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RESEARCH ARTICLE

GANODERMA DISEASE OF PERENNIAL CROPS *COCOS NUCIFERA*

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ABSTRACT

Hardwood trees planted for timber production, wildlife habitat, riparian buffers, native woodland restoration, windbreaks, watershed protection, erosion control, and conservation are susceptible to damage or even death by various native and exotic fungal or bacterial diseases. Establishment, growth, and the quality of the trees produced can be affected by these disease outbreaks. Planting a mixture of tree species will help create a diverse community that could better withstand outbreaks of disease occurrences, and help minimize the risks associated with growing single-species plantings. Healthy, vigorously growing trees are generally more capable of surviving attack from diseases. Proper site, species selection, planting, maintenance, and protection may have significant impacts on tree establishment, growth, vigor, production, and economic or ecological value. India coconut is a wonderful tree and one of the precious gifts of Mother Nature to mankind. There are several diseases caused by various microorganisms in coconut among them Basal stem rot caused by *Ganoderma lucidum* remains the major disease of oil palm in South Asia. Infected stem of coconut palm collected and causative organism was isolated. Fungal characterization, disease spread, symptoms, cultural practices were studied. The results thus reveal that the nature of organisms and management of disease provide good exposure to the farmer for the plantation of coconut palm.

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INTRODUCTION

The coconut palm' (*Cocos nucifera*), is a member of the family *Arecaceae* (palm family). It is the only accepted species in the genus *Cocos*. The term coconut can refer to the entire coconut palm, the seed, or the fruit, which, botanically, is a drupe, not a nut. The spelling cocoanut is an archaic form of the word. The term is derived from 16th-century. Portuguese and Spanish *coco*, meaning "head" or "skull", Pearsall *et al.* (1999) from the three indentations on the coconut shell that resemble facial features.

Coconut (*Cocos nucifera* L.) is an important oilseed as well as plantation crop in India with an area of 1.8 million hectares and an annual production of 54 billion nuts (Rethinam 2004). It belongs to the palm family *Arecaceae* (*Palmaceae*) which consists of 200 genera and over 2000 described species. The tree itself has been described as, "man's most useful tree, "king of the tropical forest", "true of heaven" and lazyman's crop, iter alia (Woodroof, 1970). In India, basal stem rot disease (BSR), caused by *Ganoderma lucidum* (Leyss.) Karst., is a major limiting factor in coconut production. The disease is also referred to as Thanjavur wilt, bole rot, *Ganoderma* disease and Anabe (Vijayan and Natarajan 1972; Nambiar and Rethinam 1986; Bhaskaran *et al.* 1990).

The incubation period of this disease has been determined to be several years (Turner 1981). Visible disease symptoms appear at a very late stage of infection when more than half of the root tissues have decayed, leaving no chance for the grower to cure the infected palms. Basal stem rot disease of coconut can be contained by management practices if the disease is detected in its early stages.

Kerala, Karnataka and Tamil Nadu account for more than 90 % of the total area of 1.1 million ha under coconut in India. Though Kerala ranks first in the total area and nut production, as far as productivity is concerned Tamil Nadu stands first with 10633 nuts per ha as against 4927 nuts/ha for Kerala and a national average of 5773 nuts/ha. While root (wilt) disease of coconut is a major constraint in the production of coconut in Kerala, Thanjavur wilt disease of coconut in Tamil Nadu is threatening the coconut industry not only in Tamil Nadu but also in the neighbouring states. This disease was first noticed in Thanjavur district of Tamil Nadu after the cyclones of 1952 and 1955 and hence the name Thanjavur wilts. The disease is widespread in all parts of Tamil Nadu and also in the adjoining areas of Kerala.

