

STUDIES ON THE INCIDENCE AND RESISTANCE OF SOME MAJOR DISEASES OF COCONUT PALM IN THE INDOGANGETIC PLAINS OF WEST BENGAL, INDIA

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The present investigation has explored the prevalence of 5 major diseases of coconut palm, namely bud rot, stem bleeding, mahali or fruit rot and nut fall, leaf blight or grey leaf spot and anab-e-roga in different coconut growing belts of West Bengal. All these diseases were found to be prevalent in the Indo-Gangetic plains whereas some of which were present in other coconut growing belts of West Bengal depending upon the climatic conditions. Variation in the incidence of 4 diseases, namely bud rot, stem bleeding, fruit rot and nut fall and leaf blight were recorded from one year to another and the highest incidence of all these diseases were recorded in 1986 and lowest in 1984. Comparatively cooler temperature (max 30.0 to 31.5°C and min 23.2 to 25.6°C), high relative humidity (max 88.0 to 90.0% and min 64.7 to 72.8%) and highest amount of rainfall (total 896.1 mm) were found to be the main attributing factors for the highest incidence of these diseases in 1986.

Out of 14 genotypes tested for resistance to the above four diseases, 3 genotypes, namely San Ramon, Hazari and Borneo were found resistant to all these diseases. This indicates the possibility of development of multiple resistant varieties of coconut palm for the diverse agro-ecosystems of India. Wide range of variation in respect of disease reaction in the present study indicates the heterozygous condition in the genetic make up of the tested genotypes. Locational variation in respect of reaction to bud rot disease in case of Malayan Dwarf genotypes was also recorded.

INTRODUCTION

The coconut palm (*Cocos nucifera* L.) is one of the most beautiful and useful palms in the world. It is important in that it provides a variety of useful products. Every part of the tree is utilised for some purposes or the other.

The coconut palm is grown throughout the tropical regions of the world. Because of its highly outcrossing nature, several varieties or types widely differing from each other, exist in these regions.

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The coconut is heterozygous with the result that the yield capacity due to its genetic make up varies greatly from plant to plant even within the same variety or type. Coconut palms are broadly classified into two groups, the Talls and the Dwarfs.

The Tall varieties are the common type that occur throughout this country. The Tall cultivars that are largely grown in India are the West Coast Tall and East Coast Tall. The Dwarf varieties are shorter in nature and life span as compared to Talls. They start bearing earlier compared with Taller. The size of the nut and the quality of copra are inferior to Talls. The hybrids between Tall and Dwarf forms show hybrid vigour for growth and nut yield. Among these hybrids, Chowghat Dwarf Orange x West Coast Tall (CDO x WCT), Lakshadweep Ordinary x Ganga Bondam (LO x GB), and LO x CDO are superior in both terms of yield and resistance to pest and diseases over other combinations. LO x GB and LO x CDO also showed tolerance to drought.

In Indian context, coconut palm ranks third both in term of area and production among the different coconut producing countries in the world with 1.11 million hectares and 5644.3 million nuts. India's per hectare yield of coconut is only 5100 nuts which is considered very low compared to its potential. The main reason for such low yield is that the cultivators do not pay much attention to its culture. Lack of enthusiasm among the cultivators for planting new certified seedlings of this crop has been also one of the major causes of low spread of the high yielding varieties.

The All India Coordinated Coconut and Arecanut Improvement Project (AICCAIP) has also introduced several exotic varieties of coconut mostly from Malayasia, West Indies, Philippines and British Solomon Island since 1976 onwards. With the introduction of these new varieties and other hybrids the cultivation practices seem to be very intense and such practices have favoured the incidence of a number of diseases in the different coconut growing states of India. At present a total number of 13 diseases of coconut palms are found to occur in different states of India. Most of them are considered to be major ones some of which are lethal to this crop, while others gradually reduce the vigour of the palm causing severe loss in yield (Martyn, 1955; Menon and Pandalai, 1958; Schieber, 1976; Thomas, 1978; Bose, 1985). These are listed in a tabular form.

