J. Indian bot. Soc. e-ISSN:2455-7218, ISSN:0019 - 4468 Vol. 100 (A) 2020:239-250

FUNGAL DISEASES ASSOCIATED WITH COCONUT AND THEIR MANAGEMENT-A REVIEW

SAMPAT NEHRA[1]*, RAJ KUMAR GOTHWAL[1,2], POONAM MEENA[3], P. GHOSH[1] AND P. C. TRIVEDI[3]

[1]Department of Biotechnology, Birla Institute of Scientific Research, Statue Circle, Jaipur, Rajasthan, India, [2]Department of BioEngineering, Birla Institute of Technology, Mesra, Ranchi, Jaipur-Campus, Jaipur, Rajasthan, India, [3]Deptartment of Botany, University of Rajasthan, Jaipur, Rajasthan, India

DOI:10.5958/2455-7218.2020.00055.8

Coconut (*Cococs nucifera* L.) is an important cash crop of India and contributes to about 15,000 crore rupees to GDP. India contributes around 72 % coconut production and productivity is also remarkably high. Among different states, Karnataka tops the list in the production, Tamil Nadu stands first in the productivity and Kerala tops in the growing area. The diseases are posing constant threat or challenges to coconut growers of southern states of India. Amongst all diseases, fungal pathogens are the most important factors which cause serious losses to coconut products every years. Researchers attempted integrated disease management practices to control these diseases. For selection of any management strategies early detection of the causal organism and the disease is very important step as confusion in identification process leads to inefficient disease management. Nowadays early diagnosis at early stage involves indicator plants, protein and DNA based studies, molecular identification and differentiation of the pathogen species. We will discuss here the economic importance of coconut, Indian scenario of its area, production and productivity and various fungal diseases associated with it.

Key Words: coconut, disease diagnosis, disease management, fungal diseases

Coconut (*Cocos nucifera* L.) tree belongs to palm tree family (Arecaceae) and provides food security and livelihood to a large population worldwide particularly, in Asia Pacific Countries. Coconut farming in India is interlink or bridge between the socio-historical culture as well as the ethnic identity. The coconut palm is a malleable tree crop and one of the most attractive and useful trees in the world, not any other tree crop grown can compete or match coconut palm in its versatility since all the parts-of the wonder palm are useful to make in one way or other.

Coconut: Global Scenario

Coconut is very important plantation crop and grown all around the globe. Farming of coconut is a way of life for millions of people all over the world. In most of the developing countries the agricultural crop cultivation is more concentrated along the coastal lines. Coconut tree is also known as "Tree of Abundance", "Tree of Heaven", "Kalpavriksha" and "Tree of life" since it is store house of oil, health drink, food, medicine, fiber, fuel, timber, and varieties of products of commercial importance. Coconut palms are grown in more than 90 countries and territories of the world, with a total production of over 59 million tonnes in 2016. Coconut crop is mainly grown in the tropical regions of the world, over an area of around 12,200 million ha with production of more than 69,000 million nuts and the productivity of nearly 5700 nuts/ha.

Most of the world production is in tropical Asia, with Indonesia, Philippines, and India collectively accounting for over 72% of the total world's production. India ranks third after Indonesia and Phillipines with respect to global coconut growing area (Table 1). In year 2014-2015, India secured top position in the production (~21,600 million nuts), followed by Indonesia (~16,200 million nuts) and Philippines (~14,500 million nuts). Highest productivity of nuts per hectare (~10,000 nuts/ha) was also reported in India that shows the importance of Indian coconut cultivation on the world map (Raghavi *et al.* 2019).

Coconut: Indian Scenario

India is leading coconut producing country and ranks first in production and productivity, third in growing area, being grown in an extent of around 20 lakh ha area with a production of 20,439 million nuts (CDB 2015) in global coconut scenario. In India, four southern states

Table 1. Major coconut growing countries: Area, production and productivity of coconut (2014-2015; Source: Singh 2016; Shinde *et al.* 2018).

Country	Area (0.000 ha)	Share in Area (%)	Production (Million nuts)	Share in production (%)	Productivity (Nuts/ha)
India	2141	17.55	21665	31.02	10119
Indonesia	3610	29.60	16354	23.42	4530
Phillipines	3502	28.71	14696	21.04	4196
Brazil	251	2.06	2919	4.18	11630
Srilanka	440	3.61	2870	4.11	6523
Papua New Guinea	221	1.81	1483	2.11	6710
Vietnam	159	1.30	1246	1.78	7834
Mexico	169	1.39	1119	1.60	6620
Thailand	206	1.69	1001	1.43	4859
Tanzania	128	1.05	546	0.78	4264
Others	1369	11.22	5938	8.50	4338
Total	12196	100	69836	100	5726

Table 2. Coconut in India: Area, production and productivity of (2014-2015; Source: Singh 2016; Shinde *et al*. 2018).

State/Union Territories	Area (0.000 ha)	Share in Area (%)	Production (Million nuts)	Share in production (%)	Productivity (Nuts/ha)
Kerala	649.65	32.89	4896.61	23.96	7535
Karnataka	515.00	26.07	5141.15	25.10	9982
Tamil Nadu	465.11	23.54	6917.46	33.84	14873
Andhra Pradesh	105.69	5.36	1463.56	7.16	13808
Orissa	50.68	2.57	324.89	1.59	6411
Gujarat	31.63	1.60	295.03	1.44	9328
West Bengal	29.41	1.49	372.23	1.82.	12657
Maharashtra	28.10	1.42	187.44	0.92	6670
Goa	25.79	1.31	127.72	0.62	4952
Andaman & Nicobar Islands	21.91	1.11	129.77	0.63	5923
Assam	21.41	1.07	237.49	1.16	11234
Bihar	14.90	0.75	141.38	0.69	9498
Tripura	6.93	0.35	28.41	0.14	4101
Lakshadweep	2.57	0.13	70.91	0.35	27691
Pondicherry	1.88	0.10	21.90	0.11	11641
Nagaland	1.45	0.07	16.32	0.08	11253
All India	1975.81	100	20439.60	100	10345

such as Tamil Nadu, Kerala, Karnataka and Andhra Pradesh are the prime producers of coconut contributing for around 89% (nearly 1.74 million ha) of total area and more than 90% (17,000 million nuts per annum) of total production in the country. Oil production from coconut in the country is about 4.5 lakh tonnes. Of this 40 % is consumed for edible purposes, 14% for industrial uses and 46% for toiletry use. The contribution of coconut to the GDP of India is around 15,000 crore rupees (Raghavi *et al.* 2019).

Coconuts are important and essential plants in the homestead system of farming in the West Coast of India. In India, the socio-economic life of large number of small and marginal farmers is closely and directly related with coconut farming because it provides regular income to the growers. In India, around 12 million people are dependent on the coconut sector in areas of cultivation, processing and trading business. Since more than 95 % amongst five million coconut growers in the country have less than two hectares land

holdings so coconut farmers are basically small and marginal farmers.

