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REVIEW ON THE INCIDENCE AND MANAGEMENT OF COCONUT TERMITES

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ABSTRACT

Coconut, a major plantation crop in tropics is constrained with both biotic and abiotic factors. Amongst the biotic constraints, termites are the major soil insect-pests in the orchard that can cause damage up to 20% particularly in nursery. In India, termites are found in almost all the coconut growing tracts, but not considered serious except in the nursery. Coconut is grown in cultivated, and in uncultivated (wild/semi-wild) situations in our country, are ravaged by termites mostly by *Odontotermes* spp. Other, coconut growing countries are affected by other termites (*species of Microtermes, Microcerotermes, Coptotermes, Nasutitermes and Neotermes*). Worldwide, termites attacking coconut comprise of three families (Kalotermitidae, Rhinotermitidae and Termitidae) and eleven genera. In India, termites attacking coconut are exclusively subterranean unlike in other regions (mostly Island nations), where arboreal termites are included. In the latter case, role of ants as biocontrol agent is documented. Microbial pesticides as such are not recommended, is being reasoned out. This review deals with distribution, nature of damage and management aspects in the associated context. Integrated pest management (IPM) strategies, and few indigenous traditional knowledge (ITK) are also highlighted.

Key words: Ant, IPM, indigenous traditional knowledge (ITK), Nursery, *Odontotermes*

Coconut *Cocos nucifera* L. is grown in more than 93 countries of the world in an area of 12.29 million ha with a total production in terms of copra equivalent of 11.04 million MT Indonesia (25.6%), Philippines (23.9%), India (19.2%) are the major coconut producing countries. In our country, this tree-crop is grown in 1.94 million ha in 19 states and 3 union territories of India producing 15,730 million nuts with an average productivity of 8303 nuts per ha or 44.27 nuts/palm/year (www.nabard.org). Four southern states (Kerala, Tamil Nadu, Karnataka, and Andhra Pradesh) put together account about 90% of the total coconut acreage and production in the country (data for 2011-12, http://coconutboard.nic.in). Coconut is a crop of small and marginal farmers since 98% of about five million coconut holdings in the country are less than two hectares. In the west coast of India particularly Kerala, the palm is an essential component in the homestead system of farming (https://www.nabard.org). Coconut is a major plantation crop in states like Kerala and Karnataka, as well as source of vegetable oil and several other by-products. Farmers particularly from homestead farming areas (*eg*. Kerala) are subsistence farmers (ftp://ftp.fao.org).

Many crops are recommended as intercrops with coconut (http://www.kissankerala.net), few of those intercrops those can also be attacked by termites are cereals (rice, maize); legumes and pulses (groundnut); and few fruit plants (banana).

Amongst the insect-pests, termites as soil insects are important in coconut and associated intercrops. In India, termites are found in almost all the coconut growing tracts, described by Menon and Pandalai (1958) in their monograph. Termites are normally not considered that much serious pest but in nursery. On clay soil, termites are reported to cause up to 20% loss of seedlings (Anonymous, 2006). Some termites live in soil around palm roots and some live in mounds built on earth. There has been a growing concern on termite problems in coastal tracts in India these days, probably due to the global climate changes.

Nature of damage

According to Roonwal (1979), *Odontotermes obesus* is a major pest of coconut palm both in nurseries and plantation. In drought condition sometimes the damage may be 30-40%. Krishnamoorthy and Ramasubbiah (1962) reported that in Andhra Pradesh coconut palm affected by termites (galleries on leaves and stem) at different stages of its growth in varying degrees.The damage reported greater in lateritic soils than in sandy soil. In growing palm termite generally

attack the roots and up to 10-15 cm of the stem (Nirula *et al*., 1953; Nirula and Menon, 1960; Nair, 1986).

It is estimated that nearly 20% of the coconut seedlings are damaged by termites particularly in laterite soil (http://coconutboard.nic.in; David and Kumaraswami, 1988). Usually termites attack seedlings in nursery especially in laterite areas. Invasion is either through the base of the seed nut or at the collar region. The first visible symptom of damage is wilting of the central shoot (bud leaf). When pulled off, the sprouting bud easily comes out. Therefore, damaged husk can be seen if the seedling is removed and examined. If the seed nut and the stem are split open, sand/soil incrustations can be observed which is a characteristic feature (Anonymous, 2006). Infestation also continues in the main field resulting in poor establishment. Felled trees and ornamental palms are also infested by termites to various degrees (Fig. 1). Termite does not usually kill the tree but restricts its future growth due to irreversible damage (H:\11-2-13\coconut\Coconut Palms in Belize - Other Diseases and Pests.htm).