Although coconut palm is found to be attacked by a number of diseases in the Indo-Gangetic plains including other parts of West Bengal very little work has been done in this part of the country regarding the systematic studies of these diseases. The present study was, therefore, initiated to investigate the occurrence of these diseases (bud rot, leaf blight or grey leaf spot, Mahali or fruit rot & nut fall and stem bleeding) and the factors such as atmospheric temperature, rainfall

Name of the disease	Causal organism	Distribution
*1. Bud rot	<i>Phytophthora palmivora</i>	All coconut growing states
2. Leaf rot	<i>Bipolaris halodes</i>	Southern states and coastal regions
3. Leaf blight or grey leaf spot	<i>Pestalotia palmarum</i>	All coconut growing States
*4. Mahalo or fruit rot & nut fall	<i>Phytophthora palmivora</i>	Most of the coconut growing states
*5. Stem bleeding	<i>Ceratostomella paradoxa</i>	Most of the coconut growing states
*6. Anab-e-roga or trunk and root rot	<i>Ganoderma lucidum</i>	Southern states
*7. Tatipaka disease of Andhra	Unknown Mycoplasma like organism (MLO) ?	East Godavari & other districts of Andhra Pradesh
*8. Tanjavur wilt	<i>Ganoderma lucidum</i>	West coastal areas
*9. Root wilt (Travancore wilt or Kerala wilt)	MLO ? or Virus ?	Kerala

* Diseases which are lethal.

and relative humidity leading to the severity of these diseases during the monsoon period (July to September) of the year 1984, 1985 and 1986. About 14 genotypes of coconut palm consisting of both Tall and Dwarf varieties and originating from different countries of the world were also evaluated during these years to find out the sources of resistance to these four major diseases.

MATERIALS AND METHODS

Identification of different diseases

In order to find out the prevalence of different diseases a survey was undertaken during the post monsoon period (October - November) of three successive years 1981, 1982 and 1983 at the different Indo-Gangetic belts and coastal districts of West Bengal. The field symptoms of the individual diseases were studied and these were found similar at all locations. The disease samples from the infected plants

were collected and the causal pathogens of the individual diseases (bud rot, leaf blight or grey leaf spot and Mahali or fruit rot & nut fall) were isolated and grown in the laboratory on Potato Dextrose Agar (PDA) medium at $27 \pm 1^\circ\text{C}$ for 7 days for further confirmation. On the basis of cultural and morphological characteristics the causal pathogens were identified. The other two diseases, namely stem bleeding and anab-e-roga were, however, identified on the basis of their typical external symptoms as described elsewhere in details (Bose, 1985; Muliya *et al*, 1986).

Study on the incidence of diseases in different years

The study on the incidence of 4 diseases (bud rot, leaf blight or grey leaf spot, Mahali or fruit rot & nut fall and stem bleeding) was undertaken at the University Experiment Farm, Mondouri, District-Nadia during the year 1984, 1985 and 1986 under the natural field condition. A susceptible East Coast Tall variety was included in the present study. The seedlings were planted in May-June during the year 1978 following the square system of planting in $1.0 \times 1.0 \times 1.0$ m pits previously filled with loose soil, powdered cow dung and ash upto a depth of 60 cm. The distance between one pit to another was kept 8 m. Each row consisting of 15 plants represented a single replication and 6 such replications were kept. Normal agronomic practices were followed and no plant protection measure was undertaken during the entire experimental period. The incidence of the diseases were recorded at the end of rainy season of each year. The diseases like bud rot, stem bleeding and fruit rot & nut fall were rated on the percentage basis i. e., percentage of plants infected out of total plant population, whereas leaf blight was recorded on the basis of 1 (very slight to slight infection) to 5 (very heavy infection) scale.

For studying the effect of different climatic factors in relation to the incidence of these diseases the daily maximum and minimum average temperature ($^\circ\text{C}$), maximum and minimum average relative humidity (%) and total monthly rainfall (mm) during July to September of 1984 to 1986 were recorded because the above four diseases were found to occur in nature during this period.

Study on the evaluation of different genotypes of coconut palms to the above four diseases

A total number of 14 genotypes consisting of Tall and Dwarf varieties and originating from different countries of the world were tested for resistance to bud rot, leaf, blight, fruit & nut fall and stem bleeding at the University Experimental Farm, Mondouri during the year 1984, 1985 and 1986. The germplasm were obtained from the Director, Central Plantation Crops Research Institute, Kasaragod-670124 India. The planting was done during 1980 following similar method as described earlier and normal agronomic practices were followed without taking any plant

protection measure. Each variety consisting of 5 plants represented a single replication and 4 such replications were kept. The evaluation was done under the natural field condition as per instruction received from the Coordinating Unit unless otherwise mentioned. Before planting of the experimental genotypes a local variety of coconut was planted about 3 years back as border plants surrounding the experimental genotypes. This local variety was gradually showing progressive severity of the above four diseases with moderate to heavy infection as the case arised from 1982 onwards. This process fully served the purpose of establishing donor plants for providing constant source of inoculum of the four diseases and their subsequent transmission to the acceptor experimental genotypes through natural means such as wind, rain water or insects.

