

FINAL REPORT

1. Institute Code No. **Ent.X(131 & 231)**
2. I. C. A. R. Code No. **P1-89/8-ICI-H10/2710**
3. Name and Address of Research Institute/Centre: **Central Plantation Crops Research Institute, Kasaragod 671 124**
4. Project Title: **Investigations on white grub pests of palms**
5. Name and Designation of Project Leader:
P. Rajan, Scientist (SG) w.e.f. May 1989 - June 1990
Chandrika Mohan, Scientist w.e.f. April 1990 - May 1995
B. Padmanaban, Scientist (Sr. Scale) w.e.f. June 1995 to till date
6. Name(s) and Designation(s) of Project Associates including Project Leader and work to be done:
- | Sl. No. | Name and Designation | Time spent | Work done |
|---------|-------------------------------------|--------------------------------|-----------|
| 1. | PSP Vidyasagar, Sr. Scientist | w.e.f. May 1990 to 1994 | |
| 2. | AS Sukumaran, Scientist (SG) | w.e.f. June 1995 to 1998 | |
| 3. | B. Padmanaban, Scientist | w.e.f. Sept. 1990 to till date | |
| 4. | Mariamms Daniel, Sr. Scientist | w.e.f. May 1991 to 1996 | |
| 5. | M. Saraswathy, Sr. Scientist | w.e.f. May 1992 to 1996 | |
| 6. | B. Ramanujam, Scientist (Sr. Scale) | w.e.f. May 96 to 1998 | |
| 7. | Rajagopal Raman, Scientist | w.e.f. May 1996 to Sept. 1997 | |
| 8. | S.R. Prabhu, Scientist | w.e.f. May 1997 to 1998 | |
7. Location of Research Project with complete address (Division/Section/Sub-Centre):
1. Central Plantation Crops Research Institute, Kasaragod 671 124, Kerala
 2. Central Plantation Crops Research Institute, Regional Station, Vittal - 574 243, Karnataka

8. Date of start **May, 1989**

9. Date of termination **May, 1998**

10. (a) Objectives (Not more than 150 words)

The project aims at detailed studies on different aspects on white grub problem in arecanut and coconut plantations. The main objectives are :-

1. Cataloguing the white grub pests of arecanut and coconut plantations.
2. To study the occurrence of these pests in various tracts.
3. To study the seasonal abundance and distribution of these pests.
4. To study the biology of these pests, their nature and extent of damage.
5. Studies on the alternate host plants, if any, where the adult beetles congregate and feed and to develop strategies to control them.
6. Studies on the natural enemies - Parasites, predators and pathogens.
7. Evaluation of sugars and amine acids for phageostimulatory activity.
8. Evaluation of semiochemicals for adult beetle attraction.
9. Field evaluation of plant products.

(b) Practical Utility including background information (Not more than 150 words)

In recent years, white grubs have assumed a serious proportion as pests of several crops in various parts of our country so much so that it has been recognised as a pest of national importance in 1975. In arecanut gardens, three species of white grubs viz., Leucepholis burmeisteri Brenske, L. lepidophora Blanch. L. conocephora Burm. and in coconut gardens L. conocephora and Anomala sp. are commonly found damaging the palms in Karnataka and Kerala. Information on biology of these species and integrated control measures for combating them are inadequate. Detailed information on the white grub problem is an essential prerequisite for estimating the crop losses caused by these pests cataloguing of different species will help in identifying the problem in detail. Other studies suggested will help in evolving suitable control schedules including the use of bioagents. Information on seasonal abundance and distribution range will help in evolving appropriate schedules for the integrated management of white grubs.