Ganodermataceae are cosmopolitan basidiomycetes which cause white rot of hardwoods, such as oak, maple, sycamore and ash, by decomposing lignin as well as cellulose and related polysaccharides (Hepting, 1971; Blanchette, 1984; Adaskaveg and Ogawa, 1990). Although species of *Ganoderma* are

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economically important plant pathogens, causing disease in crops such as rubber and tea and wood rot of trees, the fruit bodies are popular as, and have long been used in, traditional medicinal material in Asian countries, including China, Japan and Korea. The *Ganoderma lucidum* complex, known in Chinese as *lingzhi*, has long been considered a symbol of good fortune and prosperity and is the subject of many myths, as well as being a medicinal herb in ancient China (Zhao and Zhang, 1994). There are records of these fungi before the time of the famous medical book *Shen Nong Ben Cao Jing* (AD 25–220, Eastern Dynasty).

Depending on the different colours and shapes of the fruit bodies, they have been called the red-, black-, blue-, white-, yellow and purple-types in *Shen Nong Ben Cao Jing* by Hong Ching Tao (AD 456–536) and *Ben Cao Gang Mu* by Li Shi-Zhen (AD 1590, Ming Dynasty), as well as the antler- and kidney-shapes (Shin and Seo, 1988b; Zhao, 1989; Willard, 1990). The black fruit body referred to by the old description in China (Willard, 1990) is assumed to be *G. neojaponicum* or *G. formosanum* because the fruit bodies of these species are black in nature. However, the descriptions on the blue, yellow and white fruit bodies of the *G. lucidum* complex have not been found. *Ganodermataceae* have attracted the attention of mycologists for many years. They have been considered as either plant pathogens (Hepting, 1971; Adaskaveg and Ogawa, 1990; Adaskaveg et al., 1991, 1993), or useful medicinal herbs (Mizuno et al., 1995). Because of these fundamentally different viewpoints among collectors, the taxonomy of these fungi is very subjective and confused. Contributions to the morphology and taxonomy of the *Ganodermataceae* have been made by many mycologists, including Steyaert (1972), Furtado (1981), Corner (1983) and Zhao (1989). However, the great variability in macroscopic and microscopic characters of the basidiocarps has resulted in a large number of synonyms and in a confused taxonomy, especially in the genus *Ganoderma* (Gilbertson and Ryvarden, 1986).

MATERIAL AND METHODS

Plant

Cocos nucifera is a large palm, growing up to 30 m (98 ft) tall, with pinnate leaves 4–6 m (13–20 ft) long, and pinnae 60–90 cm long; old leaves break away cleanly, leaving the trunk smooth. Coconuts are generally classified into two general types: tall and dwarf. On very fertile land, a tall coconut palm tree can yield up to 75 fruits per year, but more often yields less than 30, mainly due to poor cultural practices. In recent years, improvements in cultivation practices and breeding have produced coconut trees that can yield more (Sarian Zac, 2010).

Distribution

This disease first appeared in the coastal areas of Thanjavur district of TamilNadu after cyclones of 1952 and 1955 and hence the names Thanjavur wilt. In Tamil Nadu it is prevalent in Thanjavur and Chengulpet districts. In Karnataka it is found in Maidan areas. This disease is of recent occurrence in many parts of Kerala, especially in the districts of Palakkad, Malappuram, Thrissur, Kollam, Thiruvananthapuram and Wayanad. In a survey conducted in 1965-66, the disease incidence was found to be 10.8 % in Thanjavur, 6.3% in



Fig. 1. Healthy Coconut Palm



Fig. 2. Diseased Coconut Palm Leaf



Fig. 3. Diseased Coconut Palm stem

Kanyakumari, 4.0% in Thiruchirapalli, 3.5% in South Arcot and 3.3 % in Chinglepet. In a limited survey conducted in 8 districts during 1980, the incidence was found to range between 2.6 and 13.5 %. In some of the severely affected gardens in Muthupet and Thambikottai, the incidence is as high as 30%. The disease has now been observed in Coimbatore dist. of Tamil Nadu and some pockets in Pal ghat district of Kerala indicating the extent of spread of the disease within a period of 30 years. A disease of coconut almost similar to Thanjavur wilt in symptomatology, associated fungus, the predisposing factors like soil conditions, nature of irrigation etc., is prevalent in Andhra Pradesh, Karnataka and parts of Maharashtra, Gujarat and Orissa. The disease is referred to as *Ganoderma* root rot or *Ganoderma* wilt or *Ganoderma* disease.

