

## Role of fungi in fruit rot and immature nut fall of coconut

S. Venugopal<sup>1</sup> and R. ChandraMohan<sup>2</sup>

### Abstract

The incidence of fruit rot and immature nut fall is on the increase in southern districts of Kerala state, India, ever since the intensity of eriophyid mite (*Aceria guerreronis* Keifer) infestation increased in this part of the country. Hence, nut samples were collected from 8 southern districts of Kerala state and studies were undertaken to find out the role of fungi in fruit rot of mite infested coconut. Out of 577 samples of coconuts at various stages of development, button to mature nuts, collected from different locations, 445 samples yielded fungi. *Lasiodiplodia theobromae* Pat., a wound pathogen was found to be the major fungus causing fruit rot and immature nut fall in coconut. The fungus enters the tissue through wounds caused by eriophyid mite in the soft tissue beneath perianth. When nearly mature /mature nuts were infected the infection spread internally into mesocarp without any external lesion or with a minute lesion on the husk surface. Infection in mature nuts continued to spread internally during storage causing rotting of kernel. Phytophthora fruit rot was observed only in Idukki district with high rain fall and humidity. Fruit rot caused by *L. theobromae* was found in all 8 southern districts of Kerala throughout the year. *Thielaviopsis paradoxa*, *Colletotrichum gloeosporioides*, and *Fusarium* sp. were also isolated from the lesions on few samples of tender nuts. But, at present they were only minor pathogens associated with rotting of young nuts.

**Key words:** Coconut, Fruit rot and immature nut fall, *Aceria guerreronis*, *Lasiodiplodia theobromae*.

- 
1. Department of Botany, N.S.S College, Pandalam, Pathanamthitta (dist), Kerala, India.  
Email: [venusunnithanpdm@yahoo.co.in](mailto:venusunnithanpdm@yahoo.co.in)
  2. Central Plantation Crops Research Institute (Regional Station), Krishnapuram P.O, Kayangulam, Kerala 690533, India. Email: [rcmcpcrri@yahoo.com](mailto:rcmcpcrri@yahoo.com)

## Introduction

In India root (wilt), leaf rot, 'Tatipaka', 'Thanjavur wilt', Stem bleeding and bud rot have been observed as major diseases of coconut (*Cocos nucifera* L.). Among the pests affecting coconut, red palm weevil, rhinoceros beetle, and leaf eating caterpillar were considered as the important pests since many years. Recently eriophyid mite (*Aceria guerreronis* Keifer) has also been added to the list of major pests of coconut occurring in Kerala. In India the incidence of mite attack on coconut palm was first noticed in 1998 in Ernakulam district of Kerala state (Sathiamma *et al.*, 1998). Since then it has spread to other parts of Kerala and other coconut growing states. With the wide spread occurrence of eriophyid mite infestation, severe incidence of rotting of nuts and immature nut fall have been observed in different locations in southern districts of Kerala state, the area which receives well distributed rain fall. Though incidences of fruit rot of coconut caused by *Lasiodiplodia theobromae* were reported earlier from isolated pockets (Gunasekaran and Srinivasan, 2000; ChandraMohan and Saritha Baby, 2004; Lakshman and Jagadeesan, 2004), further detailed studies were not conducted. With the recent widespread occurrence of eriophyid mite attack, detailed studies were under taken on the association of fungi with fruit rot and immature nut fall at different stages of maturity of coconut and in different locations.

## Materials and methods

Coconut samples with eriophyid mite attack followed by symptoms of rotting were collected during south west monsoon period (June to October 2004 and 2005) from the affected gardens in eight southern districts of Kerala state viz., Thiruvananthapuram, Kollam, Pathanamthitta, Alappuzha, Kottayam, Idukki, Ernakulam and Thrissur from where frequent reports of incidence were received from farmers and state agricultural department. Nuts with rotting symptoms (even with minute lesions)

were collected from the palms. In certain cases, when all the infected nuts were fallen at the time of collection of samples, freshly fallen nuts were collected. Samples also included fallen, nearly mature nuts without any external symptoms of rotting. Mature and stored nuts with some symptoms of rotting were collected from coconut godowns. Thus, samples consisted of nuts of different stages of maturity from button to mature and stored nuts. The number of samples collected from each district as well as each garden varied with disease incidence and area under coconut cultivation. During the collection of samples symptoms were recorded in detail.