Termites associated with coconut

Coconut is actually grown in cultivated, and in uncultivated (wild/semi-wild) situations in India, which is often ravaged by termites mostly (*Odontotermes* spp.). Other than India reported only in Sri Lanka. In other coconut growing countries termites *species of Microtermes, Microcerotermes, Coptotermes and Neotermes* are reported.

A list of species attacking coconut is given is Table 1. Among these *Coptotermes formosanus* – the Formosan subterranean termite is one of the most widely distributed and economically important. It is probably native to China, but has been transported to Hawaii, Japan, South Africa, Sri Lanka, and the south eastern US. It is considered as the most economically important insect pest in the state of Hawaii, attacking structures as well as many plants, including palms (http://idtools.org/id/palms/sap).

Control Methods

A. Cultural

A high standard of orchard sanitation is the prerequisite for preventive action. Fallen leaves and unsprouted nuts should be collected and burnt and dead trees should be properly disposed off. Termite mounds in the coconut garden/orchard should be destroyed, and if possible the queen which lives in a special chamber in the mound can be searched out and killed. If the mulch in the nurseries or around tree bases is infested, such mulch should be removed immediately. Piling of coconut husks around or near nurseries should be avoided. Termitaria elimination and adoption of field sanitation by disposal of organic matter in nursery soil; and covering germinating nuts with a layer of river sand is advocated often (http://www.advanceagriculturalpractice.in, Roonwal, 1979).

B. Chemical

During early years mixing fish-oil resin soap in the irrigation water was being recommended. The exposed galleries were scraped and the application of a paste of BHC 50% wettable powder was practised on the trunks. When the entire plant was attacked spraying with 0.25% BHC was adopted. Field experiments showed that the application of BHC 5% dust to the soil at 20 lbs. per acre was able to control metric and this is now advocated in place of fish-oil resin soap. Aldrin 5% dust, which is also a good soil insecticide, is proving better conversion BHC (Krishnamoorthy and Ramasubbiah, 1962). During land preparation, BHC 10% dustable powder could be sprinkled on the husk to prevent termite attack; it was very common practice in Kerala (http://www.keralaagriculture.gov.in). Mathen *et al.* (1964) obtained control against *Odontotermes obesus* infesting germinating nuts in nurseries by soil treatment with aldrin or chlordane (@30 g/100 sq m of 5% dust) or heptachlor (@ 27 gm/100 sq m of 3% dust). Application of dust of chlordane (@60g) or heptachlor (@50g) per 100 m^2 around the seed-nuts in the nurseries prevent damage (David and Kumaraswami, 1988). However, toxic aldrin, BHC, chlordane, and heptachlor are banned long back in India. Dusting carbaryl 10% on the coconut husk is also suggested (http://www.kissankerala.net/).

Practices like locating termite mounds and their destruction, swabbing with neem oil 5% once on the base and upto 2m height of the trunk, spraying copper sulphate 1% or cashew nut shell oil 80% or chlorphyriphos @3ml/l of water, neem oil @ 5% or NSKE @ 20% to preserve plaited coconut leaves are also advocated (http://agritech.tnau.ac.in).

In Arabian countries, control measures could be started by removing and burning destroyed offshoots. In case of a slight attack, it is recommended to clean the offshoot of soil canals and spray insecticides (chlorpyriphos or trizophos). It is also advised to turn over the surrounding soil to about 50 cm deep in order to destroy these canals and treat them with a nematicide product (http://www.fao.org).