Description of study area

Coconut is the product of the coconut palm which is a perennial tree grown as a permanent garden or plantation crop. The coconut palm not only furnishes one of the most important of vegetable oils, but a number of valuable products, the chief among which is coir or coconut fibre. The tree was widely planted along streets, walkways, homes also grown in garden in and around all districts of Tamil Nadu. In this study infected

coconut palm was selected which is located in Poondi, Thanjavur.

Test organisms

Repeated survey of coconut growing area made, infected stem was carefully examined and the symptoms of the disease were recorded. The living infected palm portion of stems were cut into small pieces with the help of knife and put in polythene bag and brought to the laboratory for the isolation of pathogens and also for further study.

Morphological analysis

This species was usually recognized due to its distinct black crust and dark brown pileus, tubes and context, as well as darkline under its cutis with a lacquered appearance but often cream or yellowish towards the margin, corky or woody & circular to semi-circular to fan shaped or kidney shaped honey like appearance. . The cutis has trichodermic (Stamets, 1993).

Isolation and identification

The infected portion of 15 cm long 6 cm breath coconut stem showing symptoms like rots was studied. They were cut into small pieces (Wang *et al.*, 2006). The pieces containing infected regions were surface sterilized with 0.1% mercuric chloride solution. The cut pieces of infected stem bits as well as infected tissues were taken in that solution and kept for about 30-40 seconds. Then, they were carefully removed and washed in distilled water. Then the bits were placed on to petriplates containing Potato Dextrose Agar medium (Chen *et al.*, 1993). Then the plates were incubated at $30\pm 2^{\circ}\text{C}$ for five days. The organisms that grew from the infected specimen over PDA medium was observed under the microscope after staining with lacto phenol cotton blue. The colony morphology of fungal species was identified by using standard manuals such as, manual of soil fungi (Gilman, 1957).

Pathogenicity test

This test was mainly determining the pathogenicity of the fungus. It was carried out by means of series of inoculation. Healthy coconut trees were selected and surface of the tree trunk bark was sterilized by ethanol and scraping was made with knife and then inoculation was done with isolated test organism by means of conidial applications with some amount of medium. Then they were allowed for incubation without any disturbances. Then they were covered with polythene sheats and pin holes were made for the passage of air. The appearances of disease symptoms and its development were recorded.

Saprophytic suppression

Pure sand inoculum of the antagonistic fungi *T.viridae* and *T.harzianum* were prepared individually as described by Garrett (1963). Acid washed sand (200g) and 3% maize were taken in 500ml saline bottle and sterilized. Each bottle was inoculated with three blocks of the individual species of antagonistic organisms. The flasks were incubated for a period of one

month and shaken at regular intervals to maintain a homogenous continuum of propagules.

Direct application method

The inoculation of *T.viridae* and *T.harzianum* were applied directly on the infected portion and also mixed in the coconut field for incubation. Observed inhibiting activity of the antagonistic organism against *Ganoderma lucidum*. Some management treatment with neem, Bordeaux and cultural practices were applied.

RESULTS

Microscopical structure of spores and hyphae of *G.lucidum* (Fig. 4 & 5)

Basidiomata annual, stipitate brilliantly laccate, mycelia mat white to light cream scattered, more or less extensive, much branched thin walled hyphae often described as “witches broom”. Aerial mycelium and the lateral branches may become a veryshort. Thick walled hyaline, branched aseptate 1.5-3.0mm, Ellipsoid to ovoid, $8.5-12.5 \times 5.5-7.5\text{mm}$. In these findings the microscopical structure of mycelium was aerial and have thick walled hyaline.