In India, traditional areas for coconut cropping are southern Indian states like Kerala, Karnataka, Tamil Nadu, Gujarat, Orissa, Andhra Pradesh, West Bengal, Maharashtra and Goa. Amongst all coconut growing states Kerala, Tamil Nadu, Karnataka and Andhra Pradesh contribute more than 88% area and more than 90% production. Many other states like Gujarat, Madhya Pradesh, Assam, Tripura, Bihar, Nagaland, Manipur, and Arunachal Pradesh are also known as non-traditional areas for coconut cultivation (Table 2).

Coconut: Uses

Coconut provides oil for edible and non edible purposes, many eatable nutritious products, nutritious drinks, other beverages, timber and fibers used by many industries, shell for fuel and industrial uses and a variety of miscellaneous products for use such as handicrafts etc. Of the total coconut production in the country 15-20% is consumed as tender coconut, 50-55% is for household consumption, 30-35% is used as copra along with other produces such as virgin coconut oil, desiccated coconut power, coconut milk/cream, etc. (ICAR-CPCRI).

DISEASES ASSOCIATED WITH COCONUT

Though coconut palm is hardy in nature and adaptable to varied climatic conditions, instead, it is affected by several diseases leading to heavy economic losses in the coconut growing countries (Henry Louis 2002, Nambiar 1994). Several different type of pathogens affect the coconut palm at different growth stages, starting from seedlings or young plantlets in the nursery to mature nut bearing palms in the coconut growing areas. Susceptibility for infection is from all plant part of the coconut to one or the other diseases. Primary infection of bud tissue turns into 'bud rot' disease. All crown diseases turns into rotting of buds and the ultimate result is very harmful for the coconut plants and nuts production. Young growing parts of the crown, the spindle leaf or the central shoot are the plant parts where earliest visible symptoms are found and are the main reasons for considerable economic losses to the cultivators in certain region of coconut growing areas worldwide. *Phytophthora* spp. cause diseases on various coconut palms include damping off and seedling blight, trunk, crown and root rots, leaf spots, petiole rot, nut drop and apical bud/heart rot which results into plant death.

Coconut palm is an essential and dominant component of the homesteads and garden lands along the coastal parts of southern India and plays a vital role in the socio-cultural and economic life of large number of small and marginal farmers (Dagar *et al*., 2014). The production of coconut is badly affected due to recurring endemic and epidemic outbreak of pests and diseases during the recent past. The major devastating diseases of coconut in southern India are basal stem rot (BSR) caused by *Ganoderma* spp., Kerala wilt or root wilt (Phytoplasma), stem bleeding disease (*Thielaviopsis paradoxa*), bud rot (*Phytophthora palmivora*), grey leaf spot or grey blight (*Pestalotiopsis palmarum*) and leaf blight (*Lasiodiplodia theobromae*; Michel *et al.* 2012).

The major diseases of coconut in Tamil Nadu are BSR and leaf blight out of which leaf blight disease has been reported as a serious problem in Tamil Nadu state for coconut cropping areas. Some districts like Coimbatore, Kanyakumari, Tirunelveli and Erodee are majorly affected by leaf blight disease of coconut resulting in to 15-25% yield loss (Johnson *et al*. 2014). Drying of leaf lets from tip to downwards in the lower fronds and the formation of dark grey to brown color lesions on the coconut nuts are the main symptoms of the leaf blight disease. The BSR disease is also known as Tanjavur wilt (Tamil Nadu) or *Ganoderma* wilt (Andhra Pradesh) or Bole rot or anabe roga (Karnataka) in different parts of coconut growing areas in southern India (Naik 2001). Various fungal diseases that