A coconut seedling damaged by termites

Seed-nuts opened up to show the damage

Sand incrustation in the seed nut

Sand incrustation in the seed nut

Mature seed-nut with damaged husk

Infested coconut trunk

Infestation in felled coconut
Damage Symptoms mature tree

Infestation in felled coconut
Damage Symptoms mature tree

Damage Symptoms ornamental palms – (a) leaves, (b) crown/fronds, (c) palm-tree trunk at crown; and (d) galleries on trunk

Fig. 1. Damage Symptoms of Coconut termites (seedling stage) Photo-courtesy: Dr Joseph Rajkumar, CPCRI, Kayamkulam, Kerala

Table 1. Termites associated with coconut

Termites associated with coconut	Area / coconut tracks	Remarks (if any)	References
Indian			
Odontotermes obesus (Rambur)	Andhra Pradesh	Attack both in nursery and the plantations. In some years when there is dearth of water there is loss of 30-40% of the seedlings. In the grown-up palms the termites are usually seen around the root zone, and in certain cases up to about 6 feet above ground level.	Krishnamoorthy and Ramasubbiah, 1962
O. obesus (Rambur)	Kerala	Nursery pest, prefer husk of seed nuts.	www.agritech.tnau.ac.in; Nair,1986; 1999; Panwar, 1995
O. redemanni (Wasmann) and *O. Obscuriceps* Wasmann		Attack of coconut seedlings, entry being made via the husk of the seed nut, eventually damage being caused by exposure of vital tissues leading to plant-death. Replanting is necessary in some cases.	Fernando, 1962; Sankaran, 1962
O. malabaricus Holmgren and Holmgren	Tamil Nadu	----------	Beeson, 1940
O. obesus (Rambur) *O. redemanni* (Wasmann)		Wilting of the central shoot is the first sign of attack by both species occurs at the base of the collar	Roonwal, 1979
(other than India)			
Coptotermes curvignathus Holmgren	New Guinea, Borneo, Malaya Peninsula, Indonesia	Tree is liable to be attacked at any stage of growth, but damage is serious at 2-4 years old seedlings. Older palms are attacked through the crown or trunk.	Mariau *et al.*, 1992
O. obscuriceps Wasmann, *O. obesus* (Rambur) and *O. redemanni* (Wasmann)	Sri Lanka	Nursery pests, also in the field soon after transplanting	Roonwal, 1979; Anonymous, 2006
Nasutitermes ceylonic us Holmgren		Constructs long run ways on the trunk. Sometimes feed tissues on the bark, thus bark easily peals off exposing, and weakening the palm	Anonymous, 2006
O. homi (Wasmann)		Lives in close contact with the roots and feeds upon the mulching materials laid on the manure circle. They occasionally attack the root system. If the termite population is high they could cause severe damage to the root system.	Anonymous, 2006
C. ceylonicus Holmgren, *O. obesus* (Rambur) and *O. redemanni* (Wasmann)	Sri Lanka	Hollow out the trunk. Wilting of the central shoot is the first sign of both the last mentioned species attack, occurs at the base of the collar	Mariau *et al.*, 1992; Roonwal, 1979

C. truncates Wasmann	Seychelles	Termite increases the damage done by beetle *Melittomma* spp. (not yet reported from India)	Lever, 1969
Schedorbinotermes marjoriae Snyder	Solomon Islands	Excavate large compact nests among the roots	Harris, 1958
Microcerotermes biroi (Desneux), *Nasutitermes princeps* (Desneux) and *N. novarumhebridarum* (Holmgren and Holmgren)	Solomon Islands and New Guinea	These three dominant species feed on the same items but never exploit the same tree. Make carton nests on trunk about a meter above ground. Not very serious.	Harris, 1958; Leponce *et al*., 1995
Microcerotermes bignioni Holmgren and Silvestri	Sri Lanka and Samoa	Nesting deep down among roots.	Harris, 1958
N. ceylonicus Holmgren	Sri Lanka	Forms nest in root zone and construct galleries on trunk of the tree	Krantz *et al*., 1978
N. epbrates Holmgren	Panama	This species lives between leaf sheath and the petiole and damages the living tissues	Lever, 1969
N. laticeps Wasmann	Madagascar	It expose the tissue of the palm to subsequent	Leponce *et al*., 1995
N. costalis (Holmgren)	Caribbean	Trunk and branches	Krantz *et al*., 1978
Allodontotermes morogoroensis Harris	Eastern Africa	----------	Lever, 1969
Macrotermes nigeriensis Sjostedt	Western Africa	50% loss occur	Lever, 1969
M. bellicosus Smeathman	Zanzibar	20% loss occur	Materu *et al*., 2013
M. gilvus Hagen	New Guinea and Malay Peninsula	20% loss occur	Majid, 2008
Neotermes rainbow Hill	Northern Cook and Ellice Islands	Infestation starts at or near ground level and many extend up the trunk as far as the crown even on tall palms.	Given, 1964; Lever, 1969
Coptotermes curvignathus Holmgren	Southeast Asia	Termites usually attack oil palm and coconut trees, the spear region of the palm. Once the spear is destroyed, the tree dies, as it is the only growing vegetative part of the palm.	UNEP, 2000
Microtermes, *Pseudacanthotermes*, *Macrotermes* and *Odontotermes* sp.	Tanzania	Most serious parts affected were plant roots, tunnelling in root collar, wilting and eventually death of the seedling. Losses range from 20-100%.	Materu *et al*., 2013
Neotermes rainbow (Hill)	Several islands of the South Pacific	They hollow out and establish colonies in the trunks of coconut palms often leading to the collapse of the tree. Coconut termites are not known to occur in the US or the Caribbean.	http://itp.lucidcentral.org/id/palms/sap/Termites.htm
Microcerotermes losbanosensis Oshima and *N. luzonicus* (Oshima)	Philippines	Minor pest	Peters *et al.*, 2008