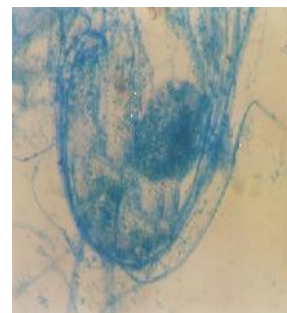


Fig. 4. Hyphae

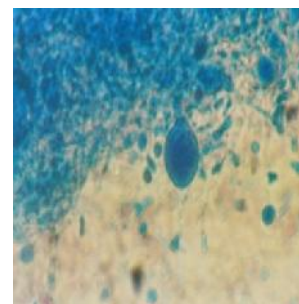


Fig. 5. Spore

Symptoms

Withering followed by yellowing and drooping of leaves in the outer whorl is the characteristic initial visible symptoms. Even before this, decay of finer roots would have started. The root decay gradually extends up to the bole region. The yellowing and withering advance to the inner whorl of leaves also (Fig:3). This is accompanied by exudation of reddish brown viscous fluid from the basal portion of the trunk. The decay of the bole slowly goes upwards into the basal portion of the stem. Some palms show wilting symptoms without any external signs of bleeding, but with extensive internal decay. It is also not

uncommon to see palms exhibiting bleeding symptoms without any drooping of leaves. In general the outer whorl of leaves droop down. The bleeding patch enlarges in size and traverses upwards, to a height of 4 metres in certain cases. There is a commensurate internal decay just below the bleeding patch. More leaves droop and along with this the bunches subtended by these leaves also droop, resulting often in nut fall. The spindle size is reduced and so also the size of the crown (Nambiar and Rethinam, 1986).

- Initial symptoms of Thanjavur wilt (*Ganoderma* wilt) start with withering, yellowing and drooping of the outer whorl of leaves. (Fig: 2)
- This is followed by exudation of reddish brown liquid through cracks at the base of the trunk and oozing spread upward. The tissues on the bleeding spots are soft to touch.
- Decaying of tissues at bleeding point and rotting of the basal portion of the stem. (Fig:3)
- The bark turns brittle and often gets peeled off in flakes, leaving open cracks and crevices. The internal tissues are discoloured and disintegrated, emitting a bad smell.
- Bracket formation at the base of the trunk. *Ganoderma* appears at the base of the trunk. Ultimately the palm dies off

Predisposing factors

- a) Trees in the age group of 10-30 years are more susceptible to the disease.
- b) Generally the disease is more in the coastal sandy loam soil where coconut is grown as high in gardens with high soil moisture stress in the summer followed by water logging or ill drained condition in rainy season.
- c) Neglected agronomic practices may aid in the spread of the disease.
- d) Lack of phytosanitation may be one of the major contributing factors of disease incidence and further spread.

Disease spread

The disease appears to spread from a particular focus of infection towards the periphery in a concentric fashion, the annual rate being 0.2-4.8 %. The spread is mainly through root contact (root graft) between diseased and healthy palms. Uncontrolled flood irrigation in the entire field or running the irrigation channels along the palm rows where diseased palms exist or repeated ploughing in the affected garden will aid in the rapid spread of the disease.

Management

- Isolation trench around the tree, 4 ft away from the base of the trunk.
- Application of Sulphur dust inside the trench.
- Soil drenching with Bordeaux mixture 1% @ 40lit/tree.
- Trunk injection / root feeding with Calixin 3ml/tree.

- Application of FYM 50kg + neem cake 5kg once in 6 month.
- Raising of green leaf manure and insitu ploughing at the time of flowering.
- Root Feeding – Calyxin 5ml + 100ml Water
- Application of 5 kg neem cake/palm/year and root feeding of 2 ml tridemorph in 100 ml of water combined with soil drenching of 40 litres of 1% Bordeaux mixture effectively controls basal stem Isolation of trench around the tree, 4 feet away from the base of the trunk. Application of sulphur dust inside the trench.
- The bleeding patches in the stem may be chiseled and protected with tridemorph (5% calxin) and subsequently with hot coal tar.
- Aureofungin-sol 2 g + 1 g Copper Sulphate in 100ml water or 2 ml of Tridemorph in 100 ml water applied as root feeding.
- Antagonistic activities of *T.viridae* and *T.harzianum* provides better results with suppression of *Ganoderma lucidum*