Table 3. Fungal diseases associated with coconut

Disease	Causal organism	Symptomatology	Management	Reference
Anthracnose	*Glomerellacingulata* (*Colletotrichumgloeosporioides*, anamorph)	Palms are infected at every stage, dried or burnt appearance of outer whorls of leaves, reddish-brown, oval to irregular sunken lesions, dark brown outer margins, lesions coalesce converts into leaf blight, salmon or reddish–brown fruitification of the fungus in the form of dots on the affected leaves. As the disease progresses to mid whorl of leaves results into premature drying and falling of leaves.	Remove and destroy diseased leaves, spray 1% Bordeaux mixture or Mancozeb (0.4%) on outer and mid whorls of leaves at every 40 days intervals. In severe disease status, spray Tilt/Contaf (0.3%) at monthly interval.	Sharma and Kulshreshtha, 2015
Bitten leaf or black rot disease or stem bleeding disease or fruit rot or fruit black rot (recently known)	*Ceratocystisparadoxa* (*Chalarap aradoxa*, anamorph) *Thielaviopsisparadoxa* (De Seyn) Holh.	Black rot of fruits, external symptoms are not correlated with the internal damage, fungus cause immature fruit drop, early symptoms are same as of *Lasiodiplodiatheobromae* (Pat.) Griffon and Maubl, another important pathogen of coconut palm, symptoms in the fruits are variable with the phenological stage, the environmental conditions and the diversity of the pathogen population since virulence in fruits is not much known, fungus leads to postharvest losses.	--	Santos *et al,* 2017; Freire*et al.,* 2013; Pinho*et al*, 2013
Bipolaris leaf spot disease	*Bipolarisincurvata*, *B. setariae*	*Bipolaris incurvata* begin as tiny water soaked flecks to cause leaf spot disease. Leaf spot become enlarge, tan to brown spots circular to oval in shape with a darker brown outer border. Around the leaf spots slight yellowing also occurs. With the enlargement of the spots, the dead leaf tissue turns tan and a yellow area surrounds the lesions. Infected tissue becomes brittle and parts of the diseased area is lost giving the leaf its tattered appearance.	Timely coconut seedlings can be treated with fungicides such as Dithane M45 to reduce new infections; removal of severely infected leaves. In case of mature coconut plants, the canopy is inaccessible and very little can be done. The older leaves should be trimmed and will result into reduction of spore levels of fungus.	Niu*et al.,* 2014; Uchida and Aragaki, 1991
Black scorch	*Ceratocystisparadoxa* (*Chalarap aradoxa*, *Thielaviopsisparadoxa*, anamorphs)	Appearance of black spots on spindle leaves. Yellowing of one or two younger leaves are earlier symptom of the disease. Disease spreads to the older leaves; sunken leaf spots are caused covering the full leaf blade. In the leaf rot disease, basal tissues are quickly and easily separated from the crown.	Not much has been done to manage the pathogen, removal of diseases leaves and tissues should be done.	Santos *et al.,* 2017; Saeed *et al.,* 2016; Abdullah *et al.,* 2009
Bud rot	*Fusariumsolani*	Rotting of the terminal bud and surrounding tissues, it infects the palms of all ages, young palms in low lying and heavy rains are more susceptible to the disease, mostly sporadic disease but sometimes endemic disease, leaves becomes chlorotic, wilts and collapses, Bud rot and premature nut fall.	IPM is the best management strategy. By combining the technologies of bio-pesticides, induced systemic resistance could be strategically utilized, from the stage of planting of coconut seed/seedling as a component of the integrated management package to effectively combat root (wilt)-leaf rot complex. Such as combination of fungicides, *Trichodermaharzianum, Bacillus subtilis, Pseaudomonasfluorescens* reported beneficial in the disease.	Srinivasan *et al.,* 2006
	Fusariumverticillioides	Mutagenic chemical compound fusarin, *F. verticillioides* produces a group of disease-causing mycotoxins - fumonisins - on infected kernels.	Fungicides such as propiconazole, tebuconazole, mancozeb could be effective in control.	Anju and Joseph, 2014
	F. proliferatum	Coconut malformation, vegetative malformation, misshapen and dwarfed leaves, shortened, thickened and tightened leaflets in zigzag and wavy form.	Apply two *Trichodermaharzianum* CPTD28 isolates enriched coir pith cakes in the inner most leaf axils just before the onset of monsoon and repeat after every two months as prophylactic measure.	Goudarzi*et al.,* 2019
	Phytophthorakatsurae *P. nicotianae* *P. palmivora*	Worldwide problem of coconut. Bud rot of coconut is very fatal disease; the first symptom of wilting of the spear leaf; tilting of the spear leaves of first leaf, while all other leaves stay green and healthy is the typical symptom; foul-smelling internal rot above the meristematic zone and the rot is surrounded by a dark yellow-brown border. In the section of rachis of the leaves sometimes found light brown speckles varying in width. Infected palms died in approximately 6-8 months and sometimes much later.	Use of systemic fungicides, remove all infected debris, good sanitation practices, remove dead trees from cropping area and destroy them, irrigate trees early in the day to allow surfaces to dry off during the day. Biocontrol agents like *Trichodermaviride*, *T. hamatum, T. harzianum, T. virens, T. longibrachiatum, T. polysporum* and *Pseudomonas fluorescens* are effective.	Aucique-Perez *et al.,* 2018;Torres *et al.,* 2016; Srinivasulu*et al.*, 2008
	Graphium sp.	Chlorosis of youngest open leaves, leaves becomes chlorotic, wilts and collapses, Bud rot, bud destroyed and premature nut fall.	Biocontrol agents such as *Trichodermaviride, T. hamatum, T. harzianum, T. virens, T. longibrachiatum, T. polysporum* and *Pseudomonas fluorescens* are effective.	Srinivasulu*et al.,* 2008
Catacauma leaf spot	*Phaeochoropsis mucosa*	Spots on the leaves.	--	--
Coconut spoilage disease	*Aspergillusflavus*	Spoilage of coconut fruits, found associated with dried coconut also.	Crop rotation is a better method, leaving a 3-4 year interval between crops of maize or peanuts planted on the same field. Rotations with vegetables or rice could be better selection of crops to reduce soil populations of *A. flavus.*	Kulkarni *et al.,* 2010; Chuku*et al.,* 2007, Gupta and Gopal, 2002
	*Aspergillusniger*van Tieghem	Spoilage of coconut fruits, seed borne fungi, found associated with dried coconut also, reduce the quality and quantity of coconut copra.	Fungus eating insects such as *A. diaperinus, Crematogaster* sp., *T. molitor* and *Necrobiaruflipes* can reduce pathogen load. Heat drying of coconut copra.	Kulkarni *et al.,* 2010; Chuku*et al.,* 2007, Gupta and Gopal, 2002
Damping off	*Fusarium* spp.	Cell wall degrading enzyme secretion by the fungus, found associated with dried coconut also.	Integrated management of damping off (i) seed treatment seedling vigor, (ii) use of resistant or tolerant cultivars to damping-off diseases, (iii) best cropping practices, and (iv) timely treatment of seedlings with effective and conventional pesticides or biopesticides/ biocontrol agents. None of these strategies is effective individually and	Lamichhane*et al.,* 2017; Kulkarni *et al.,* 2010