## Isolation of causal organism

The samples showing symptoms of rotting were used for isolation of pathogens. A layer of external husk was removed from nearly mature nuts without any external symptoms to observe internal infection, if any. The samples with rotting symptoms in the internal tissue were used for isolation of causal organism. Pieces of 5x5 mm size infected tissues were cut with sterile scalpel from the margin of the lesion. The surface sterilized pieces were quickly passed over flame of a spirit lamp and plated on potato dextrose agar medium. The inoculated plates were incubated at  $26 \pm 2^{\circ}\text{C}$  for 3 to 5 days. The fungal growths were subcultured and identified.

## Pathogenicity test

Pathogenicity of fungi associated with rotting of eriophyid mite infested coconuts was tested by wound inoculation. Wounded but uninoculated nuts served as control. Healthy nuts of about 3-4 months old collected from West Coast Tall cultivar were surface sterilized and inoculated on the nut surface at the perianth region. To inoculate the nuts, two methods were followed: multiple pin prick method and wound inoculation using cork borer. A sporulating mycelial disc taken from

the periphery of actively growing 5-day-old culture on PDA was placed on the nut surface injured with pins / in the cavity made with cork borer. The inoculated area was covered with thin moist cotton wool and each nut was placed in separate polythene bag containing wet cotton. The bags were closed and incubated at room temperature. The fungus was reisolated from the lesion formed on the inoculated nut.

### Results and discussion

The incidence of fruit rot and immature nut fall of coconut infested with eriophyid mite varied from locality to locality as well as from garden to garden. Though sporadic incidence of rotting of buttons and tender nuts caused by *Phytophthora palmivora* during rainy season was reported from some locations, fruit rot followed by nut fall caused by other fungi was a rare incidence until recently. However, with the increase in mite infestation fruit rot and nut fall have also increased considerably. The incidence was observed throughout the year.

### Symptomatology

The infection always started from the mite infested, white soft tissue beneath perianth. In majority of the cases it appeared as chocolate brown to dark brown lesion spreading towards the distal end of the nut from the white soft tissue at the perianth region (Fig. 1). The advancing margin of the lesion was light brown to chocolate brown in colour. As the lesions began to spread externally and internally the nuts were shed. The lesion continued to spread in the fallen nut. As the lesion dried up the older portion of the lesion turned to grayish brown discoloration especially under dry climatic condition. Abundant spores of the fungus were noticed as charcoal like powdery mass on the lesion surface (Fig. 2).

In certain cases, when the nearly mature/mature nuts were infected, the infection spread internally in to the mesocarp without any



Fig. 1. Natural infection of *Lasiodiplodia theobromae* starting from perianth region



Fig. 2. Advanced stage of *Lasiodiplodia theobromae* infection showing abundant sporulation like charcoal powder

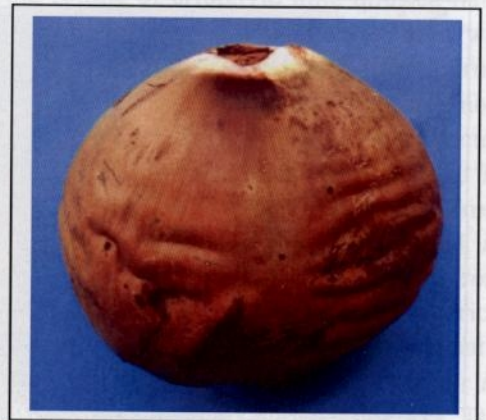


Fig. 3. Mature nuts with small external lesion at the perianth region caused by *Lasiodiplodia theobromae*



Fig. 4. Mature nut showing severe infection of internal tissue caused by *Lasiodiplodia theobromae*



