KOLEROGA OF ARECANUT

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INTRODUCTION

Arecanut or betelnut palm (*Areca catechu* L.) is a perennial crop the nuts of which are used for chewing purposes besides being used at all religious and social functions in India. They are affected by a number of maladies among which the *kolerga* is important.

Koleroga (*Kole* = rotting, *Roga* = disease) as is called in Karnataka, is otherwise known as *Mahali* (heavy devastation) in Kerala or fruit rot in a number of places. The disease was first recorded in South India by Butler in 1906. It occurs in severe form in heavy rainfall areas (Coleman, 1910; Anstead, 1924; Sundara Raman and Ramakrishnan, 1924; Venkata Rao, 1927; Venkatarayan, 1937; Marudarajan; 1950a; Kamat, 1953; Anonymous, 1954, 1962c, 1967, 1972; Gokale *et al.*, 1955; Dorasami, 1956; Nambiar, 1956; Patel and Nagaraja Rao, 1958; Mundkur, 1967; Seshadri and Rawther, 1968; Singh, 1973).

Loss due to disease

Detailed and regular surveys have not been made to estimate the loss due to this disease. However, an annual loss of 10-75% in parts of Karnataka and Kerala States, or total destruction of crops in individual gardens (Coleman, 1910; Thomas, 1937; Nambiar, 1956; Anonymous, 1960a) have been recorded. Coleman and Venkata Rao (1918) estimated an annual loss of Rs. 4 lakhs in Malnad region (Karnataka) alone.

Symptoms

The fungus makes its active appearance about 15-20 days after the commencement of South West monsoon (May-June) and persists till about October (Marudarajan, 1950a). The first sign of the disease is on the surface of arecanuts where water soaked lesions usually develop towards the base. These lesions gradually spread ultimately covering the entire nut and give dark appearance to fruits. The affected nuts rot and drop down from the bunches (FIG. 1.4.) A felt of white mycelial mass develops on the fallen nuts which soon envelops the entire surface (Butler, 1906; Coleman, 1910; Shaw, 1913; Venkata Rao, 1915, 1919; Marudarajan, 1950 a; Kamat, 1953; Gokhale *et al.*, 1955; Patel and Nagaraja Rao, 1958; Sannegowda, 1961; Mundkur, 1967; Seshadri and Rawther, 1968; Anonymous 1969 a, b, 1972; Nambiar, 1971; Rangaswami, 1972; Singh, 1973). As the disease advances, the fruit stalks and axis of inflorescence are also affected (Sundararaman and Ramakrishnan, 1924; Marudarajan, 1950 a). Affected nuts are lighter in weight and possess large vacuoles and dark brown radial strands internally. Late infections occurring

in August result in drying up of nuts which stick to bunches (Marudarajan, 1950 a; Seshadri and Rawther, 1968). These nuts are often affected by saprophytes like *Gloeosporium* sp and are locally called "dry mahali" in Central Kerala. The decreased susceptiblility of nuts to disease with increased maturity (Anonymous, 1962 a, 1963) may be probably due to prevalence of unfavourable weather factors at the time of maturity.

The same fungus also infects the crown region and causes bud rot resulting in the death of the palm. The leaves become yellow, droop down, and drop off one by one leaving the stem bare. Secondary organisms enter the rotting bud and make it into a slimy mass which would emit a fetid odour (Coleman, 1910; Nambiar, 1949, 1956; Anonymous, 1954, 1972; Naidu, 1960; Seshadri and Rawther, 1968).

Fungus

The pathogen was first named as *Phytophthora omnivora* De Bary by Sydow and Butler (1906, 1907). Later, Coleman (1910) called it as *P. omnivora* var *arecae*. Pethybridge (1913) recognized that the fungus was quite different from De Bary's *P. omnivora* and suggested that it might be regarded as *P. arecae*. Finally Butler (1918) considered it as *P. arecae* (Coleman) Pethybridge. Mycelium of the fungus is coenocytic, but sparsely septate in the older stages. It is inter and intracellular, haustoria are finger like, occasionally branched and sparsely produced. The hyphal diameter varies from 8-9 μm (Coleman, 1910; Mundkur, 1967). The fungus grows and sporulates better on steamed cornmeal than on potato dextrose agar and oatmeal agar (Tucker, 1931).

Asexual reproduction is by the production of sporangia with zoospores and by chlamydospores. Sporangia are borne on irregularly branched sporangiophores. Sporangia are papillate, pyriform to elliptical measuring 30-70 μm $\times$ 24-46 μm. (Leonian, 1925, and Herbert, 1929; Gadd, 1927; Sundararaman and Ramakrishnan, 1924; Mundkur, 1967; Singh, 1973). The average dimensions are 34.52 $\times$ 24.67 μm (Tucker, 1931) and 47.92 $\times$ 30.05 μm (Rosenbaun, 1917).

Chlamydospores form one of the perennating structures. Their size varies from 18-40 μm, average being 25.74 μm (Tucker, 1931; Gadd, 1927; Newhook *et al.*, 1978).