			thus it requires that all of them are combined within the frame of IPM to manage damping off.	
	Phytophthora katsurae	First symptom of the disease is the death of young coconut fronds. The new leaves wilt, dry, and bent or drooping into the tree canopy. Almost all new leaves lost, trees are left with only a skirt of few older leaves or many times only trunks remains. Under this stage, the heart of the tree is in advanced stages of decay, trees with this symptom never recover. Premature loss of fruits is an early sign and in advance stages, fruit rots become more common. Infected green fruits have characteristic black to brown rots, surrounded by darkened diseased tissue. Internally the diseased husk is dark brown. The fungus spreads through the skin or epidermis of the coconut fruit.	Diseased trees that have dead young leaves cannot survive, application of systemic fungicides has not prevented loss of diseased trees, removal of diseased trees, dryness, fresh air circulation, reduce humidity can be helpful. Infected leaves and petioles should be removed, diversified planting of several coconut trees is better choice, avoid planting trees close together and monitor carefully for the disease.	Uchida *et al.,* 1992; Katsura, 1976
	*Pythium*spp	Wilt, damping-off, Seedling blight, Root rot: In cold wet soils, seeds will decay, stem will turn into light brown and water-soaked near the soil line. Affected seedlings wilt, topple and finally die. Wet soils and temperatures at or above 24 ºC favor pathogen development in the host. *Pythium* spp.: Pre-emergence damping off; decay of seedling before germination in soil and common cause of poor stands, inferior quality of the seed or the untreated seeds are main reasons. *Pythium spp.* and *Phytophthora spp.* cause seed decay.	Integrated pest management is better containing these aspects- 1. Cultural practices; crop rotation, soil treatments, resistant varieties, postharvest treatment. 2. Management of pests through conservation and enhancing of indigenous natural enemies. 3. Biological pest management. 4. Biopesticides. 5. Physical strategies. 6. Synthetic pesticides.	Lamichhane*et al.,* 2017
	Rhizoctoniasolani	Post-emergence, damping-off, the disease occurs after germination of the seedlings from the soil but while still small and tender plantlets. The roots are killed, and diseased plant show water soaking and shriveling of the stems at the ground level; very soon they fall over and die	Integrated pest management is better containing these aspects-1. Cultural practices; crop rotation, soil treatments, resistant varieties, postharvest treatment. 2. Management of pests through conservation and enhancing of indigenous natural enemies. 3. Biological pest management 4. Biopesticides. 5. Physical strategies 6. Synthetic pesticides.	Lamichhane*et al.,* 2017
Dry basal rot	*Ceratocystisparadoxa* (*Thielavio psisparadoxa*, anamorph)	Aged coconut, more than 10 years are more susceptible for the disease. Early symptoms are very similar to stem bleeding disease, infected plant finally dies. *Roots:* Roots are primarily infected and first visual symptoms are visible on stem as reddish brown exudation, characteristic symptom of the disease is extensive rotting and discoloration of root system and rotting moves towards the bole, roots becomes watery with a distinct alcoholic smell. *Stem:* Disintegration of cortical tissues, stele turns brown, from the basal portions of the stem reddish brown viscous fluid exudates, is the first visible symptom of the disease in the palm. As the diseases progresses the internal tissues of the affected stem turn brown in color and rotting in the stem observed up to the height of the bleeding. Stem bleeding begins at the base and extend up to 15 feet in severe cases. Sporophores are formed. *Crown:* Leaflet wilting with yellowing of outer one or two whorls of leaves followed by drooping and drying, and in advance stage of disease the spindle alone remains, first visible symptoms are flaccidity and folding of leaflets, chlorosis and bronzing of lower whorl of leaves. Subsequently emerged spindle leaves are reduced in size and cannot unfold properly, later stem shrivels and dries up. Leaves breakoff in some cases near the base along the midrib. Soft rot of bud set in some cases emitting bad foul smell. In advanced stages of disease, all the leaves drop off leaving very thin decapitated stem, number of flowers, number of buttons reduces and normal development is stopped leading to button shedding. The leaves droop down resulting in hanging down of the bunches. Finally the plant dies.	*Biological management: Antagonistic microorganisms*: *Trichoderma* species (*T. harzianum, T. viride, T. hamatum, T. longibrachiatum, T. virens, T. polysporum*), *P. fluorescens* and *B. subtilus* are important antagonistic microorganisms reported. *Plant extracts:* Plant extracts of neem, banana, Tephrosia, garlic, Pongamia, *Prosopisjulifera*, Glyricidia and *Eichhorniacrassipes* have been found effective in various studies. *Integrated disease management:* As the disease is a constant threat to coconut farmers, various scientists attempted integrated disease management approaches to control the disease. Soil treatment can also be an effective approach to manage the disease.	Snehlataraniet *al.,* 2016; Srinivasulu and Rao 2007
Ganoderma butt rot	*Ganodermaorbiforme, G. tornatum, G. zonatum*	*Ganodermazonatumi:* Fungi enter through wounds on trunk or pruning wounds, yellowing of older fronds, gradually wilting and drooping, fronds collapsing and dying, discoloration of internal tissue of lower stem and overall reduction in vigor.	Spacing between trees manages the chance of infection via root grafts, damaging of tree trunks with tools and machinery should be controlled, remove dead or damaged trees from plantation, if an area is infected with the disease, the ground should be fallowed for 1-2 years prior to a new plantation being done.	Elliott *et al.,* 2010
Graphiola leaf spot or false smut	*Graphiolaphoenicis*	Not true smut, disease mainly affect the older leaves of the palm, also known as cosmetic disease since plants are grown for landscaping rather than nut production, 1-1.5 mm diameter small, grey or black pustules, emerge mainly on the upside of leaf surface. Pustules are on some distance above the leaf surface, and produce the spores and sterile threads of the fungus. The pustules become cup-shaped after discharge. Spores spread through wind and rain. Nut yield greatly reduced by false smut.	*Cultural practices:* Palm plants are prepared in the nursery in polythene bags at a specific distance for proper air circulation. Watering to seedling should be applied below the canopy. *Chemical control:* Copper based fungicides like mancozeb or thiophanate methyl (sometimes formulated with chlorothalanil) as a systemic product.	Jackson and McKenzie, 2017; McKenzie, 2013 a

