Bud rot disease of coconut: An overview

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Bud rot is a fatal disease of the coconut palm, characterized by the rotting of the terminal bud and surrounding tissues. Even though it affects palms of all ages, young palms in low and moist situations are more susceptible to the disease. Incidence of the disease has been reported from almost all coconut growing countries of the world.

The coconut palm (*Cocos nucifera* L.) is considered to be the most important of all cultivated palms in the world. It supplies not only food, drink and shelter but also provides raw materials for a number of important industries. This palm is regarded as the 'tree of wealth' or 'tree of life' ('Kalpavriksha') which provides all the necessities of life. The productivity of coconut in different coconut growing areas of the country varies considerably due to varying agro-climatic conditions, management practices and occurrence of pests and diseases. Loss due to diseases is one of the key factors for low productivity in several areas. Coconut palm, in spite of its hardy nature is affected by a number of diseases, some of which not only reduce the yield but also kill the palm. Root (wilt) disease, bud rot, basal stem rot and stem bleeding diseases are the major coconut diseases causing heavy losses in India.

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Disease occurrence and losses

The first report of bud rot incidence on coconut was from Grand Cayman, an island of British West Indies just south of Cuba in 1834 (Tucker, 1926). Since then, the disease has been reported from every coconut producing region of the world. The distribution of the disease occurs in both hemispheres of the world. *Phytophthora* attack on coconut was reported from India, Sri Lanka, Indonesia, Philippines, Colombia, Papua New Guinea, Vanuatu, Fiji, French Polynesia, The Dominican Republic and Cote–de–Ivoire (Quillec *et al.*, 1984).

In India, bud rot is quite common on the West and East Coast tracts (Menon and Pandalai, 1958). Radha and Joseph (1974) reported a disease incidence of 1.2 to 10.9 per cent in Kerala and 35 to 40 per cent was observed in certain gardens having large number of palms. Heavy incidence of bud rot disease has been reported from Kuttiadi, in Kerala State leading to the destruction of thousands of coconut palms in that particular region (Anonymous, 1996). Heavy incidence of 35- 40 per cent of bud rot has been reported in Kerala and Karnataka during the South West monsoon period in 1994 with disease incidence ranging from

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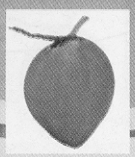

0.4 to 6.7. Ghosh and Yadav (1993) reported the incidence of bud rot varying from 1.45 to 3.65 in Tamil Nadu, 0.90 to 10.00 per cent in West Godavari, Krishna and Chittoor districts of Andhra Pradesh and 6.5 per cent in Kerala. Bud rot incidence was also noticed in other states like Karnataka, Maharashtra and Goa on a large scale, particularly in the newly planted gardens. In the non-traditional coconut growing areas of Madhya Pradesh like Bastar, Raipur and Durg, bud rot is a problem of serious concern (Dantre *et al.,* 1997). Rasmi *et al* (2004) reported that in hilly areas of Kasaragod, Kannur and Calicut districts, more than 50 per cent of the gardens in certain pockets face heavy losses due to bud rot disease. In a few gardens in these areas, more than 60% of the palms were found to be destroyed by bud rot and the disease was found to be spreading to neighboring gardens in successive years.

1. Symptom

The first externally visible symptom is the withering of the spear leaf which subsequently turns brown and bends (Plate-1). In course of time, the younger leaves, closer to the spindle also show similar symptoms. Internal tissues show discoloration assuming a pale pink coloration delimited with a brown border (Quillec and Renard, 1984) (Plate-2). The base of the spindle rots can be detached with a gentle pull. It emits a foul smell. One by one, the inner leaves also fall away, leaving only mature leaves in the lower whorl at the trunk apex. The palm ultimately succumbs to the disease if timely control measures are not taken.

2. Causal organism

The causal agent of bud rot was first suspected to be *Pestalotia palmarum* by Busck (1902). Later, *Bacillus coli* (*Escherichia migula*) was considered to be responsible for the disease (Earle, 1903; Petch,1906; Stockdale, 1907; Fredholm, 1909; Johnston, 1910, 1911). Subsequent investigations revealed the fungal origin of the disease (Shaw and Sundararaman, 1914; McRae, 1923; Tucker, 1926). E.J. Butler (1906) described bud rot in palmyra and coconut palms and isolated a fungus which he named as *Pythium palmivorum*. He placed it in the genus *Phytophthora* in 1919, and reproduced the disease symptoms by inoculation. In 1923, McRae published the results of successful inoculations of both *Borassus flabellifer* L. and *Cocos nucifera.* L. In 1919, Reinking induced bud rot in Philippines using pure cultures of *Phytophthora faberi* isolated from rotted cacao pods, and found that *Phytophthora* strains isolated from coconut and cacao were identical morphologically and physiologically.