CENTRAL PLANTATION CROPS RESEARCH INSTITUTE

KASARAGOD-670 124, KERALA

R P F III

Project No. Ent X (131 & 23)

11. Technical Programme:

Date of Start: May, 1989

1. Collection and cataloguing of different species of white grub infesting areca and coconut plantations and identification of economically important ones.
2. Life history of Leucepholis burmeisteri and L. ceneophora and its seasonal distribution.
3. Feeding habits, nature and extent of damage.
4. Identification of host plants on which the adult beetles congregate during the peak period of mass emergence.
5. Chemical control bioassay in pot culture and field testing of promising chemicals.
6. Possibility of tackling adult beetles by Manual collection
7. Combing the severely infested tracts for collection of natural enemies.
8. Evaluation of sugars and aminoacids as phagestimulants.
9. Development of artificial diet for grubs.
10. Evaluation of semiochemicals for attraction of adult beetles.
11. Evaluation of entomopathogenic fungi and nematodes.
12. Evaluation of plant products.
13. Survey on white grub endemic areas of Kerala in search of entomophili nematodes (EPN)
14. Identification of EPN, mutualistic bacteria and pathogenicity studies
15. Insecticide field trial to schedule time of application.
16. Dissipation of pherate in soil.

CENTRAL PLANTATION CROPS RESEARCH INSTITUTE

KASARAGOD-670 124, KERALA

R P F III

Project No. Ent.X (131&231)

12. Final Report: 19 89 —1998

Date of Start: May, 1989

Ent.X(131 & 231) : Investigations on white grub pests of palms

(P. Rajan, P. Chandrika Mohan, P.S.P.V. Vidya Sagar
A.S. Sukumaran, B. Padmanaban, Mariamma Daniel,
K.C. Chenchaiiah, N. Saraswathy, B. Ramanujam,
Rajagopal Raman and S.R. Prabhu).

Objectives of the projects were:

- (a) Cataloguing the white grub pests of arecanut and coconut plantations (b) To study the occurrence of these pests in various tracts (c) To study the seasonal abundance and distribution of these pests (d) To study the biology of these pests, their nature and extent of damage (e) Studies on the alternate host plants (f) studies on the natural enemies (g) evaluation of sugars and amino acids for phagostimulatory activity (h) evaluation of semiochemicals for adult beetle attraction (i) studies on plant products & (j) pheromone studies.

Salient research findings :

Arecanut :

Collection and cataloguing of white grubs from different gardens from South Kanara, North Kanara, Coorg, Chickmagalur, Shimoga in Karnataka and Kasaragod in Kerala revealed that the white grub infesting areca palms in these areas is Leucopholis burmeisteri Br., L. lepidophora Bl. Helotrichia bicolor and Anomala malabariensis.

In addition to arecanut the grubs fed on roots/tubers/rhizomes of the plants such as Musa sp., elephant foot yam, cococasia, arrow root, cassava, pineapple, cocoa, cashew, mango, coconut and Atrocarpus sp. Under laboratory conditions adult beetles found to feed on leaves of Ficus sp., cashew, hog plum, sapota, mango, rose and tamarind.

The life cycle of Leucopholis burmeisteri Bren. on arecanut, banana and cocoa was observed to be annual. Among the developmental stages of the pest, the third instar grubs showed considerable difference in duration, which lasted for 108.2, 129.2 and 141.0 days respectively when reared on banana, arecanut and cocoa.

Sustained root feeding of white grub caused considerable root damage which resulted in reduction in apical stem girth commonly referred as "Stem tapering". Six such types were recognised. Reduction of apical stem girth due to root damage considerably affected the yield. Studies revealed a significant negative correlation between stem tapering and the yield.

13. Approximate expenditure incurred in the Project: (Give reasons for variation, if any, from original estimated cost)

Rs. 15,00,000/-

14. Publications and material (one copy each to be supplied with this proforma)

a) Research papers

b) Popular articles

c) Reports

Enclosed Annexure - I

d) Seminars and workshops (Relevant to the Project) in which the Scientists have participated:

(1) Attended PLACROSYM X CPCRI, Kasaragod (2-4, Dec. 1992) and presented a research paper entitled 'Biocology of coconut white grub, Leucophelis coneophora Burm. in Kerala (Chandrika Mohan & PSPV Vidyasagar).

(2) Attended Indo-British workshop on current approaches to pheromona technology held during November 29 to December 2, 1995 CLRI, Madras (B. Padmanaban)

(Contd...)

e) Material developed (such as new varieties of crops or breeds of farm animals, implements, products, etc.)