Gray leaf blight	*Pestalotiopsispalmarum*	Fungi infects and colonize young, wounded or weakened tissues. Disease emergence enhanced by more rainfall and more humidity. Small, yellow-brown spots on leaflets that develop gray centers and dark green borders. Lesions coalesce to form large necrotic patches, tips of leaflets turning gray, canopy converts into blighted appearance.	Usually beneficial to control the disease nurseries as infection of mature coconut palms are rare. Broad spectrum protective fungicides is the solution.	McKenzie, 2013 b
Leaf blight	*Cytosporapalmarum, Pestalotiopsispalmarum, Lasiodiplodiatheobromae*	*Lasiodiplodiatheobromae:* The disease remains problem for aged palms. Infected plants show delayed flowering and exhibit drying of leaf lets from tip to downwards in the lower fronds and the undulated dark grey to brown-colour lesions in the nuts. The conidia are airborne in nature. The infected nuts exhibit brown lesions, undulated wavy margins to cracking symptoms with black pycnidia. Ultimately results into nut reduction.	Integrated disease management strategies should be opted to prevent further spread of this disease. Wounds or injuries to leaf lets are the main predisposing factor for initial infection and further establishment of disease. Avoiding injuries to plant parts can be significant in reducing the incidence and spread of the disease.	Ashokkumar*et al.,* 2018; Dheepa*et al*., 2018; Surulirajan*et al.,* 2014; Marques *et al*., 2013
Leaf spots	*Alternaria sp.; Bipolarisincurvata; Pestalotiopsispalmarum; Pseudoepicoccumcocos; Botryosphaeriadisrupta; Capitorostrumcocoes; Cercospora sp.; Cochliobolushunatus; Cylindrocladiumpteridis; Drechsleragigantea; D. halodes; Epicoccumnigrum; Helminthosporium sp.; Macrophoma sp.; Macrosporiumcocos; Melanconium sp.; Mycosphaerellapalmicola; Periconiellacocoes; Phomopsis sp.; Phyllosticta palmetto; Ramularianecator*	*Alternaria* spp.: Found associated with dried coconut, spots on leaves, and leaf spots of coconut caused by *Bipolarisincurvata*begin as tiny water soaked flecks. These expand into larger, tan to brown spots which are circular to oval with a darker brown border. *Pseudoepicoccumcocos:* Cause brown leaf spot in which oval shaped spots with grey centers appears on upper surface of older leaves (~ 9-10 mm long and 3-4 mm wide) surrounded by dark brown margins. On the underside of leaf, the margins of the spots are not very distinct, but black powdery spore masses develop, spores are very small and round, and cannot seen with naked eyes. The disease affects all varieties of coconuts, high rainfall areas with low temperature are more prone to this disease. *Pestalotiopsispalmarum:* Causes grey leaf spots (~ 15 mm diameter), slightly larger than brown leaf spot, grey with a thin dark brown border. Sometimes, the spots coalesce and are surrounded by yellow halo. Development of fungal fruiting structures, as tiny black dots within the spots, especially on the upper surface of the leaves. Spores spread through rain and wind, so the diseases are more common during wet weather. This disease causes a blight of coconuts. If older leaves are severely blighted this indicates unfavorable growing conditions. These fungal diseases affect more on older leaves. Neither disease is likely to affect production of nuts, although neither has been studied giving proper attention.	*Biological control: Trichodermaharzianum* isolate, they have reported with chitinase and β-1,3-glucanase activity. *Cultural control:* The disease affects older leaves with no effect on yield reduction. Rarely, disease can be severe during long periods of wet weather, low temperature and where palms are growing in nutritionally poor soil. Improve nutrition and growing conditions. When disease occur in nurseries, and plants are under shade, shade levels should be decreased. *Resistant varieties:* Malayan Dwarf and its hybrids are more susceptible to brown leaf spot disease, but no more studies have been done out in Pacific island countries. Fungicides are not advised.	Viriyasuthee*et al.,* 2019;Kulkarni et al., 2010; Kohler et al., 1997
Lethal bole rot	*Marasmielluscocophilus*	Older leaves of palm turns yellow and wilt, reddish-brown rot in bole tissue and deterioration of root system.	Bermuda grass have been reported as alternative hosts for the fungi; infected trees should be uprooted and burned. Soil treatment and fallowing before plantation has been found effective.	Iyer*et al.,* 2018; Jackson and McKenzie, 1988
Lixagrande or Lixapequena or Queima Das Folhas or leaf blight or large verrucosis	*Camarotellacostaricensis, C. torrendiella, Coccostromopsispalmicola, Sphaerodothisacrocomiae (Camarotellaacrocomiae), Catacaumatorrendiella, C. torrendiella,* (disease is of parasite complex)	Also known as leaf blight. In severe infection plant completely dry out, results into complete wilt of the lower and middle leaves of the coconuts in some Brazilian plantations. Immature nut-fall resulting in 20-40% yield losses. *Coccostromapalmicola* is a leaf parasite forming big, drying of leaves, green and cracked stromata (perithecia) concentrated along the edge of leaflets, hence the name lixagrande (in contrast to lixapequena) in Portuguese. This promotes other fungal growth as *Botryosphaeriacocogena* and *P. torrendiella*, and forms a perfect parasite complex.	Effective control for this disease is not known and even chemical control measures are also ineffective.	Vitoria *et al*., 2008; Warwick and Abakerl 2001; Subileau, 1993
Bud rot or immature nut fall disease	*Phytophthorapalmivora; P. katsurae; P. nicotianae; Fusariumverticillioides; Graphium* sp.	The first symptom is wilting of the spear leaf; tilting of the spear leaves of first leaf, while all other leaves stay green and healthy is the typical symptom; foul-smelling internal rot above the meristematic zone and the rot is surrounded by a dark yellow-brown border. In the section of rachis of leaves sometimes found light brown speckles varying in width. Black spots appear on the spindle leaves, Basal tissues of the leaf rot can be easily separated from the crown. If infection spreads to the older leaves, cause sunken leaf spots on the complete leaf blade. Leaf spot margins are irregular and water soaked, and as the leaves are unfolded the specific irregular spots are conspicuous on the blade. Infected palms died approximately in 6-8 months and sometimes much later. This disease is also known as bud rot of coconut and is very fatal.	Remove all infected debris, follow good sanitation practices, remove dead trees from cropping area and destroy them. Irrigate palms early in the day to allow surfaces to dry off during the day. Biocontrol agents like *T. viride, T. hamatum, T. harzianum, T. virens, T. longibrachiatum, T. polysporum*and *Peudomonasfluorescens* have been found effective. Systemic fungicides can also be used to control the disease.	Aucique-Perez *et al.,* 2018;Torres *et al.,* 2016;Srinivasulu *et al.,* 2008; Harrison and Jones, 2003
Nut rot of coconut, Leaf blight of coconut	*Lasiodiplodiatheobromae; Botryosphaeriacocogena*	*Lasiodiplodiatheobromae:* Isolated from coconut tree, pathogenic for both plants and mammalian cells, discoloured lesions on the fruits, first of all symptoms appear on leaflets of matured outer fronds and further spread to other fronds leaving top most leaves including the spindle, unaffected. The spreading of disease starts from the distal end of the leaflets and move towards the midrib then end. At the time of severe infection, whole fronds would be affected and finally nut are reduced.	Quarantine the exotic pathogens is better to prevent the spreading, pathogen developed symptoms on the matured fronds and nuts, so integrated disease management strategies are needed to prevent further spread of the disease. Wounds on the leaf lets are the main predisposing factor for initial establishment therefore, avoiding injuries to plant parts can be beneficial for reducing the incidence and spreading of the disease.	Ramjegathesh*et al*., 2019; Felix *et al.,* 2018; Correia and Costa, 2005
Rot of kernel	*Rhizopusstolonifer* Lind	*Rhizopusstolonifera:* Seed borne fungi, found associated with dried coconut. Cell wall degrading enzyme secretion by the fungus, reduce the quality and quantity of coconut copra.	Seed borne disease, heat drying of coconut and coconut copra, fungus feeding insects are better choice.	Kulkarni *et al.,* 2010; Chuku*et al.,* 2007
	Penicilliumitaliucum Wehmer	*Penicilliumitaliucum:* Seed borne fungi, found associated with dried coconut, reduce the quality and quantity of	Seed borne disease, heat drying of coconut, Heat drying of coconut copra	Chuku*et al,* 2007