The genus *Phytophthora* was erected by Anton de Bary in 1876. In this genus both heterothallic and homothallic species are reported. Both sexual and asexual modes of reproduction are present in *Phytophthora.* Studies have clearly shown the existence of two dominant *Phytophthora* spp. viz., *P. palmivora* (Plate-3) *and P. katsurae* as incitants of bud rot of coconut. The occurrence of *P. katsurae* causing bud rot has been reported from Hawaii and also from Ivory Coast. Veena *et al.*, (1997) reported *P. katsurae* from Kuttiadi area in Kerala. *P. katsurae* was first isolated from Chestnut in Japan. It was named as *P. castaneae* and later renamed as *P. katsurae.* The causal organism of diseased coconut in Ivory Coast was called *P. heveae* but is now believed to have been misidentified. The Ivory Coast isolate of *Phytophthora* has

Plate 1. Coconut palm affected with bud rot disease

Plate 2. Internal decay

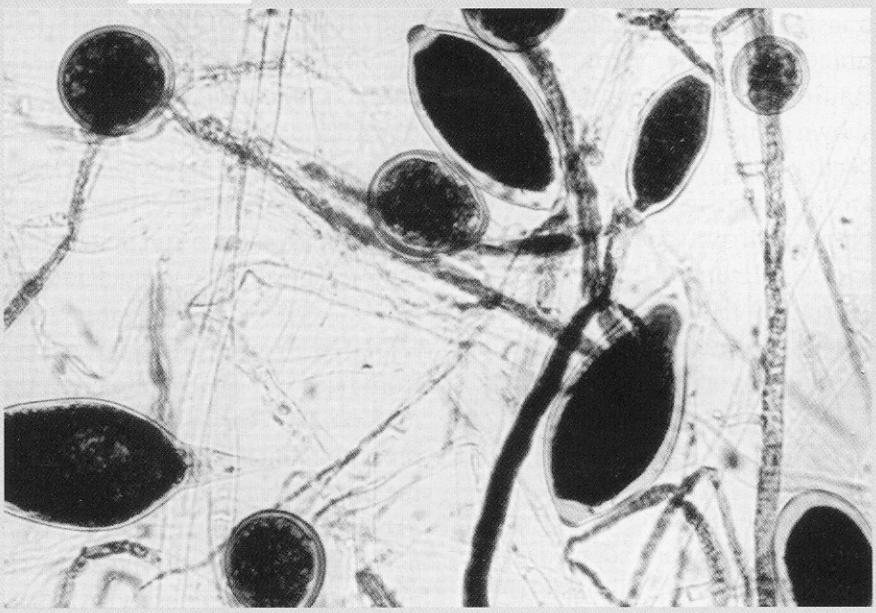

Plate 3. *Phytophthora palmivora*

oogonial protuberances like that of the coconut pathogen found in Hawaii. *P. heveae* does not have oogonial protuberances like the coconut isolate from Hawaii.

3. Epidemiology

Bud rot disease is favoured by conditions of high humidity such as found in low lying badly drained lands, in plantations with a very dense stand and under conditions of extensive rainfall. Disease development is related to relative humidity (Menon and Pandalai, 1958; Darwis, 1992). Rainfall aggravates the infection and young palms in the low lying and moist conditions are more susceptible (Thevenin *et al.*,1992; Brahmana *et al.*, 1992; Mangindaan *et al.*,1992; Pohe,1992., Steer,1992). Rillo and Paloma (1989) found that in Philippines higher incidence of *Phytophthora* was always preceded by high rainfall during the previous months. Even though palms of all ages are susceptible to the disease, it was more rampant in palms which are below 20 years of age. The period elapsing between the first infection and withering of heart leaf depends on a number of factors, the more important of which are, relative humidity and the point of infection. This period might vary from three to nine months or even longer. With the onset of dry weather, the infection becomes less severe and pathogen remains dormant. The fungus was found to survive in the frond base or basal part of the crown (Menon and Pandalai, 1958; Radha and Joseph, 1974) or in roots (Harris *et al.*,1984).

Seasonal factors are found to be associated with the incidence and spread of the disease. Disease incidence is found to be severe during monsoon when the relative humidity is high. Studies conducted at CPCRI Regional Station, Kayangulam (Radha and Joseph, 1976) revealed that the favourable period of infection is when the relative humidity is above 94 per cent and temperature is below 24°C. The rate of disease development was determined by the number of favourable days. In young palms between the age of 5 and 10 years, the occurrences of favourable days are more frequent and hence more disease incidence in such young palms was noted (Radha and Joseph, 1974). An infection cycle of *P. palmivora* in coconut is completed within 6 days under favourable conditions of humidity (98-100 per cent) and temperature (22-24°C). Inoculation of young seedlings (1 to 2 years old) grown in pots and provided with conditions like, temperature at 24°C and relative humidity of 98 – 100 per cent, resulted in infection and death of seedlings. It took one week for the fungus to complete its life cycle from sporangia to manifestation of the disease (Radha and Joseph, 1974). Coconut is a sun-loving crop, and it requires high solar radiation and high humidity. However, high rainfall intensity in certain areas causes low solar radiation and high air humidity.