Fig. 5. *Lasiodiplodia theobromae* infection spreading to the kernel and causing extensive rotting



Fig. 6. *Lasiodiplodia theobromae* infection through the wounds caused by harvesting knife

external lesion or with a small lesion on the husk surface (Fig. 3). Thus the rate of spread of infection was more in the internal tissue than the outer husk (Fig. 4). In majority of the cases there was no external lesion when mature nuts were infected. But the infection in the mature nuts continued to spread internally during storage, and entered the kernel through soft eye causing rotting of the kernel (Fig. 5) thereby, making it unfit for consumption. Abundant spores were found in the mesocarp around the eye as well in the rotten kernel. Isolation of causal organism from different parts of the infected tissues of the nut showing such symptoms invariably yielded *L. theobromae*. Before the severe wide spread occurrence of eriophyid mite infestation the incidence of fruit rot caused by fungi, especially *L. theobromae* was very rare (Gunasekaran and Srinivasan, 2000; Sulladmath and Shanthappa, 1979). It was not considered as a serious problem until recently. *L. theobromae*, being wound pathogen enters the tissue through the wound caused mainly by eriophyid mite in the soft tissue beneath the perianth. The tissue at this region being soft may be very congenial for the fungus to penetrate through the wounds, ramify and multiply causing extensive rotting. Thus, the injury caused mainly by the mite makes the entry points for the fungus. The fungus can enter the tissues through any types of wounds either caused by other insects or by mechanical means (Fig. 6). Therefore, the higher incidence of fruit rot and immature nut fall observed recently has a definite relation with wide spread incidence of mite infestation. During 2006, very high incidence of slug caterpillar (*Contheyla rotunda* Harm) damage was observed on coconut palms at Nagarcoil area (Tamil Nadu) causing severe damage to leaves (Singh and Rethinam, 2006). Its attack was also observed on nuts. Some such nuts were found showing symptoms of rotting and immature nut fall. Isolation of causal organism from such infected nuts also yielded *L. theobromae*. But at this location rotting and

immature nut fall is negligible at present. *L. theobromae* was also isolated from the lesion on buttons infested with coreid bug (*Paradasynus rostratus* Dist.) and mealy bug followed by rotting. But, wide spread occurrence of these pest were not noticed during the present study. Injuries caused during harvesting also pave way for the entry of *L. theobromae* leading to storage rot. In some coconut gardens rare incidence of *L. theobromae* infestation on tender rachilla was noticed. As the lesion enlarged and progressed on the rachilla, buttons were dried and ultimately shed from the rachilla.

The infection on certain mite infested nuts appeared as irregular dark brown to brownish black lesion with water soaked margin on the nut surface leading to severe rotting and nut fall. Isolations from such lesions yielded *Thielaviopsis paradoxa*. Though at present the incidence of rotting and immature nut fall caused by this fungus was very rare, It caused severe rotting on tender nuts like *L. theobromae* infection (Table 3). The rate of spread of lesion caused by *T. paradoxa* was faster than that caused by *L. theobromae* when nuts were inoculated during rainy season. *T. paradoxa* infection was observed only during rainy season and growth of fungus consisting of mycelia and conidia was observed on the nut surface, when the lesion spread to a considerable size.

Rarely the infection appeared as small and round grayish brown or light brown lesion with brown to dark brown margin which enlarged, coalesced and formed bigger lesion ultimately leading to immature nut fall. Such lesions yielded *Colletotrichum gloeosporioides* Penz. In very few cases the infection appeared as light brown to grayish brown water soaked lesion during rainy season. *Fusarium* species was isolated from these nuts. However, the incidences of fruit rot of coconut caused by *T. paradoxa*, *C. gloeosporioides*, and *Fusarium* sp. were very rare and highly negligible. Pathogenicity of all the fungi was established by artificially inoculating tender coconuts of WCT

cultivar and the mean of lesion size caused by isolates of each fungus is presented in the Table 3.