		coconut copra.		
Stem bleeding or trunk rot	*Ceratocystisparadoxa* (*Chalarap aradoxa*, *Thielaviopsisparadoxa*, anamorphs)	Exudation of a dark reddish brown liquid from the longitudinal cracks in the bark and wounds on the stem, liquid oozing out dries up and changes black, as the disease progresses lesions spread upwards, the tissues below the lesions rotten and change into first yellow then black. In advance stage of disease, interior tissues decay and trunk become hollow, the outer whorl of the leaves turn yellow, dry and shed prematurely. The production of bunches greatly reduced, trunk gradually tapers at the apex and crown size reduced in severe cases and nut get fall down.	*Disease avoidance:* Avoid wounding on stem/trunk maintenance and during their harvest and transport. For installation in a landscape, avoid contact of injured coconut stems with soil, avoid wounding and overwatering, and avoid using spikes to climb the palms for pruning maintenance, avoid installing sprinkler irrigation emitters that spray water on coconut trunks. Burn/destroy the chiseled pieces. For severe diseased palms, removal and destruction in the only option. *Treatment:* Early treatment carries the best chance for disease control, in early infections scrape out the rotten portion. On the base of affected coconut apply neem cake. *Chemical:* Treat infected areas or injured parts with fungicide such as, Bordeaux paste, Mancozeb, or copper oxychloride followed by sealing with coal tar.	Nelson, 2005; Ploetz 1999
	Thielaviopsis spp.	Killed large numbers of coconut palm in southeastern Florida, very deleterious fungi for the coconut palm crops.	No efficient method available to prevent or cure this disease. The palm should be removed immediately, destroyed and should not be recycled.	Elliott et al., 2010
Stigmina leaf spot	*Stigminapalmivora*(Sacc.) Hughes	Important foliage disease of palms, severe leaf spotting is caused by the fungus, necrosis of frond. It starts with small dark circular to irregular lesions which appear water soaked or edema-like. Around the original leaf spot, a tan band of necrotic tissue develops as the disease develops, these necrotic areas are surrounded by a thin ring of dark water soaked necrotic tissue. Within these tan areas, the fungus sporulates and easily seen with a hand lens as dark olivaceous-brown tufts scattered randomly within the leaf lesions. Typical symptoms as dark water soaked center and the necrotic peripheral ring are quite distinctive when compared to other palm leaf diseases caused by various species of *Bipolaris, Cylindrocladium, Drechslera* and *Exserohilum.*	Proper air circulation, reduction of overhead watering, distancing between the plants and removal of leaf litter will control the spread and severity of the disease. Fungicides as Bordeaux mix, basic copper sulfate and iprodione (Chipco 26019) will be effective if used with previously mentioned cultural controls practices.	Elliott, 2005; Leahy, 1988
Thread blight	*Ceratobasidiumnoxium, Corticiumpenicillatum, Pellicula riafilamentosa*	*Corticiumpenicillatum* fungal threads move up and down the midrib, confined to the underside of the leaflet, colonizing the leaflets one after the other. Disease appears on the lower side of a leaflet, in the middle, and then the threads of the fungus move to the leaf midrib known as rachis. Rots start developing near the midrib and destroy the leaflets except the tips which remains green, the midrib of the frond does not appear to be injured by the fungus. Fungus is non-sporulating in this disease, although it is stated that primary infection of the leaflets are caused by airborne spores. Infection also occurs by leaf-to-leaf contact.	Thread blight can withstand desiccation from sun and drying winds. Heavy rainfall, shade, high humidity, close spacing between the plants will enhance the disease severity and avoidance of these conditions is better to control disease. Maintain free flowing of wind to dry the surface of leaflets and reduce the chance of thread blight infection. Also avoid leaf wetness for prolonged periods. Cutoff the infected leaves and burn immediately. Fungicides can be applied on young palms only.	Manimekalai et al., 2010
*Ganoderma*wilt or Tanjare wilt or Basal Stem-end	*Ganodermalucidem, G. applanatum*	Primary symptoms start with yellowing, withering and drooping of the outer whorl of leaves which is followed by exudation of reddish brown liquid through cracks at the base of the trunk and oozing spread upward. Rotting of the basal portion of the stem, bracket formation at the base of the trunk and tissues decay at bleeding points. The stem bark turns brittle and often gets peeled off in flakes, forming open cracks and crevices. Inner tissues turn discolored, disintegrated and emit a bad smell. Finally, the palm dies off. *Ganoderma* usually appears at the base of the stem.	*Cultural methods:* Remove and destroy diseased plants. At the time of flowering, grow any green manure crop and ploughed in. *Biological methods:* Apply *Pseudomonas fluorescens* (Pfl) along with *Trichodermaviride*, *Phosphobacter* along with *Azotobactor* and FYM, FYM along with neem cake and fertilizers. *Chemical methods:* The bleeding patches in the stem may be chiseled and apply tridemorph (5% of calxin) and subsequently with hot coal tar. Make a trench, 4 feet away from the base of the trunk and apply Sulphur dust inside the trench. Forty litres of 1% Bordeaux mixture should be applied as soil drench around the trunk in a radius of 1.5 m. Aureofungin-sol + $CuSO_4$ in 100 ml water or Tridemorph in 100 ml water should be applied as root feeding. Trunk injection or root treatment with Calixin also help to control the incidence.	Snehalatharani et asl., 2016

has been found associated with coconut globally are summarized in table (Table 3).

CONCLUSIONS

Multispecies cropping system is required to be used to enhance production per unit area of orchards of coconut palm. Tender coconut water, coconut powder, coconut charcoal, virgin coconut oil, tender ball copra, coconut chips, coir industry etc are the need of hour for product diversification. To increase area and production is greatly possible under coconut cultivation because of availability of small irrigation reservoirs and fresh river water for irrigation of coconut in all districts of southern India.

In major coconut growing states occurrence and distribution of different fungal diseases bare that the fungal disease is not confined to any soil type, however is more prevalent in lighter soils. Morphological, cultural and molecular studies of the isolated pathogens revealed that high degree of variation was found between these pathogens. Although, early detection involving indicator plants, protein and DNA based molecular identification is found promising in monitoring and bio-control based integrated disease management measures of the difficult soil borne fungal pathogens in coconut (Nguyen *et al*., 2016, Niral *et al.*, 2019). Countrywide and worldwide research scientists have given efforts, thereby resulting in identifying etiology of the disease, phases in symptom development, role of weather, temperature, humidity and soil on the disease and how to control or contain the disease using bio-control agents and chemical fungicides. Scientists have made great efforts time and again on reviewing the status of the disease and its development (Jnanadevan 2019, Josephrajkumar *et al.* 2018).

Intensive care and management, intercropping and pest control can lead to increment in coconut productivity in India, as it is already high in the country. India alongwith recent developments in early detection, molecular identification and integrated disease management methods and to identify research priorities and knowledge gaps can lead in coconut production as well as in productivity and marketing.

REFERENCES

Abdullah SK, Asensio L, Monfort E, Gomez-Vidal S, Salinas J, López Lorca L and Jansson H 2009 Incidence of the two date palm pathogens, *Thielaviopsis paradoxa* and *T. punctulata* in soil from date palm plantations in Elx, South-East Spain. *J. Plant Prot. Res.* **49** 276–279.

Anju C and Joseph J P 2014 Fungicidal Bioassay on Foliar Fungi Associated with Yellowing Disease of Coconut. *Pesti Res J* **26**(1) 90- 93 ISSN : 0970-6763. Online ISSN : 2249-524X.

Ashokkumar P, Ushamalini C and Ramjegathesh R 2018 Variations in Morphological and Molecular characterization of *Lasiodiplodia theobromae* (Pat.) Griffon and Maubl associated with coconut leaf, *Madras Agric. J.,* **105** (1-3) 66-71.

Aucique-Perez CE, Daza ES, Avila-Diazgranados A and Romero HM 2018 Chlorophyll a fluorescence and leaf temperature are early indicators of oil palm diseases, *Scientia Agricola*, **77**(2) e20180106, doi: http://dx.doi.org/10.1590/1678-992X-2018-0106

CDB 2015 Cotton Development Board, Bangladesh, Dhaka

Chuku EC, Ogbalu OK and Osakwe JA 2007 Fungi of coconut (*Cocos nucifera* L.)-their deteriorative ability, quality stability and the role of the fungus-eating insects, *Journal of applied sciences*,volume 7 (20): 3106-3110.