Nil

15. Details (Nos. etc.) of Field/Laboratory Note books and final material and their location

Available at Entomology section, CPCRI, Kasaragod

16. Comments/suggestions of Project Leader regarding possible future line of work that may be taken up arising of this project:

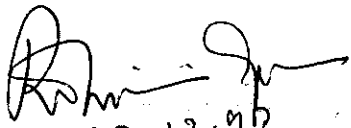
The following future line of work may be taken up keeping in view of the seriousness of the pest (i) Detailed studies on entomopathogenic nematodes from the white grub endemic areas for the management of white grubs (ii) as an alternate method for the management of white grubs eco-friendly method, investigations on phenomene studies is most important.

17. Signatures with name of Project Leader and Associates:



22/12/97

Dr. B. PADMANABAN
Scientist Sr. Sc. (Ent.)
C P C R I
KASARAGOD-671124

18. Signature (with comments, if any) of Head of Division/Section/Station:


23.12.97
HEAD
Division of Crop Protection
Central Plantation Crops Research Institute
KASARAGOD - 671124, Kerala

19. Signature (with comments, if any) of Director:



BIOECOLOGY OF COCONUT WHITEGRUB *LEUCOPHOLIS* *CONEOPHORA* BURMEISTER IN KERALA

CHANDRIKA MOHAN and P.S.P.V. VIDYASAGAR

Central Plantation Crops Research Institute, Kasaragod 671 124, Kerala

ABSTRACT

Studies were carried out on the ecology, biology and population dynamics of *Leucopholis coneophora* Burmeister (Coleoptera: Scarabaeidae: Melolonthinae), a key pest of coconut in India. The adult emergence from soil was observed in the field after 4-5 rainy days irrespective of the amount of rainfall, combined with a sudden fall in soil temperature. In the field-collected samples the ratio of female to male was 1:8. Adults of both sexes were also found attracted to light traps in small numbers and their female to male sex ratio was 1:5. Out of several plant species screened in lab cages, the tender leaves of mango (257 mm²/day) were preferred over cashew, banana, sapota and coconut.

An average fecundity of 23.08 (\pm 1.985) eggs per female was observed in the lab. The incubation period was 23.94 (\pm 0.134) days and the I, II and III larval instars were completed in 40, 55 and 175 days respectively followed by the pupal period of 25 days. Feeding potential of III instar larvae has revealed that an average of 1.03g of fresh coconut root/larva was consumed in 24 hours. The phenology of the pest has been investigated and the peak population of the pest was observed in the field during the month of September.

INTRODUCTION

White grub *Leucopholis coneophora* is one of the key pests of coconut in the coastal Kerala and Karnataka. Nirula (1958) reported yellowing of the leaves and premature shedding of nuts due to the feeding of the white grub on coconut roots. The biology of *L. coneophora* along with two related spp. infesting arecanut namely *L. lepidophora* and *L. burmeisteri* were reported by Veeresh *et al.* (1982), Abraham and Mohandas, (1988) and Kumar and Veeresh (1990). Though the crop loss caused by white grub has been reported by Sekhar (1958) and Kurian and Abdulla Koya (1974), information on the feeding potential of white grub, phenology of the pest and adult emergence behaviour is not available. The present investigation on the bioecology of coconut white grub was undertaken with a view to formulate an integrated management schedule for the effective control of the pest.

MATERIALS AND METHODS

The investigations were carried out in sandy loam soil at CPCRI, Kasaragod, Kerala in a coconut monocropping system for a period of two years during 1990 and 1991. Adults emerging

from the soil of a marked area were collected and counted between 20th May and 20th September during sunset hours. The field collected beetles were maintained in laboratory cages (30 x 30 x 30 cm). A glass trough (20 cm x 11 cm) was kept at the bottom of the cage filled with 10 cm soil. Freshly laid eggs were collected from the soil of these cages and placed in petriplates (9 cm x 1.5 cm) containing moist soil. The larvae upon hatching were removed to separate containers (6.5 cm x 9.5 cm) provided with moist soil (13.09% moisture) and roots of grass/coconut/sweet potato as food. After a period of one month they were transferred to earthen pots.

To assess the attraction of adults to light source two light traps were operated from 6 pm to 6 am with a mercury bulb (165 lm) in two white grub infested plots, throughout the experimental period. Data on the catches were tabulated.