Bud rot disease incidence was high in the hilly tracts where cooler temperatures coupled with very high relative humidity prevails for extended periods in the coconut crown because of the high altitude of the place. The cooler post - monsoon weather also favours the formation of dew for extended periods and this conducive factor favours the development of fresh disease incidence in the hilly tracts compared to the planes. However, in the plains disease incidence was recorded only up to September. Initial incidence of bud rot disease is always dependant upon the

monsoon showers. However, the occurrence of bud rot in subsequent months i.e. from October- January could be attributed to the favorable microclimatic conditions inside the crown with consistent high humidity, low night temperature and the presence of water droplets from dew drops (Rasmi *et al.*, 2004).

4. Dissemination of the pathogen

Epidemiological models applied to plots affected by *Phytophthora* in the Ivory Coast suggest the existence of two propagation phases, an aggressive phase during which contamination occurs from tree to tree and a regular phase, during which new cases appear some distance away from the initial foci (Renard and Darwis, 1993). The disease is primarily disseminated by wind and wind blown rain and to a lesser extent by insect, birds and climbers. The disease spreads and gets distributed over large areas due to the influence of environmental conditions in the plots. The wind pattern and direction are required to interpret the disease spread. Dauzat and Lecoustre (1992) reported that there are two phases for bud rot disease propagation. One is cluster phase during which contamination would seem primarily to spread by degrees around contamination foci and another is a regular phase during which new cases of disease occur further away from the contamination foci. Rain water acts as a vector for the infectious propagules and plays an important role in the spread of the disease (Thevenin,1992; Brahmana, *et al.*, 1992). Insects also spread the pathogen over large area by moving from one place to another, their legs and mandibles seem to be helpful in transferring the propagules from one place to another (Pohe, 1992). Radioactive tracer studies have shown that certain flying insects and beetle, caterpillar and snail species are involved in the spread of the pathogen from one cacao tree to another. Evans (1973); Julia and Mariau (1982) reported that two species of *Sogatella* as vectors of dry bud rot of young coconut in Ivory Cost.

5. Control measures

Control measures are effective only when they are adopted in the initial stage of the disease. If the disease is detected when the central shoot just withers, chemical control by the application of 10 per cent Bordeaux paste on the affected portion can check the disease. Bordeaux paste has to be applied after thorough cleaning and removal of infected material. The treated portion should be given a protective covering of plastic sheet to prevent washing off of the paste during rain. As a prophylactic measure, adjacent healthy palms should be sprayed with 1 per cent Bordeaux mixture. Other fungicides advocated earlier against bud rot disease include Phenyl mercuric urea applied in the form of powder or pellets in the leaf axils (Peiris, 1962), or stem injection or root infusion of Aliette or Ridomil or Akomin (Phosphonic acid). Regular spraying with copper fungicides at 40-day intervals especially before and after monsoon is an effective preventive measure. In copper sensitive palms, keeping perforated sachets containing Dithane M-45 in the leaf axils during rainy season is useful (Schutt, 1975; Nambiar and Rawther, 1993). Radha and Joseph (1974) found that Demosan 1200 ppm effectively checked infection in laboratory tests. Renard and Quilleck (1984) Renard, (1992) and Brahmana *et al.*, (1992) reported that injection of the coconut stem with systemic fungicides like Aliette (Fosetyl Al) and Ridomil (Metalaxyl) at 3g a.i./palm were effective in protecting the palms from bud rot of coconut caused by *P. heveae*. Rohini Iyer (1997) reported that stem injection/root feeding with systemic fungicides like Aureofunginsol (46.5%) 36.4g/palm, Calixin (Tridemorph 80%) 21 ml/palm, Aliette (Phosetyl-Al 80% wp) 21g/palm and Akomin (Phosphonic acid) 16.8 ml/palm can protect the crown from *Phytophthora* attack for a period of eight weeks.