Correia MS, Costa JL and da S 2005 Dispers~ao anemofila do fungo *Lasidiplodia theobromae* em plantacoes de coquiero. *Fitopatol Bras* **30** 150–154.

Dagar JC, Pandey CB and Chaturvedi CS 2014 Agroforestry: A Way Forward for Sustaining Fragile Coastal and Island Agro-Ecosystems. In: *Agroforestry Systems in India: Livelihood Security and Ecosystem Services, Advances in Agroforestry, eds.* Dagar JC, Singh AK & Arunachalam A Springer Publisher. Pp 185–232. doi: 10.1007/978-81-322-1662-9_7

Dheepa R, Goplakrishnan C, Kamalakannan A, Nakkeeran S, Mahalingam, CA and Suresh J 2018 Coconut nut rot disease in India: Prevalence, characterization of pathogen and standardization of inoculation techniques. *Int J of Curr Micro and App Sc* **7**(2) 2046-2057.

Elliott ML, Des Jardin EA, O'Donnell K, Geiser DM, Harrison NA and Broschat TK 2010 *Fusarium oxysporum* f. sp. *palmarum*, a novel forma specialis causing a lethal disease of *Syagrus romanzoffiana* and *Washingtonia robusta* in Florida. *Plant Dis* **94** 31-38.

Elliott ML 2005 Leaf Spots and Leaf Blights of Palm, Plant Pathology Department, UF/IFAS Extension. Pp 218

Felix C, Salvatore MM, Della Greca M, Meneses R, Duarte AS, Salvatore F, Naviglio D, Gallo M, Jorrin-Novo JV, Alves A, Andolfi A, and Esteves AC 2018 Production of toxic metabolites by two strains of *Lasiodiplodia theobromae*, isolated from a coconut tree and a human patient, *Mycologia*, 110(4) 642-653,doi: 10.1080/00275514.2018.1478597

Freire MGM, Souza CLM, Portal TP, Machado RMA, Santos PHD, Dias VM 2013 Effect of castor bean oil on post harvest fungal pathogen of coconut: *Lasiodiplodia theobromae*. *J of Pl Physiol & Patho*l, Los Angeles, 1 1-7 doi: 10.4172/2329-955X.1000108

Goudarzi A, Seyahooei MA, Bagheri A 2019 Coconut malformation: An emerging disease caused by *Fusarium proliferatum* in southern Iran. *J of phytopathol* 167(11-12) 609-617, https://doi.org/10.1111/jph.12851.

Gupta A and Gopal M 2002 Aflatoxin production by *Aspergillus flavus* isolates pathogenic to coconut insect pests. *J Microbial Biotechnol*. **18** 325-331.

Harrison NA and Jones P 2003 Diseases of coconut. In: *Diseases of tropical fruit crops, eds* Ploetz RC CAB international. Pp 197-225.

Henry Louis I 2002 Coconut–The Wonder Palm, Pp. 206–218. Hi-Tech Corporation Ramanputhoor, Nagercoil.

ICAR-CPCRI 2015 Vision 2050. ICAR - Central Plantation Crops Research Institute, Kasaragod. Pp 71.

Iyer R, Gunasekharan M and Hegde V 2018 Coconut: Maladies and Remedies, In: *The Coconut Palm (Cocos nucifera* L.*) - Research and Development Perspectives*. DOI: 10.1007/978-981-13-2754-4_10

Jackson GVH and McKenzie EHC 1988 *Marasmiellus cocophilus* on coconuts in Solomon Islands. *FAO Plant Prot Bull* **36** 91-97.

Jackson G and Eric McKenzie E 2017 Pacific Pests and Pathogens - Fact Sheets. Pestnet, Australian centre for international agricultural research. Australian govt.

Jnanadevan R 2019 Timely management of Nutrient Deficiencies for reaping higher yield, ICAR- CPCRI, Kasargod. *Indian coconut journal* 2019

Johnson I, Meena B and Rajamanickam K 2014 Biological management of leaf blight disease of coconut using rhizosphere microbes.

J Plant Crops **42**(3): 364-369.

Josephrajkumar A, Chandrika M, Prathibha PS, Rajkumar, Nalinakumari T, Nair CPR 2018 Pest Dynamics and Suppression Strategies. In: *eds* Nampoothiri K, Krishnakumar V, Thampan P & Nair M. *The Coconut Palm (Cocos nucifera L.) - Research and Development Perspectives*. Springer Singapore. https://doi.org/10.1007/978-981-13-2754-4_12

Katsura K 1976 Two new species of *Phytophthora* causing damping-off of cucumber and trunk rot of chestnut. *Trans. Mycol. Soc. Japan* **17** 238-242.

Kohler F, Pellegrin F, Jackson G, McKenzie E 1997 Diseases of cultivated crops in Pacific Island countries. South Pacific Commission. Pirie Printers Pty Limited Canberra Australia.
KulkarniI JR, Padule DN and Umrikar SH 2010 A study on presence of Aflatoxin in dried coconut*, Asian J Bio Science* 4(2) 142-145.

Lamichhane JR, Durr C, Schwanck AA, Robin MH, Sarthou JP, Cellier V, Messean A, Aubertot JN 2017 Integrated management of damping-off diseases. A review. *Agron. Sustain. Dev.* **37** 10
https://doi.org/10.1007/s13593-017-0417-y

Leahy RM 1988 Stigma leaf on palm, Plant Pathology Circular No. 308. Fla. Dept. Agric. & Consumer Serv. Division of Plant Industry.
Manimekalai R, Soumya VP, Sathish Kumar R, Selvarajan R, Krishna Reddy M, Sasikala George V Thomas, Rajeev M and Baranwal VK 2010 Molecular detection of 16Sr XI group Phytoplasma associated with Root (Wilt) Disease of coconut (*Cocos nucifera* L.) in India. *Plant disease* **94** 636 .

Marques MW, Lima NB, de Morais MA, Barbosa MA, Michereff SJ and Camara MP 2013 Species of *Lasiodiplodia* associated with mango in Brazil. *Fungal Diversity* **61** 181-193.
McKenzie E 2013a *Graphiola cocoina* PaDIL - http://www.padil.gov.au.

McKenzie E 2013b Pestalotiopsis palmarum *(Pestalotiopsis palmarum)*. Available online: PaDIL - http://www.padil.gov.au.