Cultural practices

- (i) Repeated ploughing in the garden should be dispensed with since this will help carry the infected propagules from the diseased site to the healthy ones.
- (ii) Irregular planting and closer spacing should be avoided.
- (iii) Adequate soil moisture may be provided through irrigation coupled with mulches wherever practicable. While irrigating, flood irrigation to the entire field should not be followed. Instead, drip or basin type of irrigation may be adopted taking care that water from the basins of the diseased trees does not go out to healthy palm basins. The irrigation channels should not run along palm rows in which there are diseased trees.
- (iv) In ill-drained gardens, good drainage provision may be made.
- (v) *Ganoderma* resistant species of crops, like banana, Ailanthus etc. may be used as far as possible, in the inter and mixed cropping systems in coconut.

DISCUSSION

Among some 50 diseases affecting the coconut palm, basal stem rot (BSR) disease caused by the species of *Ganoderma lucidum*. The genus *Ganoderma* has worldwide distribution cause root and stem rots of many plantation groups. This disease can be managed effectively by an integrated disease management (IDM) package, if the disease is diagnosed before the external symptoms are produced (Samiyappan *et al.*, 2006). While cultural studies and microscopic observation of fungal structures were highly accurate for diagnosis. In the present study BSR disease is easily spread to adjacent coconut trees by root contact and are abundantly present in Poondi, Thanjavur (Dt).

There is good reason, especially in tree hazard assessment, to make accurate identification at the species level of the fungi concerned, because the behavior of wood-rotting fungi in terms of aggressiveness and ability to overcome host defense can be

highly variable among different species with in genera (Turner 1981). In the present study, wood rotting capacity of *Ganoderma lucidum* was more due to its release of cell wall degrading enzymes such as cellulose and pectinase (Cellulolytic activity) by which the pathogen can easily colonize on the tree trunk. A major part of the unknown taxa is suppressed to be found in tropical regions, where the diversity of fungi higher than in temperate areas. In the present investigation was expanding the knowledge of the basidiomycetes and also the pathogen which cause basal stem rot was identified as *G.lucidum* belongs to the basidiomycetes. And also the reliable and quick technique for testing the pathogenicity of the *Ganoderma* fungus by inoculating application of conidia with some amount of medium of coconut palms. This technique should be useful to screen coconut palm for resistance to *Ganoderma* and host pathogen interaction, infection biology, disease development and disease management. *T.viridae* and *T.harzianum* were applied on the infected portion of coconut tree (BSR). *T.viridae* was inhibited the growth of *G.lucidum* than *T.harzianum*

Conclusion

In the present investigation revealed that the Basal Stem Rot disease was caused by the fungus *Ganoderma lucidum* which comes under basidiomycetes family. Symptoms, disease management, cultural practices were studied well and useful for further studies.