The incidence of the diseases were recorded each year after the monsoon and the final data were recorded in the year 1986. The individual diseases was rated similarly as before and the type of disease reaction in a genotype/variety was determined as follows.

1. Leaf blight

Average disease index

1 to 1.5

Intensity of infection
Very slight to slight infection, one or two to few scattered lesions on mature leaves of the outer whorl

Reaction

Resistant

1.6 to 2.5

Light infection, moderate number of lesions on mature leaves only of the outer whorl.

Moderately resistant

2.6 to 3.5

Moderate infection, abundant lesions on mature leaves of the outer whorl

Moderately susceptible

3.6 to 4.5

Heavy infection, lesions abundant on mature leaves, extending to upper leaves of the whorl

Susceptible

4.5 to 5.0

Very heavy infection, lesions abundant and coalesce to form irregular necrotic patches on the mature leaves of the outer whorl and complete drying and shrivelling of the leaf blade.

Highly susceptible

2. Bud rot, stem bleeding and fruit rot & nut fall

Plants infected (%)	Reaction
Below 20	Resistant
21 to 40	Moderately resistant
41 to 60	Moderately susceptible
61 to 80	Susceptible
Above 80	Highly susceptible

RESULTS

Study on the individual diseases

Leaf blight or grey leaf spot (*Pestalotia palmarum*) — The disease was found to be widely prevalent in all the coconut growing belts of West Bengal. The disease symptom was found to be started with the onset of the monsoon and the maximum infection was recorded at the end of the monsoon period. Most of the local cultivars both Tall and Dwarf were found to be moderately susceptible to highly susceptible to this diseases. The symptoms generally develop in the mature leaves of the outer whorl. Minute yellow spots encircled by greyish bands appear on the leaf surface which later become greyish white. The spots later coalesce into irregular necrotic patches. In case of severe infection complete drying and shrivelling of the leaf blade are observed (Fig. 1).

Bud rot (*Phytophthora palmivora*) — The disease was recorded in comparatively cooler and high rainfall areas. Most of the local varieties were found to be moderately susceptible to susceptible in disease reaction. The disease appears during the monsoon period. The first symptom of the disease is the yellowing of one or to young leaves surrounding the spindle. The spindle withers and droops down. The tender leaf bases and the soft tissues of the crown rot into a slimy mass decayed material, emitting a fowl odour. The disease proves fatal if it is not checked in the early stage. Even after the death of the central bud the outer leaves and bunches many continue to remain intact for several months. Palms of all ages were found to be susceptible to this disease, but it was more frequent in young palms (Fig. 2).

Mahali or fruit rot & nut fall (*Phytophthora palmivora*) — The symptoms of this disease are shedding of female flowers (buttons) and mature nuts. Water soaked lesions appear on the young fruit or buttons near the stalks which later develop into a decay of the underlying tissues. The pathogen appears as whitish webby growth on the surface of the affected part. The pathogen is more active during the rainy season when the atmospheric conditions are favourable for its growth. The



(1)



(2)



(3)

Figures 1 to 3. Field symptoms due to three diseases of coconut palm : (1) Anab-e-roga or trunk and root rot, (2) Bud rot and (3) Leaf blight or grey leaf spot.

disease was found to be more destructive in the cool and humid areas. The local cultivars were found moderately resistant in reaction to this disease.

Stem bleeding (*Ceratostomella paradoxa*)- The disease was widely found to be prevalent throughout the coconut growing belts of West Bengal. Most of the local cultivars were found to be moderately susceptible to susceptible in disease reaction. The typical symptom of the disease is observed as the exudation of a reddish brown liquid through cracks developing on the trunk. The cracks are generally noticed in the lower portion of the stem but they spread throughout as the disease advances. On drying, the liquid turns black. The tissues around the bleeding points start decaying first which later develop into a general decay of the tissues underneath the bark. The disease may be fatal under the favourable climatic condition of moderate temperature and high humidity. In some cases of advanced stages, infestation with *Diocolandra* weevil can be seen which quickens the deterioration of the palms. The disease was more common in the older plants.