The sexual spores, oospores were reported to be absent (Sundararaman and Ramakrishnan, 1924). The failure to observe oospores in nature was thought to be due to the presence of two strains which are localised (Uppal and Desai, 1939). In fact, Uppal (1942) recorded the occurrence of + and — strains. Antheridia are amphigynous and the oogonia range from 28-40 μm (Coleman, 1910) and the oospores from 17.5–24.4 μm (Thomas *et al.*, 1947) to 25-35 μm (Newhook *et al.*, 1978) in diameter. The fungus produces oospores on inoculated arecanuts and on *Cereus formosus* and *Clarkia elegans* (Coleman, 1910), as well as on fresh bean agar (Desai, 1950 a, b). As the homothallic nature of the fungus was observed by some investigators (Narasimhan, 1932 Ramakrishnan, 1954; Ramakrishnan and Seethalakshmi, 1956 a), others (Ashby, 1929); Narasimhan, 1930, 1931 a; Venkatarayan, 1932; Uppal and Desai, 1939; and Marudarajan, 1941) reported that it was heterothallic. Narasimhan (1930, 1931a) reported that the strains from areca and *Loranthus* have male mycelium and those of *Santalum* and *Jatropha*

the female mycelium. Venkatarayan (1932) even observed the formation of oospores when mixed with the heterothallic strain from *Santalum album*. The formation of oospores in the mixed cultures of *P. arecae* with isolates from coconut, palmyrah palms, and *Hevea* but not among themselves was observed by Marudarajan (1941) and Thomas *et al.*, (1947). Ashby (1929) obtained oospores in mixed cultures of *P. arecae* and *P. meadii*, whereas Gallegly (1964) did so in paired cultures of *P. arecae* and *P. infestans*.

Epidemiology

While heavy rainfall with constant high humid conditions (Narasimhan, 1922; Venkata Rao, 1925; Mundkur, 1967,) and an alternation of sunshine and rain (Coleman 1910; Mundkur, 1967) are conducive to disease development, the heavy rain and wind (Coleman, 1910; Venkata Rao, 1925; Nambiar, 1956; Mundkur, 1967) and to certain extent insects and small birds (Coleman, 1910) facilitate its spread. It is pertinent to note that this period is also marked by low temperature (20-23°C). The intensity of koleroga is often very severe in plantations situated in valleys or those surrounded by thick belts of trees (Kamat, 1953) or covered heavily with intercrops resulting in high humid conditions.

With a view to correlating the disease incidence with meteorological data, these were examined for the years 1970-1979 (Table 1.13). The data showed that the annual rainfall

Table 1.13. Meteorological data during South West monsoon season for the years 1970–1979 at CPCRI, Regional Station, Vittal*

Month	Rain fall (mm)	Temperature (°C)		Humidity %	Sunshine (Hrs)
		Max.	Min.		
May	169.1	32.9	24.1	74.1	7.6
June	982.5	29.6	23.0	85.1	3.9
July	1339.7	27.9	22.6	89.2	2.3
August	779.1	28.4	22.7	87.2	3.7
September	294.2	29.9	23.0	81.9	6.1
October	188.0	31.3	22.7	77.5	5.7

*Mean values.

varied from 3255.3 mm (1973) to 5088.6 mm (1978) with an annual average of 3278.8mm. Much of the rains are received during May-October; i.e. South West monsoon season, heavy rainfall being in June-August. During this period the maximum temperature is between 27.9–32.9°C and minimum 22.6–24.1°C. The humidity varied from 74.1%–89.2%, and sunshine hours 2.28–7.55 hr (Table 1.13) and these facilitate the rapid development of the pathogen (Coleman, 1910; Tucker, 1931). These conditions reach a peak in July.

In the year 1978, the *Koleroga* disease was very rampant and losses ranging from 50–90% were estimated in a number of gardens. When the weather data for this year was compared to the other years from the Station, it was found that in 1978 the favourable conditions for the disease existed for a prolonged period i.e. from May to September. The total rainfall in 1978 was 5088.6 mm, the highest in the last 10 years. The rains started

during the first fortnight of May itself, continued raining almost everyday in June, July and August months, thus leaving no time for the farmers to take up prophylactic spraying operation against the disease. Further the maximum temperature was less than 30°C (June-September) and the humidity was more than 80% throughout the season. The bright sunshine hours was also less in 1978 when compared to other years. These conditions might have favoured the rapid spread of the disease. Though many variable factors are involved in the disease development, and its spread, the weather data and the inoculum potential of the pathogen may be considered to predict the occurrence of the disease in susceptible hosts.

Resting spores and mycelium are the main source of inoculum which are present in dead parts such as dried bare bunches, leaves, diseased nuts and refuse in the garden. During dry season they survive on the upper layers of soil (Coleman, 1910; Nambiar, 1956). Areca palms may also possess latent infection in their crown during non-monsoon periods. Such trees are potent sources of primary infection (Kamat, 1956, Mundkur, 1967; Singh, 1973).

