and taproots from diseased trees were unsuccessful (Supriadi *et al*. 2002). This study was aimed to assess distribution of the brown root rot disease in Pekat District and its causal agent.

MATERIALS AND METHODS

Disease Distribution

Disease survey was conducted in several villages in Pekat District such as Pekat, Beringin Jaya, Sorinomo, and Nangamiro in 2003 (Fig. 1). Two subvillages in Pekat Village, i.e. Sorisoga I and Sorisoga II, were selected for disease distribution study. These subvillages' coverage is about 10% (148.5 ha) of the total population in Pekat Village (1,398.3 ha).

Data of the disease distribution were obtained by interviewing 76 smallholders in Pekat Village. These

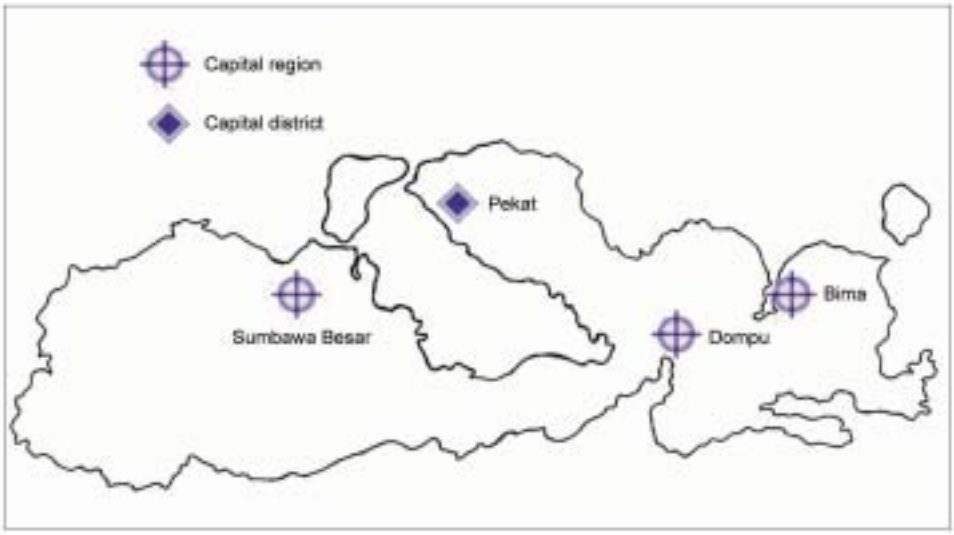

Fig. 1. Sumbawa Island, West Nusa Tenggara.

farmers were all participants of the Farmer Field School. They were trained to identify disease symptoms. Later, they recorded all diseased cashew trees found in their own fields. To confirm their data, lateral and tap roots near collar were taken from the diseased trees. Root samples were analysed in the laboratory for isolation and identification of pathogen as described below.

Isolation of the Fungus

Diseased roots were freed from sand and soil particles. A small portion of wood of the roots was aseptically taken and put on plate containing a selective agar medium described by Chang (1995a; 1996) with little modification. The base medium is malt extract (ME) agar 20 g, supplemented with benomyl 10 mg, amoxycillin 100 mg (instead of ampicillin in the original recipe), gallic acid 500 mg, agar 20 g, and distilled water 1 liter. The inoculated plate was incubated at 29°C for few days. Cultures of fungi which produced brown pigmentation were transferred onto the fresh ME medium. Cultures were then examined under a light microscope for the presence of arthrospore mycelium, which is typical for *Phellinus noxius* (Chang 1995a; 1996). The positive cultures were kept on slopes of ME or potato dextrose agar (PDA) or sterile distilled water and stored at air-conditioned room. Mycelia characteristics of the isolated fungi were compared with the reference strain of *P. noxius* kindly supplied by Dr. T.T. Chang (Division of Forest Protection, Taiwan Forestry Research Institute, 53 Nan Hai Road, Taipei, Taiwan).

Multiplication of Pathogen

An isolate of *P. noxius* (C122) from diseased cashew tree from Pekat, Dompu, was used for pathogenicity test. The isolate was grown on a medium described by Ann *et al.* (1999) with modification using materials available locally. The medium was prepared as follows: 25 g of rice grain and 25 g of broken corn grain were put in a flask of 250 ml then washed with tap water for several times until free from debris. After the excess of tap water was drained, 25 ml of distilled water was added into the flask. The flask was then plugged with cotton wool covered with aluminium foil paper, and sterilized in an autoclave at 121°C for 30 minutes. Few small portions of one week-old culture of *P. noxius* (isolate number C122) were transferred onto the sterile rice-corn medium. The flask was incubated at 29°C for one month.