Anab-e-roga or trunk and root rot (*Ganoderma lucidum*) - The disease was observed in an isolated case only in a local variety at the University Experimental Farm during 1986. Young plant of about 5 years old developed infection due to this disease. The disease was probably found to be favoured by comparatively lower temperature, high relative humidity and high rainfall during the monsoon months of this year. The older leaves first showed the sign of drooping and withering and remained suspended around the trunk for several months. Younger leaves remained green for sometime. The tree ultimately become barren and it did not show any sign of inflorescence. The crown was reduced in size and the new leaves became smaller and yellowish in colour which finally withered as the bud decayed (Fig. 3).

Study on the incidence of the four diseases in different years

The data incidence of the four diseases of coconut palm in different years are presented in Table 1. It is evident from the table that the incidence of these diseases varied from year to year. The incidence of all these diseases were recorded to be highest in 1986 and lowest in 1984. Among the four diseases the incidence of leaf blight was recorded to be highest (60 to 85%) followed by stem bleeding (55 to 70%), bud rot (35 to 50%) and fruit rot & nut fall (25 to 45%). The results of the present study indicate that the incidence of the above four diseases was favoured by 1986 rainy season.

Reaction on the different genotype/varieties of coconut palm to four diseases

The reaction of different genotypes/varieties of coconut palm to leaf blight, bud rot, stem bleeding and fruit rot & nut fall has been presented in Table 2. The table

Table 1. Incidence of four diseases of coconut palm in different years

Year	% Plants infected by different diseases			
	Bud rot	Stem bleeding	Mahali or fruit rot and nut fall	Leaf blight or grey leaf spot*
1984	35.0	55.0	25.0	60.0 (3.3)
1985	40.0	62.0	30.0	70.0 (3.6)
1986	50.0	70.0	45.0	85.0 (4.2)

*The figures in the parentheses indicate average disease index in case of leaf blight under 1 to 5 scale.

Table 2. Reaction of different genotypes of coconut palm to four diseases

Genotype	Bud rot		Stem bleeding		Mahali or fruit rot & nut fall		Leaf blight or grey leaf spot	
	%	Reaction	%	Reaction	%	Reaction	(1-5)	Reaction
Malayan Dwarf Green	20.0	MR	5.0	R	10.0	R	2.0	MR
Malayan Dwarf Yellow	25.0	MR	5.0	R	10.0	R	3.8	S
Malayan Dwarf Orange	40.0	MS	7.5	R	15.0	R	3.0	MS
Java	20.0	MR	70.0	S	75.0	S	1.5	R
Borneo	20.0	MR	20.0	MR	10.0	R	2.0	MR
San Ramon	10.0	R	0.0	R	15.0	R	1.0	R
St. Vincent	10.0	R	20.0	MR	10.0	R	2.5	MR
Gonthembili	20.0	MR	70.0	S	10.0	R	1.0	R
Federal Malayan Straight Settlement	10.0	R	50.0	MS	15.0	R	2.5	MR
Jamaican Tall	10.0	R	10.0	R	50.0	MS	3.0	MS
British Solomon Island	10.0	R	50.0	MS	10.0	R	2.0	MR
Zanzibar	20.0	MR	30.0	MR	75.0	S	2.5	MR
Hazari	0.0	R	0.0	R	0.0	R	2.0	MR
Local	85.0	HS	60.0	S	20.0	MR	4.0	S

R = resistant, MR = moderately resistant, MS = moderately susceptible, S = susceptible and HS = highly susceptible.

shows that the genotypes varied greatly in respect of their reaction to all the four diseases the average grade ranging from resistant to high susceptible. Out of 14 genotypes tested one genotype, namely San Ramon (Philippine origin) was resistant to all the four diseases whereas another genotype, namely Hazari was resistant to three diseases (but rot, stem bleeding, fruit rot & nut fall) and moderately resistant to one disease (leaf blight). Among the remaining genotypes 3 genotypes, namely Malayan Dwarf Green, Malayan Dwarf Yellow and Malayan Dwarf Orange were resistant to stem bleeding and fruit rot & nut fall. Resistance to two diseases was also recorded in some other genotypes such as St. Vincent to

bud rot and fruit & nut fall and leaf blight, Federal Malayan Straight Settlement to bud rot and fruit rot & nut fall, Jamaican Tall to bud rot and stem bleeding, British Solomon Island to bud rot and fruit rot & nut fall. Two important genotypes, namely Borneo was resistant to fruit rot & nut fall and leaf blight, and moderately resistant to bud rot and stem bleeding, and Java was resistant to leaf blight and moderately resistant to bud rot. Notable susceptibility was recorded in case of local genotype to bud rot, stem bleeding and leaf blight, Malayan Dwarf Yellow to leaf blight, Java to stem bleeding and fruit rot & nut fall, Gomthembili to stem bleeding and Zanjibar to fruit rot & nut fall.