Various bushes and trees, notably *Bryophyllum calycinum* (Venkata Rao, 1925; Narasimhan, 1926, 1927) *Colocasia antiquorumi. Ficus nitida, Jatropha glandulifera, Citrus medica, C. limonum*, jack, sandalwood, mango, rubber (Narasimhan, 1926, 1927; Ramakrishnan and Seethalakshmi, 1956b; Nambiar, 1956), and coconut (Sundararaman and Ramakrishnan, 1924; McRae, 1924; Gadd, 1927) harbour the fungus. Further, it was known that *P. arecae* on artificial inoculation could infect potato tubers (Rosenbaun, 1914; Tucker, 1931), apple fruits (Tucker, 1931), very young tomato (Coleman, 1910, Dastur, 1913) and brinjal seedlings (Coleman, 1910) as well.

Control

The earlier practice of controlling *Koleroga* comprises providing covers to arecanut bunches, made of either arecanut leaf sheaths called '*Kotte*' in Malnad region or a kind of grass in other parts named '*Karada*'. These covers, though expected, neither helped in preventing nor in eradicating the disease (Coleman, 1910, 1915; Anonymous 1954, 1956a; Krishnamurthy, 1955; Nagaraja Rao, 1960). Coleman (1910) was the first to recommend spraying of 1% Bordeaux mixture with resin-washing soda as an adhesive to control the disease. Various workers tested the efficacy of different adhesives and spreaders with Bordeaux mixture with good results (Narasimhan, 1923, 1924; Venkata Rao, 1925, 1926, 1927). Potash alumn with casein called Martin's Bordeaux mixture (Narasimhan, 1928 a, b, 1931b; Venkata Rao, 1926, 1927, 1929), and vegetable oils, such as groundnut, gingelly, coconut or safflower oil (Narasimnan, 1931 b, 1934, 1935; Thomas, 1938, Thomas and Marudarajan, 1938, 1952; Patel and Nagaraja Rao, 1958; Nagaraja Rao, 1960) added to Bordeaux mixture protected the arecanut palms against *Mahali*. However, it was also shown that plain 1% Bordeaux mixture without any adhesive was equally effective in controlling the disease (Thomas and Marudarajan, 1938; Venkatarayan 1943; Marudarajan, 1950a, b, 1952; Marudarajan and Kalyana Subramanyam, 1948, 1952) and therefore, prophylactic sprayings with Bordeaux mixture alone two-three times a year, has been recommended and is in use ever since, (Sundararaman and Rama Krishnan, 1924; Thomas, 1938; Thomas and Marudarajan,

1938, 1952; Marudarajan, 1950 a, b, 1952; Marudarajan and Kalyana Subramanyam, 1948, 1952; Nambiar, 1956; Patel and Nagaraja Rao, 1958; Anonymous, 1926, 1954, 1956a, 1961, 1967, 1969b, 1972; Nagaraja Rao, 1960; Sannegowda, 1961; Seshadri and Rawther, 1968; Nambiar, 1971). Spraying campaign against *Koleroga* was undertaken in Karnataka on payment basis (Kulkarni, 1924) and an improved sprayer called 'Primus sprayer' was developed for the purpose (Narasimhan, 1938)

A number of other chemicals besides Bordeaux mixture were also tested against the pathogen. Among them, the mercurised copper oxychloride, and blitane inhibited the fungal growth in nutrient media (Rawther, 1969) whereas nickel chloride had no effect (Anonymous, 1963, 1964). Field trials revealed that copper exychloride checked *Koleroga* (Anonymous, 1956b, 1960a, b, 1962b). However, Thomas (1938), Thomas and Marudarajan (1938, 1952) and Uppal (1942) recorded that they were not effective, and that they even caused copper injury to nuts at 0.5% concentration (Anonymous, 1967). Proprietary copper fungicides such as Fycol 8, Fycol 8E, Oleocop and Lovel sprayed with low volume sprayers too, could not protect tne nuts (Ramamurthy, 1962, Rawther, 1969). The reported control of the disease from Adyanadka by spraying mud solution was far from truth (Anonymous, 1959).

Besides attempting to the protective sprays against the disease, it is also necessary to reduce the inoculum potential by adopting phytosanitary measures such as removal and destruction of fallen nuts, diseased bunches, tree tops and other plant parts in the field (Coleman, 1910, 1915; Anonymous, 1926, 1972; Kamat, 1953; Nambiar, 1971; Koti Reddy *et al.*, 1978). Efforts should also be bestowed to eliminate the alternate hosts of *P. arecae* from the vicinity of the gardens, popularisation of the above plant protection measures against *Koleroga* pays rich dividents. Above all, it is worthwhile to develop efficient forecasting systems for different agroclimatic conditions in our attempts to contain the disease.

ACKNOWLEDGEMENT

We thank Dr. N. M. Nayar and Mr. K. N. Murthy of Central Plantation Crops Research Institute for the valuable suggestions given in preparing the paper.

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DISCUSSIONS

H. S. Sohi : The disease attacks the nuts as was pointed out by the speaker. I would like to know whether the foliage is also infected. If so, spraying of the crown is also essential.

Answer : Yes, it is being recommended and practised to prevent bud rot.

Abicheeran : What is the primary source of inoculum?

Answer : The sources of primary inoculum are infected fallen nuts and infected dried inflorescences.