Inoculation Methods

Seeds of cashew, Balakhrisnan variety, were grown in heat-steam sand in a plastic box (10 cm x 25 cm). After having 3-5 leaves, seedlings were transferred into plastic bags (2 kg volume) filled with sterile soil-sand-manure medium. The seedlings were kept in a glasshouse and periodically watered. Five month-old cashew seedlings were used for the pathogenicity test as followed.

Soil medium around the collar stem was removed. The stem was sprayed with ethanol 70% and rub with a tissue paper. A fine wound is marked on the stem. About 10 g of one month-old inoculum of the *P.*

noxius was placed around at the wounded collar stem. The stem was then covered with soil. All inoculated plants were incubated in a glasshouse. The plants were replicated 10 times. Control treatment was non-inoculated plants.

Periodically inoculated plants were examined for any disease symptom development, particularly the occurrence of discoloration of the leaves, defoliation, and wilting. All wilted plants were taken and the pathogen was re-isolated on ME selective medium as described above.

RESULTS AND DISCUSSION

Disease Symptoms

Diseased cashew tree showed leaf yellowing and defoliation leading to death within several months (Fig. 2). Few trees, however, died rapidly without intensive defoliation. The lateral and taproots near collar were encrusted with gravel, earth, and brown mycelia sleeve. Brown mycelia lines were seen on root surface beneath epidermis (Fig. 3). Encrusted roots became soft and fragile (Fig. 4).

In several farmer fields, disease symptoms were also found in a hedge tree *(Lannea coromandelica* [Houtt.] Merr.*)* (Anacardiaceae), locally named *kedondong pagar* or *kayu bantenan*. The brown mycelia mats were consistently found to colonize the lateral and tap roots near collar. The tree eventually fell down. So far, no fruiting body of the fungus has been found.

Isolation of the Pathogen

On PDA or ME agar medium supplemented with gallic acid 0.05% (Chang 1995a; 1996), the fungus produced diffusible dark brown pigmentation (Fig. 5).

Fig. 2. Cashew tree naturally affected with brown root rot disease shows leaf yellowing and failing.

Fig. 3. Brown mycelia mats on diseased root.

Fig. 4. Encrustation of diseased root surface with soil and sand particles.

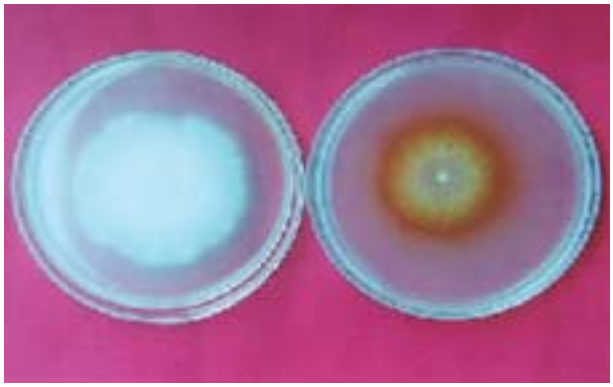

Fig. 5. Culture of *Phellinus noxius* on agar medium containing 0.005% gallic acid shows brown pigmentation.

Early growth colony of the fungus was irregular, white mycelia on its margin, and brownish discoloration started from the central. Microscopic examination showed hyaline to brownish mycelia with typical formation of arthrospores (Fig. 6). The arthrospores were spherical to ovoid. The mycelium did not produce clamp connection. These characters are in agreement with the description of brown root rot fungus, *P. noxius* (Chang 1996; Ann *et al*. 1999). Arthrospore production is the most important characteristics in aiding to identify cultures of *P. noxius*, because we have observed that other isolates of Basidiomycetes fungi also produced brown pigmentation on the same agar medium (unpublished data).

Although *P. noxius* has not shown to produce fruiting bodies on diseased cashew trees, Ann *et al*. (1999) found the fruiting bodies on infected litchi *(Lichi chinensis)* and sugar apple *(Annona squamosa)*, and also on *Casuarina equisetifolia*, *Delonix regia*, and *Ficus microcarpa* (Chang and Yang 1998) in Taiwan. The fruiting bodies are brown, resupinate, 0.4-2.5 cm thick, which permanently turned black when added with 5% KOH solution (Chang 1995b). The fungus produced fruiting bodies on sawdust medium supplemented with rice bran, sucrose, and $CaCO_3$ or NH_4NO_3 (Chang 1995b, 1996; Ann *et al*. 1999).