#### Association of fungi with rotting of nuts at different stages of maturity

Out of 577 samples of nuts of various stages of development, from button to mature/stored nuts, with eriophyid mite infestation followed by rotting symptoms collected from eight southern districts of Kerala state, 445 samples yielded fungi indicating the role of fungi in fruit rot and premature nut fall as well as storage rot. Among the different stages of maturity of nuts, the incidence was the highest in 2-3 month old nuts (79.38 %). The incidence on nuts above 6 months old, mature nuts and stored nuts was less and hence samples collected were also lesser than very young nuts (up to 3 months old) (Table 1). Some of the samples collected did not show the involvement of fungi. The reason for this may be attributed to collection of nuts fallen due to other factors and rotting symptoms observed may be secondary. Since samples with some symptoms of rotting were only collected, premature nut fall due to other factors was not separately studied. Thus five fungi viz; *L. theobromae*, *Fusarium* sp, *P. palmivora*, *T. paradoxa*, and *C. gloeosporioides* were found causing rotting of eriophyid mite infested nuts. Among the five fungi, *L. theobromae* was found associated with samples collected from all the eight southern districts of Kerala (Table 2). More than 60 % of the samples collected from all the districts except Idukki yielded *L. theobromae*. Out of 577 samples collected from 8 districts, 373 samples (64.6%) yielded *L. theobromae*. *P. palmivora* was isolated from samples collected only from Idukki district. Probably, the high rainfall and other climatic condition in Idukki district are congenial for *P. palmivora* infection (Nambiar, 1994). The association of other fungi such as *Fusarium* species, *T. paradoxa*, and *C. gloeosporioides* with rotting of eriophyid mite infested nuts was

**Table 1: Association of fungi with rotting of coconuts of different age groups collected from different localities in southern Kerala**

Maturity (Age group of nut)	No. of samples collected	Samples yielding fungi		Nut fall due to other reasons	
		No	%	No	%
Button size (1 months old)	362	278	(76.79)	84	(23.21)
Fistula size (2-3 months old)	160	127	(79.38)	33	(20.63)
Tender nut (5-6 months old)	24	15	(62.5)	9	(37.5)
Mature nut	20	17	(85)	3	(15)
Stored nut	11	8	(72.72)	3	(27.28)
Total	577	445	(77.12)	132	(22.87)

**Table 2: Districtwise occurrence of fungi causing rotting in coconut**

Sl.No	District (Kerala State)	No. of samples collected	No. and (%) of samples yielding fungi					Total No. of samples yielding fungi
			Lt	Fs	Tp	Pp	Cg	
1	Thiruvananthapuram	116	79 (68.1)	5 (4.31)	1 (0.86)	0 (0)	0 (0)	85 (73.27)
2	Kollam	77	52 (67.5)	4 (5.19)	0 (0)	0 (0)	0 (0)	56 (72.72)
3	Pathanamthitta	45	35 (77.7)	0 (0)	0 (0)	0 (0)	0 (0)	35 (77.7)
4	Alappuzha	85	59 (69.41)	4 (4.7)	0 (0)	0 (0)	1 (1.17)	64 (75.29)
5	Kottayam	42	28 (66.66)	3 (7.14)	2 (4.76)	0 (0)	0 (0)	33 (78.57)
6	Idukki	60	14 (23.33)	0 (0)	0 (0)	42 (70)	1 (1.66)	57 (95)
7	Ernakulam	83	52 (62.65)	5 (6.02)	1 (1.20)	0 (0)	1 (1.20)	59 (71.08)
8	Thrissur	69	54 (78.26)	2 (2.89)	0 (0)	0 (0)	0 (0)	56 (81.59)
	Total	577	373(64.6)	23(3.98)	4(0.69)	42(7.27)	3(0.51)	445(77.12)

Lt=*Lasiodiplodia theobromae*, Fs=*Fusarium species*, Tp=*Thielaviopsis pradoxa*, Pp=*Phytophthora palmivora*, Cg=*Collatotrichum gloeosporioides*

