



# Epidemiological studies of rotting and immature nutfall of eriophyid mite infested coconut caused by *Lasiodiplodia theobromae*

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## Abstract

The intensity of rotting and immature nutfall of coconut caused by *Lasiodiplodia theobromae* was recorded from a 20-year-old coconut garden in Kerala State, India during June, 2003 to May, 2005 and correlated with climatic factors. A significant correlation coefficient was obtained between disease incidence and relative humidity and minimum temperature. There was a positive correlation between disease incidence and rainfall and number of rainy days. Rotting of eriophyid mite (*Aceria guerreronis*) infested coconuts caused by *L. theobromae* increased with increase in rain. The percentage of disease incidence was high during south-west monsoon period (April-October) in both the years, whereas, it was comparatively low during post-monsoon period. During post-monsoon period the incidence of mite infestation was also the lowest. In both the years, the intensity of *L. theobromae* infection of coconuts increased with rainfall (April onwards), attained peak during July to October and gradually decreased as the temperature rose from November. Identification of critical period of rotting and immature nutfall of coconut will be helpful in formulating proper disease management strategies.

**Keywords:** *Aceria guerreronis* Keifer, *Cocos nucifera* L., disease incidence, epidemiology, *Lasiodiplodia theobromae* Pat.

## Introduction

In India, coconut (*Cocos nucifera* L.) is grown in an area of 1.935 million ha with a production of 12,833 million nuts. Coconut plays an important role in the economy of the states of Kerala, Tamil Nadu, Karnataka and Andhra Pradesh. The palm is susceptible to a number of diseases and pests. Eriophyid mite (*Aceria guerreronis* Keifer) has also been added to the list of major pests of coconut in India. The incidence of mite attack on coconut palm in India was first noticed in 1998 in Ernakulam district of Kerala State (Sathiamma *et al.*, 1998). From there it has spread to other parts of the state as well as other coconut growing areas in the country. With the wide spread occurrence of eriophyid mite infestation severe incidences of coconut rot and fall caused by *Lasiodiplodia theobromae* have been observed in different locations especially in areas with well distributed rainfall (Venugopal, 2008).

Being a wound pathogen, *L. theobromae* gains easy entry into the nut tissues through the injury caused by the mite. The infection invariably starts from the mite infested white soft tissue beneath the perianth as dark brown lesion spreading towards the distal end of the nut.

As the lesions begin to spread externally and internally, the nuts are shed. Abundant spores of the fungus are noticed as charcoal like powder on the lesion surface. In nearly mature or mature nuts, the lesion spreads internally sometimes without any external lesion, and reaches the kernel. Infection in the mature nut continues to spread internally during storage causing rotting of the kernel (ChandraMohanan and Baby, 2004; Venugopal and ChandraMohanan, 2006; Venugopal, 2008). Considering the economic loss caused by this recently emerged problem, investigations were undertaken to study the epidemiological aspects of nut rot and fall causal by *L. theobromae*.

## Materials and Methods

**Disease incidence:** Observations on the intensity of *L. theobromae* infection of mite infested nuts were made from the coconut farm of Central Plantation Crops Research Institute, Regional Station, Kayamkulam, Kerala state, India. This coconut garden planted at a spacing of 7.5 x 7.5 m had 20 year old palms of West Coast Tall (WCT) cultivar which were not sprayed with any plant protection chemicals. Data were collected from

100 palms at monthly interval for two years from June 2003 to May 2005. The total number of nuts at each time of observation, number of mite infested nuts and number of mite infested nuts with rotting caused by *L. theobromae* in each bunch of each palm were separately recorded at monthly interval and expressed as percentage of the total number of nuts present at the time of observation. During each observation, representative samples were collected from each palm and examined in the laboratory to ascertain the presence of *L. theobromae*. After each observation, the fallen infected nuts were removed from the base of each palm to avoid overlapping of counting during next observation. Thus, every time, nuts with fresh infection and freshly fallen infected nuts were only observed to find out the seasonal variation in disease intensity. Monthly disease incidence was correlated with the climatic data.