For adult feeding studies the leaves of various plants grown in the vicinity of the Institute such as coconut, arecanut, oil palm, cashew, ficus, hibiscus, rose, banana, sapota, clove, guava, mango, jack, cocoa, neem, acacia, subabul and moringa were collected and placed

in insect cages with adult beetles. First the leaves were bulk screened and later those preferred for feeding were individually tested in batches of 10 adults to find out the quantity of feeding. The leaves were changed daily and feeding area, if any was plotted on a graph paper.

For estimating the feeding potential eight larvae of 2nd and 3rd instar grubs were individually caged in 1000ml beakers, three-fourth filled with moist soil. Each beaker was provided with a fresh tender coconut root replaced at an interval of 24 hours. Fresh roots were individually kept in four beakers without any grubs to serve as control. The weight of

the root was taken before and after the feeding. The loss of weight in the root due to grub damage was calculated after taking into account the loss in the weight of roots kept in the control. This experiment was conducted for a period of 30 days and was repeated thrice.

For estimating the per palm field population of grubs in the soil to a specific depth, monthly samples consisting of 10 numbers were randomly collected from 200 palms and the life stages obtained therein were recorded. Thus the seasonal phenology of the pest was investigated. Emergence of the adult beetle was correlated with rainfall and soil temperature.

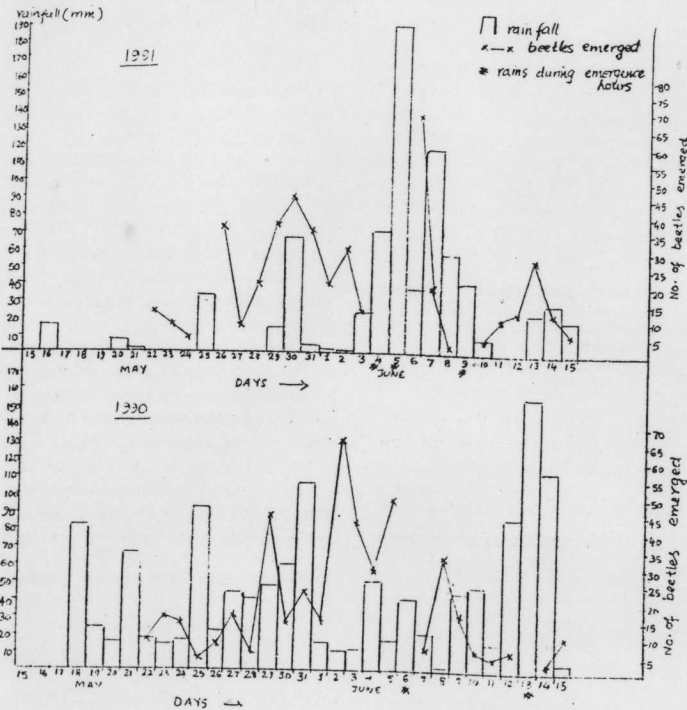


Fig. 1 Adult emergence of *L. coneophora* in relation to rainfall during May-June

RESULTS AND DISCUSSION

Adult emergence of *L. coneophora* started in the last week of May in both the years. The rainfall data when correlated with the adult emergence indicated the commencement of emergence after 3-5 rainy days irrespective of the amount of rainfall (Fig. 1). When the data pertaining to the month of May were

scrutinized, it was found that there was a sharp decline in the soil temperature in the second fortnight from 35.5°C to 31.6°C. A combination of 3-5 rainy days and fall in soil temperature perhaps triggered the adult emergence (Fig. 2). In *Holotrichia serrata* the adult emergence and egg laying are dependant on rains in April-May irrespective of the soil moisture. Veeresh (1977) reported that saturation of atmospheric humidity

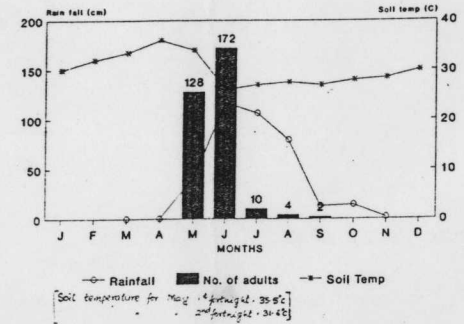


Fig. 2 *L. coneophora* adult emergence in relation to rainfall and soil temperature