Coconut Board advocates adoption of field sanitation by disposal of organic matter in nursery soil and covering germinating nuts with a layer of river sand, drenching nursery with chlorpyriphos (0.05%) twice at 20-25 days interval, and swabbing termite-affected trunk with the same chemical (http://coconutboard.nic.in).

C. Preplanting seed nut treatment

The recommended insecticides and their dosages are given below:

- Imadacloprid 20 % (Admire® SL 200) @ 1-2 ml/l of water or chloropyrifos 20% EC@ 3-5 ml/l of water (Anonymous, 2006).
- Chlorpyriphos @ 3.8 g/nursery bed (7.5 m^2) or fipronil granules @ 2.3 g/nursery bed before sowing seed nuts (Josephrajkumar *et al.,* 2012).

Method of application: Seed nuts are to be dipped in one of the above solution for 3 minutes prior planting. If the attack occurs after transplanting, one of the recommended insecticides should be drenched to the soil using a watering can. Five litres of an insecticidal solution is required for one square meter of the area. Since the most serious damage occurs in the nursery and during the first year of growth, it is particularly important that treatment is applied whenever necessary during initial stage, in order to ensure that palms are free from termites. When adult palm is attacked drenching with five litre of the recommended insecticide solution is resorted to around the tree base.

Nursery beds prepared with mixture of soil and sand promotes soil aeration and root spread, reduce attack (cuticular aberration by sand on termite body), this ensure better drainage, enhance germination, and enable easy lifting of the seedlings. Application of a mixture of sand, salt and ash in the pit before transplanting is advocated by Husain and Sundaramari, (2011). The suggested practice in Kerala is to remove the soil in affected areas, up to a depth of about 15 cm and dusting the soil and nuts with carbaryl or chlorpyriphos. Treatment is repeated if attack persists (KAU, 2002).

D. Biocontrol

Termites have a wide variety of predators, both opportunist and specialist, but ants are the greatest enemies of termites in all regions of the world. Although ants limit termite numbers under natural conditions, their suitability for use as biological control agents for target termite management has yet to be ascertained. Naturally termites are predated upon by various animals – frogs & toads, lizards, snakes etc.

Ants as biocontrol agent

Red ant (*Oecophylla smaragdina*) was traditionally used in Southern China for many years to control citrus insect pests, but then abandoned around 1960s. Again in 1990s onwards interest in utility of these weaver ants in pest management of various crops – mango, cashew, and coco was seen (Mahapatro, 2008; Mahapatro and Jose 2015). A keen and in depth look into Table 1 reveals that termites in India attacking coconut is mostly subterranean, not arboreal like in other regions (New Guinea, Borneo, Malaya Peninsula, Indonesia, Sri Lanka, Solomon Islands Samoa, Madagascar, Caribbean, Eastern and Western Africa, Northern Cook and Ellice Islands and Several islands of the South Pacific).

Leponce *et al.* (1999) investigated the incidence of inquiline ants and of arboreal-nesting ants on a community of three arboreal-nesting termites living in New Guinea coconut plantations. Inquiline ants were present in 10% of *Microcerotermes biroi* nests and in 4% of *Nasutitermes princeps* nests. Live termite nests inhabited by the most common inquiline ant, *Camponotus* sp., were generally left by the ant after several months. In some nests, *Camponotus* sp. was observed coexisting with its host during the whole observation period (3 years). Therefore, *Camponotus* sp. was apparently an opportunistic inquiline which did not affect significantly the mortality of termite colonies.