Michel D, Franqueville HD, Ducamp M 2012 Bud rot and other major diseases of coconut, a potential threat to oil palm. Texte de la communication presentee lors du congres : Existing and Emerging Pests and Diseases of Oil Palm - Advances in Research and Management. 4th IOPRI-MPOB International Seminar, Bandung Indonesia http://seminar.iopri.org/
Naik RG 2001 Chemical control of basal stem rot of coconut. *Agric Sci Dig* **21**(4) 249

Nambiar KKN 1994 Diseases and disorders of coconut. In: *Advances in Horticulture*, Vol. X – *Plantation and Spice Crops* Part – 1. Pp 857–82. *eds* Chadha KL & Rethinam P. Malhotra Publishing House New Delhi.
Nelson S 2005 Stem Bleeding of Coconut Palm, UH–CTAHR. *Plant Disease* Pd-30

Nguyen NH, Song Z, Bates ST, Branco S, Tedersoo L, Menke J, Schilling JS, and Kennedy PG 2016 Funguild: an open annotation tool for parsing fungal community datasets by ecological guild. *Fungal Ecology* **20** 241–248.

Niral V, Samsudeen K, Sudha R, and Ranjini TN 2019 ICAR- CPCRI, Kasargod, Genetic resource management and improved varieties of coconut, *Indian coconut journal* 2019

Niu X-Q, Yu F-Y, Zhu H and Qin W-Q 2014 First report of leaf spot disease in coconut seedling caused by *Bipolaris setariae* in China. *Plant Disease* **98(12)** 1742 https://doi.org/10.1094/PDIS-05-14-0522-PDN

Pinho DB, Dutra DC and Pereira OL 2013 Notes on *Ceratocystis paradoxa* causing internal post-harvest rot disease on immature

coconut in Brazil. *Tropical Plant Pathology* Brasília DF. **38** 152–157 doi: 10.1590/S1982-56762013000200010

Ploetz RN, Harrison and Jones P 1999 Common names of plant diseases: Diseases of coconut palm. *Amer Phytopathol Soc* http://www.apsnet.org/online/common/names/coconut.asp .

Raghavi MD, Sakthi Balaa M, Surender S, Lokesh P and Kalidas K 2019 Review on area, production and productivity of coconut in India. IMPACT: *Inter J Res Bus Manage* (IMPACT: IJRBM) ISSN (P): 2347-4572 ISSN (E): 2321-886X 7(1) 1-6

Ramjegathesh R, Johnson I, Hubballi M and Maheswarappa HP 2019 Characterization of *Lasiodiplodia theobromae* causing leaf blight disease of coconut. *J of Plantation Crops* **47**(2) 62-71 doi: 10.25081/jpc.2019.v47.i2.5763

Saeed EE, Sham A, El-Tarabily K, Abu-Elsamen F, Iratni R and AbuQamar SF 2016 Chemical control of black scorch disease on date palm caused by the fungal pathogen *Thielaviopsis punctulata* in United Arab Emirates. *Plant Dis* **100** 2370–2376

Santos PHD, Mussi-Dias V, Freire MGM, Carvalho BM and Silveira SF 2017 Diagrammatic scale of severity for postharvest black rot (*Ceratocystis paradoxa*) in coconut palm fruits. *Summa Phytopathologica* 43(4) 269-275 https://doi. org/10.1590/0100-5405/170792.

Sharma M and Kulshrestha S 2015 *Colletotrichum gloeosporiodes*: An anthracnose causing pathogen of fruits and vegetables. *Biosci Biotechnol Res Asia* **12** (2).

Shinde VV, Kshirsagar PJ, Talathi JM, Ghavale SL, Wadkar SS, Sanap PB, Patil VK, Rane AD, Wankhede SM, Hake AD, Dodake SB, Haldankar PM and Bhattacharyya T 2018 Coconut - Real Kalpavriksha to Raise Farmers' Income. *Adv Agric Res & Tech J* **2**(2).

Singh AK 2016 Coconut development in India-The status. *Indian Coconut J* **59** 5-10.
Snehlatharani A, Maheswarappa HP, Devappa V and Malhotra SK 2016 Status of coconut basal stem rot disease in India – A review. *Ind J Agric Sci* **86** (12) 1519–29.

Srinivasan N, Jyothi Rahn S and Anishkumar VK 2006 Evaluation of fungicides and antagonistic organism against major pathogens of leaf rot disease of coconut and their eco-friendly management. *Cord* 2006 **22** (1).

Srinivasulu B and Rao DVR 2007 *Coconut Diseases*, Pp 114. International Book Distributing Co. Lucknow UP India

Srinivasulu B, Gautam B, Sujatha A, Kalpana M, Vijayalakshmi P, Pavani Rani A, Satya Ratna, B, Chandran S and Rama Krishna Y 2008 Bud rot disease of coconut. Project AICRP on Palms (ICAR). Andhra Pradesh Horticultural University India

Subileau UC 1993 Systematique et biologie du complexe parasitaire constitué du *Phyllachora torrendiella* (Bat.) nov. comb. et du *Botryosphaeria cocogena* nov. sp., agents fongiques du dessèchement foliaire du cocotier au Brésil. Paris Université Paris **6** 121 Thèse de Doctorat.

Surulirajan M, Rajappan K, Satheesh K, Annadurai K, Jeevan K and Asokhan M 2014 Isolation of leaf blight of coconut and screening of fungicides against the pathogen. *Int J Trop Agric* **32**(3) 475-478.

Torres G, Sarria G, Martinez G, Varon F, Drenth A, Guest D 2016. Bud rot caused by *Phytophthora palmivora*: a destructive emerging disease of oil palm. *Phytopathol* **106** 320-329.

Uchida JY and Aragaki M 1991 Bipolaris and Exserohilum leaf spots. In*: Diseases and*

Disorders of Ornamental Palms. eds Chase & Broschat. APS Press St. Paul Minnesota. 55 Pp.

Uchida JY, Aragaki M, Ooka JJ and Nagata NM 1992 *Phytophthora* fruit and heart rots of coconut in Hawaii. *Plant Disease* **76** 925-927.

Viriyasuthee W, Jogloy S, Saksirirat W, Saepaisan S, Gleason ML and Chen RS 2019 Biological Control of Alternaria Leaf Spot Caused by *Alternaria* spp. in Jerusalem Artichoke (*Helianthus tuberosus* L.) under Two Fertilization Regimes. *Plants* ***8*** 463.

Vitoria NS, Bezerra JL, Gramacho Karina P and Luz Edna DMN 2008 *Camarotella torrendiella* comb. Nov. *C. acrocomiae*: agentes etiologicos das lixas do coqueiro. *Trop. plant pathol.* **33**(4) Pp.295-301. ISSN 1982-5676. https://doi.org/10.1590/S1982-56762008000400006.

Warwick DRN and Abakerli RB 2001 Chemical control of Lixas and leaf blight disease of coconut. *Palms* **45**(4) 168-170.