**Climatic data:** Maximum and minimum thermometer and dry and wet bulb thermometer kept in Stevenson screen in the meteorological observatory by the side of the experimental garden were used to record temperature and relative humidity. Rainfall was recorded with an automatic recording rain gauge kept in the observatory. From these, data on (1) monthly mean minimum and mean maximum temperature, (2) monthly mean relative humidity as well as (3) number of rainy days and total rainfall per month from June 2003 to May 2005 were determined.

### Results and Discussion

Rotting and immature nutfall of coconut known as fruit rot, caused by *Phytophthora palmivora* Butl. have been reported as early as in 1922 from Sri Lanka (Gadd, 1922) and in 1924 from northern districts of Kerala (Sundaraman and Ramakrishnan, 1924). The disease occurs only during the rainy season and is not observed as a serious problem in all the locations. The intensity varies from location to location as well as from garden to garden and warrants control measures only in certain gardens. But, fruit rot of arecanut (*Areca catechu* L.) caused by *Phytophthora meadii* McRae leading to heavy nut shedding in all the arecanut growing areas with heavy regular rainfall is a major disease causing heavy economic loss to the farmers, if timely prophylactic control measures are not adopted (Kumar and Saraswathy, 1994). Fruit rot of coconut caused by *L. theobromae* has been reported from Brazil, Brunei, Indonesia and Vietnam (Johnston, 1965). Sulladmath and Shantappa (1979) reported *Botryosphaeria rhodina* (Berk. & Curt.) V. Arx as the causal organism of immature nutfall of coconut in Karnataka State. It was observed as

a minor problem. Gunasekaran and Srinivasan (2000) reported the rare occurrence of *L. theobromae* infection of immature coconuts in Alappuzha district of Kerala State. Since it was a minor problem at that time, further studies were not conducted. In Kenya, *Colletotrichum* sp. has been reported to cause falling of buttons and nuts (Mac Donald, 1924). Almeida Jr. and Aquino (1978) reported the occurrence of a fruit rot of coconut caused by *Colletotrichum gloeosporioides* Penz. in Brazil affecting 1.5 to 41% of the harvested nuts in some gardens. Venugopal and ChandraMohan (2006) reported the wide spread occurrence of fruit rot and nutfall of coconut caused by *L. theobromae* in southern parts of Kerala.

Environmental factors are known to play an important role in the occurrence and severity of diseases and pests. Indeed a disease will not develop unless there is an active pathogen, a susceptible host and suitable environmental conditions for infection, establishment and multiplication of pathogen. Environmental factors, particularly relative humidity and temperature played an important role in the occurrence and severity of coconut rot and fall caused by *L. theobromae* after the outbreak of eriophyid mite infestation of coconut.

**Disease incidence in relation to climatic factors:** Total rainfall during 2003, 2004 and 2005 were 1926.5, 2438.3 and 2252.2 mm, respectively. Rainfall was intense between April-December 2003, May-November 2004 and May-December 2005. During these periods, there was rain in most of the days of the month (average rainfall/day 7.43 mm in 2003, 10.58 mm in 2004 and 8.63 mm in 2005). During December to March, there were fewer rainy days (0.935 mm in 2003, 0.049 mm in 2004 and 1.52 mm in 2005). The rainy days were the highest during August (25 days) in 2003 and July (24 days) in 2004 and 2005. Relative humidity remained high during May-November in the forenoon and in the afternoon. It was very high (>95 %) during the early hours of the days of all the months. The mean minimum and maximum temperatures during 2003-2005 did not vary much, though the mean minimum (23.47° C) and maximum temperatures (32.41 °C) during 2003 were slightly higher than 2004 and 2005. The mean minimum and maximum temperatures during 2004 and 2005 were 22.22° C and 32.19° C and 22.27° C and 32.3° C, respectively.