Fig. 6. Arthrospores of *Phellinus noxius*.

Pathogenicity Test

Isolate of *P. noxius* from diseased cashew trees consistently induced leaf yellowing and wilting in the inoculated young cashew seedlings. The inoculated seedlings died within 3 weeks after the inoculation. The fungus was re-isolated from the diseased wood. It is therefore confirmed that *P. noxius* is the causal agent of the brown root rot disease of cashew. The fungus was also pathogenic on other woody plants such as *Cinnamomum casia*, *C. burmanni*, *Coffea arabica*, and *Jatropa curcas* (Supriadi *et al*. unpublished data).

Disease Distribution

According to local farmers, brown root rot disease of cashew was first seen 5 years ago. Diseased trees tend to cluster or were in a straight line, indicating a root-to-root contact mode of infection. Number of cashew trees died in the two locations, i.e. Sorisoga I and Sorisiga II of Pekat Village, is shown on Table 2.

Table 2 shows that brown root rot disease has been widespread in all 76 locations at Pekat Village, with the total number of cashew died was 1,075 trees or about 10% of the population. The number of died trees in Sorisoga II was higher than that in Sorisoga I with the average tree died of 9.7 and 2.5, respectively. Once the disease present in a plantation, it is potential to

Table 1. Pathogenicity of *Phellinus noxius* isolate on 5 month-old cashew seedlings.

Isolate	Number of replicate	Average time to die (d)	Percentage of plant death
C121	10	23.6 + 5.38	100
Control (uninoculated)	10	0	0

Table 2. Number of cashew trees showing brown root rot disease in two locations in Pekat Village, West Nusa Tenggara, 2003.

Location	Total acreage (ha)	Total died trees	Average dying trees per ha	Estimated total yield loss (kg kernel)[1)]
Sorisoga I	87.5	312	3.71 + 2.54	1,482.00
Sorisoga II	61.0	763	12.13 + 9.71	3,624.25
Total	148.5	1,075		5,106.25

[1)] Average productivity per tree was 4,75 kg kernel.

cause tremendous devastation if no control method is taken, due to its growth habit of spreading from root to root (CPC 2002). In addition, *P. noxius* could survive for 10 years in infected debris (Chang 1996).

Recent report indicated that the disease was also found in surrounding villages such as Beringin Jaya, Sorinomo, and Nangamiro. According to the local estate extension staff, disease incidence in Beringin Jaya was more severe than that in Pekat. The disease is then a real threat for cashew plantation in the whole area of Pekat District (6,727 ha). At present, the total cashew areas in Beringin Jaya, Surinomo, and Nangamiro are 1,487 ha, 1,195 ha, and 1,026 ha, respectively. The disease is not found in three other villages, i.e. Doropeti, Kadindi and Tambora, which cover around 792 ha, 656 ha, and 169 ha, respectively. It is therefore urgent to take necessary action to control disease distribution in the whole areas of Pekat District.

Economic loss due to the disease can be estimated. If the average productivity per tree was 4.75 kg kernel, and the price of kernel was Rp4,000/kg, the yield loss was as much as 5,106 kg kernel worth Rp20.5 million. According to Nandris *et al*. (1987), mycellial growth rate of *P. noxius* on the superficial root of rubber was estimated to be 0.7 m per year. At the plant spacings of cashew trees in Pekat which are 3 m x 12 m, 6 m x 6 m, and 10 m x 10 m, and majority of the trees were 10-12 year-old, the lateral roots of adjacent trees are intermingled. Therefore, the pathogen will spread within rows faster than between rows. Assuming that the same rate is also for *P. noxius* on cashew root, in the next 5 years, the number of diseased trees will double as low as 2,796 trees; about 2% of the population in Pekat Village will be wiped out. Yield loss in Pekat Village alone may reach Rp33 million. Since the disease is also found in other three villages, total yield loss due to the disease is very serious.

CONCLUSION

Brown root rot disease on cashew is widely distributed in Pekat District, West Nusa Tenggara. The disease is caused by *P. noxius*. The pathogen induced leaf yellowing and wilting and death in inoculated cashew seedlings. Besides cashew tree, the pathogen also infects a hedge tree *(L. coromandelica)*. The most important diagnostic characters of the pathogen are a brown mycelia encrustation on diseased collar and main roots. The pathogen produces brown pigmentation on agar medium containing gallic acid 0.05%, and forms arthrospore. Disease loss in two subvillages Sorisoga I and Sorisoga II was 1,075 trees worth 5,106 kg kernell equals to Rp20.5 million.

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