**Table 3: Pathogenicity of fungi isolated from coconut with symptoms of rotting**

Fungi isolated	No. of isolates studied	Mean lesion size (mm) caused by different isolates of each fungus					
		Days of incubation					
		5		10		15	
		L	B	L	B	L	B
<i>Lasiodiplodia theobromae</i>	273	27 (9-34)	12.5 (9-14)	61 (12-84)	26 (11-59)	Severe rotting covering almost entire nut surface	
<i>Fusarium</i> species	23	16 (13-19)	12 (11-14)	23 (21-31)	13.4 (13-16)	33 (27-39)	21 (16-24)
<i>Colletotrichum gloeosporioides</i>	3	15 (14-16)	11.5 (11-12)	18.5 (16-21)	11.7 (11-12)	19.5 (16-21)	12.5 (11-14)
<i>Phytophthora palmivora</i>	42	41 (16-54)	24 (19-31)	94 (38-98)	37 (39-72)	Severe rotting covering whole nut	
<i>Thielaviopsis paradoxa</i>	4	35.6 (21-49)	21 (14-26)	74 (36-92)	36 (19-53)	Severe rotting covering almost entire nut surface	

Figures in parenthesis are range in lesion size of different isolates of each fungus

very rare and only less than 5% of the samples yielded these fungi.

### Conclusion

The detailed studies on the role of fungi in fruit rot and nut fall of coconuts in southern parts of Kerala State revealed *L. theobromae* as the predominant and major fungus causing rotting of nuts at different stages of maturity and in stored mature nuts. Though a weak pathogen *L. theobromae* became a serious pathogen, causing considerable loss to coconut growers in Kerala state. The soft and white tissue beneath the perianth where eriophyid mite caused injury appeared to be very much vulnerable to infection by *L. theobromae*. Since the infection is on the nuts it causes direct loss to coconut growers. It is worthwhile to find out the occurrence and intensity of *L. theobromae* fruit rot of coconut in the other coconut growing countries. This

problem remains unnoticed in the initial stages because of the sporadic occurrence and low intensity. Management of eriophid mite *Aceria guerreronis* is the key for reducing the damage by the fungal pathogen.

### Acknowledgements

The authors are thankful to Director CPCRI, Kasargod and Head, CPCRI, Regional station, Kayangulam for providing necessary facilities and encouragement during the course of the study.

### References

- ChandraMohanana. R. and Saritha Baby, 2004. Rotting and immature nut fall off eriophyid mite infested coconut. *Indian Cocon. J.* 34: 23-24.

- Gunasekaran, M. and Srinivasan, N. 2000. involvement of *Lasiodiplodia theobromae* (Pat) Griffon and Maublin fruit rot of coconut in India. *Trop. Agric.* 77: 123 - 125.
- Lakshmanan, P. and Jagadeesan, R. 2004. Malformation and cracking of nuts in coconut palms (*Cocos nucifera*) due to the interaction of the eriophyid mite *Aceria guerreroni*s and *Botryodiplodia theobromae* in Tamil Nadu, India. *J. Plant Dis. Prot.* 11(2): 206-207
- Menon, K.P.V. and Pandalai, K.M. 1958. *The coconut palm - a monograph*. Indian Central Coconut Committee, Ernakulam, Kerala, India, 73-78 pp.
- Nambiar, K.K.N.1994. Diseases and disorders of coconuts. In: *Advances in Horticulture vol. 10 Plantation and Spice Crops Part 2*. K.L.Chadha and P. Rethinam, (Eds.). Malhotra Publishing House, New Delhi, 857-882 pp.
- Sathiamma, B., Nair, C.P.R.and Koshy, P.K. 1998. Out break of a nut infesting eriophyid mite *Eriophyes guerreronis* (K.) in coconut plantation in India. *Indian Cocon. J.* 29:1-3.
- Singh, S.P. and Rethinam, P. 2006. Slug or nettle caterpillar pests of coconut. *Cocoinfo Int.* 13(1): 25-35.
- Sulladmath, V.V. and Shantappa, P.B. 1979. Nut fall in coconut associated with *Botryosphaeria rhodina* (Berks and Curt pv. Arx). *Curr .Res.* 8:13.