The total number of nuts in the palm at the time of observation, number of mite infested nuts and number of mite infested nuts with rotting caused by *L. theobromae* are presented in Table 1. The relationship between climatic factors and fruit rot caused by *L. theobromae*

Table 1. Monthly data on mite infestation and rotting of mite infested nuts caused by *L. theobromae* (2003 June to 2005 May)

Month and year	*No. of bunches	*Total no. of nuts	No. of mite infested nuts	No. of mite infested nuts with rotting	% of mite infested nuts caused by <i>L.t</i>	% of mite infested nuts with rotting (out of total nuts observed)	% of nuts with <i>L.t</i> rotting (out of total mite infested nuts)
Jun-03	586	2691	1891	70	70.27	2.60	3.70
Jul-03	634	3745	2284	397	60.99	10.60	17.38
Aug-03	505	2796	1898	290	67.88	10.37	15.28
Sep-03	591	4257	2567	527	60.30	12.38	20.53
Oct-03	505	2796	1898	290	67.88	10.37	15.28
Nov-03	602	3309	2191	228	66.21	6.89	10.41
Dec-03	586	2728	1900	149	69.65	5.46	7.84
Jan-04	562	3192	2197	372	68.83	11.65	16.93
Feb-04	510	2619	1765	187	67.39	7.14	10.59
Mar-04	468	2596	1800	293	69.34	11.29	16.28
Apr-04	557	3241	2222	433	38.56	13.36	19.49
May-04	477	2740	1809	319	66.02	11.64	17.63
Jun-04	557	3241	2227	444	68.71	13.70	19.94
Jul-04	521	2710	1888	410	69.67	15.13	21.72
Aug-04	591	4257	2567	527	60.30	12.38	20.53
Sep-04	546	3812	2166	580	56.82	15.22	26.78
Oct-04	518	3415	2159	600	63.22	17.57	27.79
Nov-04	524	3000	1726	416	57.53	13.87	24.10
Dec-04	534	2274	1260	108	55.41	4.75	8.57
Jan-05	559	3309	2284	392	69.02	11.85	17.16
Feb-05	591	4277	2574	525	60.18	12.27	20.40
Mar-05	468	2596	1800	293	69.34	11.29	16.28
Apr-05	591	4257	2567	527	60.30	12.38	20.53
May-05	587	2841	1897	208	66.77	7.32	10.96
Average	548.75	3195.79	2064	357.7	63.77	10.8	16.9

*L. t.*: *Lasiodiplodia theobromae*

\*Observation from 100 palms (Bunches with nuts of 2 months and above)

infection on mite infested coconuts was analyzed. The linear correlation coefficients between different climatic factors and the percentage of mite infested nuts and the percentage of mite infested nuts with rotting (*L. theobromae*) was found out (Table 2). A significant correlation coefficient was obtained between disease incidence and relative humidity and minimum temperature. There was a positive correlation between the disease incidence and rainfall. The correlation between maximum temperature and fungal rotting was negative. The most significant factor which affects the disease incidence was relative humidity. Rotting of eriophyid mite infested immature nuts caused by *L. theobromae* increased with the increase in rain.

The percentage of mite infested nuts was 63.77 and *L. theobromae* infested nuts was 10.8 (average of 2003-2005) out of the total nuts observed. The percentage of mite infested nuts with *L. theobromae* infection out of

total mite infested nuts was 16.9. The highest percentage of *L. theobromae* infection was observed during September, whereas it was low during December in both the years.

**Seasonal variation:** In general, the percentage of disease incidence was high during monsoon (April to October) in both the years whereas, it was comparatively low during post monsoon period (November to December). The presence of water, high relative humidity and low temperature during monsoon period were ideal for peak incidence of rotting of mite infested nuts. During pre-monsoon and post-monsoon periods there was decrease in fungal infection. When mean maximum temperature was the lowest, the disease incidence was the highest. During November-December (post-monsoon period), when mean maximum temperature was the highest, the incidence of the disease was the lowest. In both the years the intensity of fungal infection of mite

Table 2. Correlation coefficient between climatic factors and mite infestation and disease (*L. theobromae* infection) incidence

	Temp (max) °C	Temp (min) °C	R.h. (%)	R.F (mm)	R.D	M. nuts (no.)	M+F nuts (no.)	(M) (%)	(M+F) (%)
Temp (max)	1.000								
Temp(min)	-0.262	1.000							
RH. (FN)	-0.647	0.575	1.000						
R.F (mm)	-0.717	0.573	0.618	1.000					
R.D	-0.829	0.517	0.634	0.934	1.000				
M nuts (no.)	-0.209	0.147	0.449	0.174	0.161	1.000			
M+F nuts (no.)	-0.237	0.337	0.559	0.155	0.182	0.690	1.000		
%(M)	0.027	0.084	-0.147	0.177	0.108	-0.122	-0.420	1.000	
%(M+F)	-0.227	0.429*	0.514*	0.203	0.223	0.390	0.898	-0.209	1.000