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REFERENCES

- Adaskaveg, J.E. and Ogawa, J.M. 1990. Wood decay pathology of fruit and nut trees in California. *Plant Disease* 74, 341–352.
- Adaskaveg, J.E., Blanchette, R.A. and Gilbertson, R.L. 1991. Decay of date palm wood by white-rot and brown-rot fungi. *Canadian Journal of Botany* 69, 615–629.
- Adaskaveg, J.E., Miller, R.W. and Gilbertson, R.L. 1993. Wood decay, lignicolous fungi, and decline of peach trees in South Carolina. *Plant Disease* 77, 707–711.
- Bhaskaran R. 1990: Biological control of Thanjavur wilt disease of coconut. In: National Symposium on Biocontrol of Root Disease. Annamalai University, Annamalaiagar: 7–8.
- Blanchette, R.A. 1984. Screening wood decayed by white rot fungi for preferential lignin degradation. *Applied Environmental Microbiology* 48, 647–653.
- Chen, A.W. and W.W.L. Hu, 1993. Strategies for obtaining monocaryons in *Ganoderma* species. *Ganoderma: Systematics, Sathology and Sharma-cology* proceedings of contributed symposium. 59 A, B, 5th International Mycological Congress, Vancouver.
- Corner, E.J.H. 1983. Ad Polyporaceas I. *Amauroderma* and *Ganoderma*. *Nova Hedwigia* 75, 1–182.
- Furtado, J.S. 1981. Taxonomy of *Amauroderma*. *Memoirs of the New York Botanical Garden* 34, 1–109.
- Garrett, S.D., 1963. Soil fungi and Soil fertility. Oxford Pergamon Press.
- Gilbertson, R.L. and Ryvarden, L. 1986. *North Americal Polypores. Part 1*. Fungiflora, Oslo, Norway.
- Gillman J.C., 1957. Sexual spores, A manual of soil fungi. 2nd Ed, Pp 4.
- Hepting, G.H. 1971. *Diseases of forest and Shade Trees of the United States*. US Department of Agriculture, Agricultural Handbook, 386, 1–658.
- Mizuno, T., Wang, G.Y., Zhang, J., Kawagishi, H., Nishitoba, T. and Li, J.X. 1995. Reishi, *Ganoderma lucidum* and *Ganoderma tsugae*: Bioactive substances and medicinal effects. *Food Reviews International* 11, 151–166.
- Nambiar K. K. N. and Rethinam P. 1986. All India Co-ordinated Research Project on Palms., Pamnhlet No . 30 September, 1986.
- Nambiar K.K.N., Rethinam P. 1986. Thanjavur wilt *Ganoderma* disease of coconut. Pamphlet No. 30. Central Plantation Crops Research Institute, Kasaragod.
- Pearsall, J. ed. 1999. "Coconut." *Concise Oxford Dictionary*. 10th ed. Oxford: Clarendon Press. ISBN 0-19-860287-1.
- Rethinam P. 2004. Coconut – making industry competitive. In: The Hindu Survey of Indian Agriculture: 70–72.
- Samiyappan, R., Bhaskaran, R., and Rethinam, P. 1996. Diagnosis for early detection of *Ganoderma* diseases in Perennial crop: Approaches and prospects. *Journal of plant disease and protection*, 103: 85-93
- Sarian, Zac B. August 18, 2010. New coconut yields high. *The Manila Bulletin*. Retrieved April 21, 2011
- Shin, G.C. and Seo, G.S. 1988b. Classification of strains of *Ganoderma lucidum*. *Korean Journal of Mycology* 16, 235–241 (in Korean).
- Stamets, P. 1993. *Ganoderma lucidum* (Wm, Curtis: Fries) Karsten. In *Growin Gourmet and Medicinal Mushrooms* (ed. P. Stamets), pp. 355-369. Ten Speed Press, Berkeley, CA.
- Steyaert, R.L. 1972. Species of *Ganoderma* and related genera mainly of the Bogor and Lieden herbaria. *Persoonia* 7, 55–118.
- Turner P.D. 1981. Oil Palm Diseases and Disorders. Oxford University Press, Kuala Lumpur.
- Vijayan K.M., Natarajan S. 1972. Some observations on the coconut wilt disease of Tamil Nadu. *Coconut Bulletin*, 2 (12): 2–4.
- Wang, H and Ng, T.B. 2006. *Ganodermin*", an anti-fungal protein from fruiting bodies of the mushroom, *Ganoderma lucidum*. *Peptides*, 27 (1): 27-30.
- Willard, T. 1990. *Reishi Mushroom, 'Herb of spiritual potency and medical wonder'*. Sylval Press, Issaquah, Washington, p. 167.
- Woodroof, J.G. 1970. Coconuts: Production, Processing, Products. The AVI Publishing Co., Inc., 241.
- Zhao, J.D. 1989. The *Ganodermataceae* in China. *Bibliotheca Mycologica* 132. J. Cramer, Berlin, Stuttgart.
- Zhao, J.D. and Zhang, X.Q. 1994. Importance, distribution and taxonomy of *Ganodermataceae* in China. In: Buchanan, P.K., Hseu, R.S. and Moncalvo, J.M. (eds) *Ganoderma – Systematics, Phytopathology and Pharmacology*. Proceedings of Contributed Symposia 59A, B, Fifth International Mycological Congress, Vancouver, August 14–21, 1994, pp. 1–2.