Another method of control is through the identification of resistant sources and breeding for resistance. Characterization of resistant sources can be made by assessing the field performance of planted varieties. The performance of coconut varieties depends on the regions where they are planted. Quillec *et al.*, (1984) observed that hybrids were less sensitive than West African Tall. However, Brahmana and Kelana (1988) found that in Indonesia, dwarf palms are more sensitive and others are more tolerant. In Dwarf varieties, Nias Yellow Dwarf (NYD) seems to be the most susceptible one (Bennett *et al.*, 1986). Bud rot is also observed predominantly in areas planted with PB 121 (MYD x WAT) coconut hybrids. Exotic talls such as Rennel Tall and local Indonesian talls are more tolerant (Renard and Darwis, 1992). Dwarf x WAT

hybrids are highly susceptible to bud rot in Indonesia (Mangindaan, *et al.*, 1992). Hybrids of Malaysian Yellow Dwarf x Rennel Tall or Local Tall were found to be less affected than PB 121. The NIWA hybrids obtained by crossing NYD x WAT are susceptible to bud rot. Rillo and Paloma (1989) found that *Phytophthora* incidence was higher in Cameroon Red Dwarf and MYD compared to Catigan. Coffey *et al.*, (1990) reported that in Indonesia dwarf selections such as Jombang and Raji appeared to be more resistant to nut fall in inoculation trials.

In Asia, local ecotypes are generally more tolerant of *P. palmivora* than introduced ecotypes, although the Polynesian Tall and Rennel Tall are less severely affected than the Bali Tall in North Sumatra. Malayan Red Dwarf (MRD) is susceptible to bud rot caused by *P. katsurae* in Cote - de - Ivoire and is also susceptible to the same damage in Jamaica, where as Red Dwarf x Tall coconut hybrids are more tolerant of bud rot than the Red Dwarf parent. Both Malayan Red Dwarf and West African Tall were susceptible to bud rot, whereas the Malayan Yellow Dwarf (MYD) and the Polynesian, Rennel and Malaysian Talls are hardly susceptible or are even highly tolerant in Jamaica. In Philippines, MAWAT hybrid (Malayan Yellow Dwarf x West African Tall) was found to be susceptible to bud rot infection. For avoiding economic loss, it is recommended that the choice of planting material should be done by taking into account the environmental conditions (Mangindaan *et al.*, 1992).

Proper spacing among the palms is important for the management of the disease. Too close planting encourages spread of the disease. A good spacing between palms favours air movement and dissipation of the excess humidity that can build up in the gardens (Ohler, 1984). When grown without proper drainage the coconut palms are highly susceptible to bud rot disease. The lowlands with generally high humidity are very favourable for the development of the disease, especially when the drainage is poor.

Organic matter application favours the growth of a variety of microbes including antagonists such as *Trichoderma* and *Gliocladium* spp. which multiply on them and help in reducing the population of soil - borne pathogens like *Phytophthora*. Biological control is geared towards identifying microorganisms effective against *Phytophthora*.

Regular use of site specific fungicide is not recommended because fungicide resistant isolates or strains of *Phytophthora* spp. may occur through their continued use (Cohen and Coffey, 1986). Copper injury to certain dwarf varieties occurs due to fungicidal treatment (Schutt,1975), and the cost of fungicides is also high. Lack of trained labourers for spraying is another problem faced while advocating fungicidal control for bud rot disease.

Though many bacteria, actinomycetes and fungi are antagonistic to *Phytophthora*, their activity in the field is limited. The issue of microbial antagonism against *Phytophthora* is an important component of disease control, and such systems are operating in nature (Malayczuk, 1983; Shea and Broadbent, 1983). However, the prospect of implementing by use of biological antagonism is still uncertain, especially on a practical short-term basis (Shea and Broadbent,1983). The development of effective biological control of *Phytophthora* species has been fraught with difficulties because of their ability to produce several forms of inoculum (zoospores, sporangia, chlamydospores, and mycelium) rapidly and repeatedly, their ability to penetrate and infect a host plant with in a few hours, and their ability to exist in soil to depths allow them to escape most antagonists and in some cases due to their wide host ranges. Several genera of bacteria, actinomycetes and fungi have been shown to parasitize and lyse *Phytophthora* propagules in soil (Weste and Vithanage, 1978; Sutherland *et al.*, 1984). These antagonists exert lytic effect on mycelium, chlamydospores and oospores. Among different fungi isolated from endemic plots, *T. harzianum* and *T. viride* was identified as the most effective antagonistic fungus of the bud rot pathogen, *P.palmivora in vitro*. However, the results of pot experiment revealed that, T. *harzianum* has a higher competitive saprophytic ability in soil compared with that of *T. viride*. Moosa *et al* (1998) reported the occurrence of endophytic *Bacillus* antagonistic to *Phytophthora palmivora* in coconut seedlings.

The major problem for the use of pesticides is, in some areas species like black pepper and cardamom are

grown as intercrops in coconut gardens, whose export is highly sensitive to pesticide residue. Chemical control though effective is undesirable as they pollute the environment and the residue lefts in the products are hazardous to human health. To minimize the use of pesticides, biological control becomes imperative in integrated management of the disease. At present, there is a need for an effective, broad-based integrated control of *Phytophthora* diseases. This control may combine the use of resistant varieties, improvement of cultural practices, new translocation fungicides and development of biological control methods (Tuset *et al.*, 1984 and 1992; Coffey, 1987).

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