Temp (max): Maximum temperature; Temp (Min): Minimum temperature; RH: Relative humidity; RD: Rainy days RF: Rainfall; M. nuts : mite infested nuts; M+F: mite infested nuts with symptom of rotting caused by *L.theobromae*

\*Significant correlation between disease incidence, minimum temperature and R.H

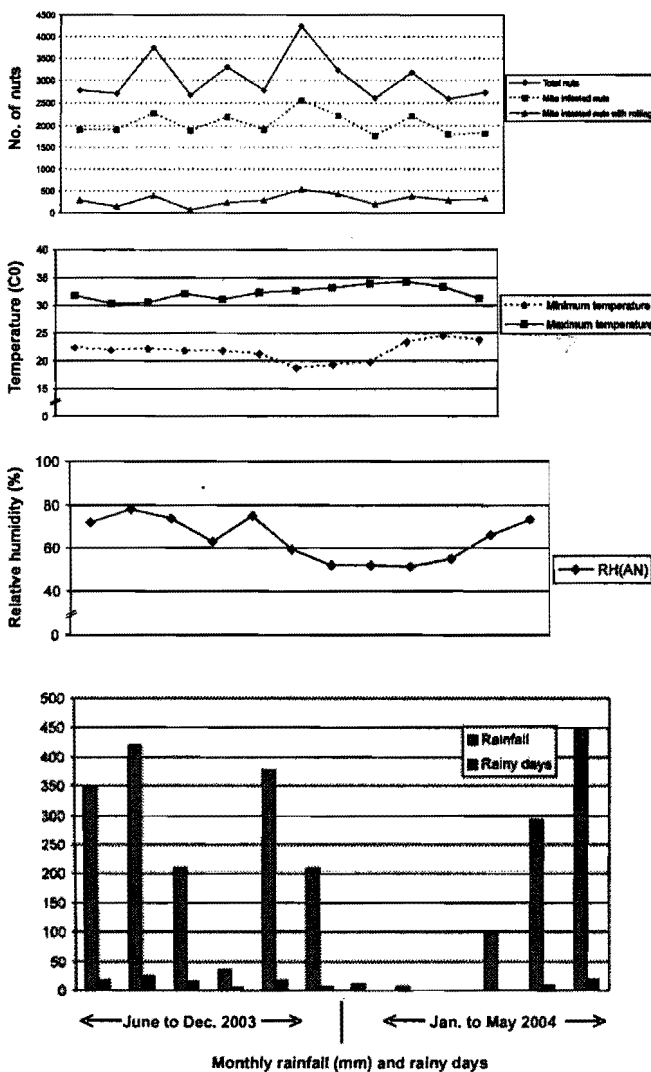


Fig. 1. Seasonal variation in rotting and immature nutfall of coconut caused by *L. theobromae* in relation to climatic factors (2003 - 2004)