DISCUSSION

The present study has explored the prevalence of 5 major diseases of coconut palm, namely bud rot, stem bleeding, fruit rot & nut fall, leaf blight and anab-e-roga in different coconut growing belts of West Bengal. All these diseases were found to be severe in the Indo-Gangetic plains whereas some of which were severe in other parts of West Bengal depending upon the climatic conditions. Variation in the incidence of 4 diseases, namely bud rot, stem bleeding, fruit rot & nut fall and leaf blight was also observed from one year to another in the Indo-Gangetic plains and their incidence was recorded to be highest in 1986 and lowest in 1984. This variation in the incidence may be explained on the basis of available weather data recorded from July to September of these years (Table 3), because during this monsoon period these diseases have been found to be favoured by high rainfall, low atmospheric temperature and high relative humidity during the monsoon period particularly in the Southern States and coastal regions of India (Menon and Pandali, 1959; Mulyar *et al*, 1986). During the monsoon months (July to September) of 1986 highest amount of rainfall (total 896.1 mm), comparatively lower atmospheric temperature (max 30.0 to 31.5°C and min 23.2 to 25.6°C) and high relative humidity (max 88.0 to 90.0% and min 64.7 to 72.8%) were recorded as compared to that of other two years 1984 and 1985. Therefore, the existing weather conditions during the monsoon period might be the main factors for the highest incidence of these 4 diseases in 1986. Thomas (1978) and Radha and Thomas (1982) have also observed that the bud rot disease becomes more destructive when the atmospheric temperature becomes low and the relative humidity becomes high during the monsoon period.

Among the various approaches of management practices of coconut diseases highest importance has been accorded to the exploitation of host resistance breeding. In the present study out of 14 genotypes tested 3 genotypes, namely San Ramon, Hazari and Borneo were resistant to moderately resistant to all the four diseases. This indicates that the resistance to all these diseases of coconut palm is common

Table 3. Meteorological data during the monsoon period of different years*

Months	1984			1985			1986		
	Tempe- rature (°C)	Relative humidity (%)	Rainfall (mm)	Tempe- rature (°C)	Relative humidity (%)	Rainfall (mm)	Tempe- rature (°C)	Relative humidity (%)	Rainfall (mm)
July	Max	33.0	90.2	161.8	31.4	70.0	192.0	31.5	88.0
	Min	29.2	69.1		22.6	56.0		25.2	72.8
August	Max	33.2	91.2	368.8	32.2	73.3	214.0	32.2	88.0
	Min	26.5	69.2		26.5	58.7		25.6	64.7
September	Max	33.8	83.9	188.2	32.0	70.0	141.0	30.0	90.0
	Min	25.6	49.4		22.4	53.2		23.2	68.5

*Meteorological data were recorded from the Plant Virus Research Centre of the Department of Plant Pathology, Bidhan Chandra Krishi Viswavidyalaya.

in same genotypes. It may be mentioned that among the materials released by the AICCAIP which are resistant to one disease, or one set of diseases, most turn out to be susceptible to another set of diseases in different environments. Therefore the development of multiple resistance to major diseases prevalent in the diverse agro ecosystems of India seems more appropriate. These resistance as observed in the present case may be further exploited for the development of multiple disease resistant varieties. It was further observed that the 3 exotic materials of Malayan Dwarf origin which were recorded moderately resistant to moderately susceptible to bud rot diseases, were reported susceptible to this disease under South Indian condition (Radha and Thomas, 1982). This variation in the disease reaction may be attributed to the change in the environment of different races of the pathogen used for screening. It may be also noted from the present study that the genotypes tested, varied greatly in respect of their reaction to all the four diseases. This heterozygosity in respect of disease reaction in coconut palm is probably due to the heterozygous condition of its genetic make up which varies greatly from plant to plant even within the same variety or type.

It may be mentioned here that there is some controversy regarding the age of infection in case of *anab-e-roga* disease in coconut palm. There are reports that the disease is more prevalent in old palms than young palms (Govindu *et al.*, 1982; Papa Rao and Govinda Rao, 1966). But, incidence of this disease on palms less than 10 years and above 40 years old has been also sometimes noticed (Naidu *et al.*, 1966). In the present study the incidence of this disease has been also observed in 5 years old plants.

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