The arboreal-nesting ant, *Crematogaster irritabilis*, was locally found occupying up to 99% of the trees present in 1 ha plots. In such hotspots, the overall abundance was approximately half that of plots devoid of *C. irritabilis*. The high density of *C. irritabilis* may be an important limiting factor for the termite assemblage, by hastening the death or hindering the establishment of arboreal colonies.

Microbials: Termites nesting in soil environments are in constant contact with entomopathogens but have evolved a range of defence mechanisms, resulting in individual and social immunity that reduce the chance for epizootics in the colony. Recently it was reported that the faecal nest supports the growth of Actinobacteria which provide another level of protection to the termite *Coptotermes formosanus* against entomopathogens (Chouvenc *et al.*, 2013). A *Streptomyces* species with *in vivo* antimicrobial activity

against fungal entomopathogens was isolated from the nest material of multiple termite colonies. Termite groups were exposed to *Metarrhizium anisopliae*, a fungal entomopathogen, during their foraging activity and the presence of *Streptomyces* within the nest structure provided significant survival benefit. Fifty years of analysis on attempted biological control implicated the practical failure (Chouvenc *et al.*, 2011). Therefore, it is preferred not to suggest any biocontrol agents.

E. ITK

A traditional method of control in Sri Lanka is noted by P A Henry. At the onset of rainy season farmers remove the aerial part of colony, a basin like depression is made covering entire area of the colony. Rain water is facilitated to be collected in this depression during rainy season. Entire colony may be wiped out by this method.

Husain and Sundaramari (2011) documented 129 traditional practices on coconut cultivation in Kerala. Aspects such as collection and storage of seed nuts (20.15%), cultural operations (14.73%), manuring (13.95%) and nursery management (13.18%) constituted the dominant categories of indigenous knowledge. Of the 129 practices, 30 were analysed for their scientific rationality and awareness and adoption among farmers and 19 practices studied for their perceived effectiveness. Of the 30 practices, 24 were found to be rational, while the rest six were adjudged as irrational. The scientific rationale/ operational principles behind 24 rational ITK were also elucidated in their study. Twelve practices were adopted by 57.5 to 82.5% farmers. Of the 19 ITK studied for effectiveness, 17 were perceived as effective by the farmers, implying that many indigenous practices were both rational as well as effective. This calls for more scientific intervention to validate the indigenous knowledge, which in turn would enrich our agricultural technology. They reported nut sowing procedure that is, with 50% of the nut size above the nursery bed for better rooting and reducing termite attack. It was reasoned out that lower planting depth promotes rooting and germination and positioning the point of attachment of fruit stalk above soil reduces attack. They recommended pre-transplanting application of mixture of sand, salt and ash in the pits. Sand improves drainage, salt improves soil conditions and loosens the laterites, and ash enriches soil potassium levels. This mixture also provides protection against termites. It is pertinent to note these ITKs were adopted by >75% of the farmer-respondents. The former is considered by the farmers as a good technique to reduce damage and to stimulate rooting, without additional labour.

Swapna (2003) narrated few relevant ITKs in Kerala. These include : planting turmeric and arrowroot (*Maranda arundinacea*), 'kattarvazha' (*Aloe vera*) etc. in nursery. Application of crushed fenugreek (*Trigonella foenum-graecum*), and application of salt and ash in the coconut basin, are found to control termites. She also documented that application of neem (*Azadirachta indica*) cake and salt in equal proportion in the basin.

CONCLUSION

A fusion of valid traditional technologies with the prevalent modern techniques of IPM is to be carried out in location specific modes in the coconut growing tracks. Undoubtedly, termites are of economic concern in coconut, only in the nursery. The logic being, coconut is a perennial crop; and correct virulent seedling selection is of prime importance. Mixture of sand, soil and ash recommendation may be adopted as per the existing local recommendations. Fortunately as such, termites in sand is low and needs regular watering (low water holding capacity) which practically wards off termites. Though coconut growing is limited in coastal states, ornamental palm trees are planted in many of the cities and urban environment for aesthetic cause. The termite management recommendations for coconut can be adapted conveniently for these palms as well by the gardeners.

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