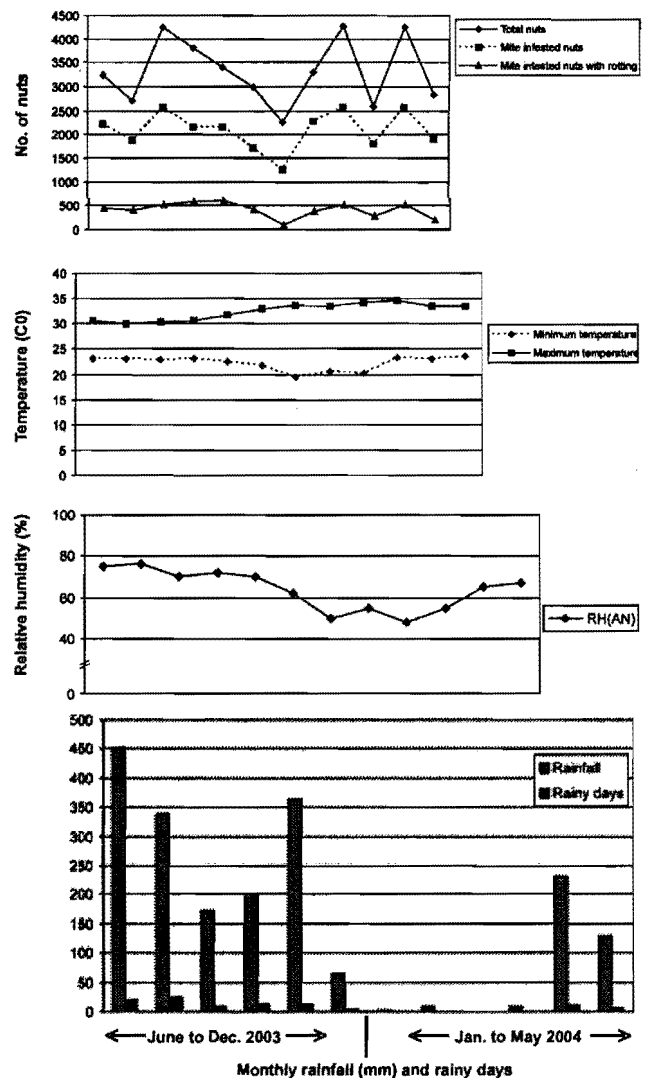


Fig. 2. Seasonal variation in rotting and immature nutfall of coconut caused by *L. theobromae* in relation to climatic factors (2004 - 2005)

infested nuts increased with rainfall (April onwards), attained peak during the south - west monsoon period (July to October during 2003 and 2004) and gradually decreased as the temperature rose from November (Fig. 1 and 2).

In general, *L. theobromae* infection increased with the increase in mite infestation. Thus, fruit rot and immature nutfall of coconut caused by *L. theobromae* occurred throughout the year with peak incidence during rainy months. The disease also increased with the years. The percentage of nuts with *L. theobromae* infection during July, August, September and October (the peak period of south-west monsoon) were 10.6, 10.3, 12.4 and 10.4 during 2003, whereas, it was 13.7, 15.3, 12.38 and 15.12 during 2004, respectively during the same period. During post monsoon period of both the years, the incidence of mite infestation was also the lowest. Radha and Joseph (1974) reported that relative humidity and rainfall were more related to fungal infection and disease development in coconut. The incidence of nutfall disease of coconut caused by *L. theobromae* began to increase with the onset of south-west monsoon in the month of June, when there was constant low temperature and high relative humidity.

It has been reported that there was a rapid increase in the intensity of rot in guava fruit caused by *Botryodiplodia theobromae* (*L. theobromae*) at 30°C and 100% relative humidity (Patel and Pathak, 1995). Wadia *et al.* (1986) observed the maximum spoilage of fruits and vegetables from July to November when there was high humidity of 80-100%. Alasoadura (1970) also reported that for conidial germination of *L. theobromae*, besides high humidity, availability of free water is also essential. The availability of water, low temperature and high relative humidity during monsoon period were congenial for *L. theobromae* infection on coconut. Based on a survey, Chakraborty and Chatterjee (2002) reported that most of the fruit rotting fungi required an average humidity of 88-93% for causing disease. Tandon and Srivastava (1968) and Prasad and Bilgrami (1973) also found the maximum disease development in guava and litchi fruits caused by *L. theobromae* at 90 – 100% humidity.

The incidence of rotting of mite infested coconut was observed throughout the year in southern parts of Kerala state. There was well distributed rainfall throughout the year (2003-2005) with varying intensity. Though disease incidence was recorded throughout the year, the intensity of infection was high during monsoon

season. It is possible that water available on the coconut surface during rainy season might have facilitated conidial germination and infection.

The critical period for rotting and immature nutfall caused by *L. theobromae* may vary slightly from year to year due to variations in climatic conditions such as rainfall, temperature and relative humidity. However, the information on critical period will be helpful in adopting disease management practices especially prophylactic control measures in disease endemic areas or gardens.

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