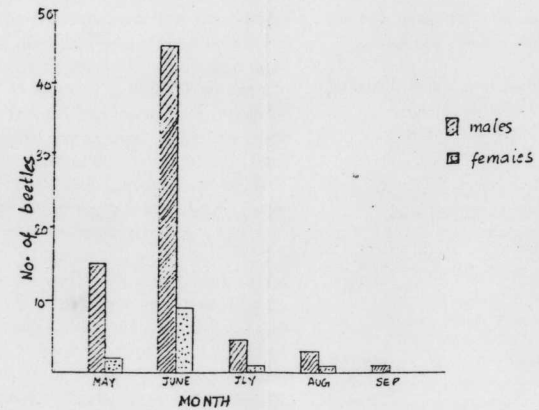


Fig. 3 No. of *L. coneophora* beetles collected in Light trap

seems to have more influence on adult emergence in these months than the moisture content of soil.

When a light trap with a light source of 165 l/m mercury bulb was operated, a few adults were collected in the insect catches (Fig. 3). Sex ratio of female to male in the light trap collections was found to be 1:5. These observations of female attraction towards light traps are contradictory to the observations of Abraham and Mohandas (1988) who reported that females seldom flew or make emergence holes. During the adult emergence both males and females, were collected from the field and the sex ratio was 1:8. Abraham and Mohandas (1988) have reported female to male ratio as 0.099: 1 (i.e approx 1:10) under field conditions. The results obtained from the light trap catches are in agreement with the population dynamics of the pest.

Many species of white grubs are known for the congregation of their adult stages on a particular host. For example, *Holotrichia* sp. has been reported to congregate on the leaves and branches of neem trees immediately after emergence (Gupta, 1973; Veeresh, 1977; Raodeo and Deshpande, 1987). However, in *L. coneophora* congregation of adults on any food plant has not been observed. Moreover, earlier workers reported that adults do not feed on any food plant. (Sekhar, 1958; Nirula, 1958; Veeresh *et al.*, 1982; and Abraham and Mohandas, 1988). With a view to identifying a plant as a preferred host, so that a suitable bait formulation can be evolved at a later stage, a number of species occurring in the neighbouring localities of coconut gardens were screened. Out of several species tested in the laboratory cages maximum feeding of 257 mm²/day was recorded on the tender leaves of mango. Other host plants in order of preference are

cashew, banana, sapota and coconut (Table I).

The preoviposition period lasted for 10 days, followed by a 4-day egg laying period. Fecundity was observed to be 23.08 (± 1.985) egg/female. The incubation period on an average was 23.94 (± 0.134) days. The biology is in confirmation with the observations made by earlier workers with three larval instars of 40, 55 and 175 days respectively followed by a pupal stage of 25 days.

Formation of egg laying chamber in *L. coneophora* was reported by Abraham and Mohandas (1988). However, in the present study, no such egg laying chamber was observed. Eggs were found loosely scattered in soil at a depth of 10-15 cm both in the field and laboratory.

The experiments conducted on the feeding potential of 2nd and 3rd instar larvae have revealed that an average of 0.52g and 1.03 g of fresh root was consumed by a single 2nd and 3rd instar grub respectively in 24 hours (Table II.). Since the 1st instar feeds mainly on grass roots damage caused to coconut root is negligible. A single second instar stretching for a period of 55 days consumes about 28 g of

Table II. Feeding potential of *L. coneophora* grubs

Batch No.*	Amount of coconut root (g) consumed/24 hour/grub	
	2nd instar	3rd instar
1	0.46	1.04
2	0.54	0.98
3	0.56	1.07
Mean	0.52	1.03

* Number of grubs per batch = 8

Table I. Feeding potential of *L. coneophora* adults

Batch No.*	Area of leaf fed (mm ²) / beetle / day				
	Mango	Cashew	Banana	Sapota	Coconut
1	200	95	78	58	50
2	325	96	88	50	53
3	300	103	86	66	53
Mean	275	98	84	58	52

* Number of beetles per batch = 10.

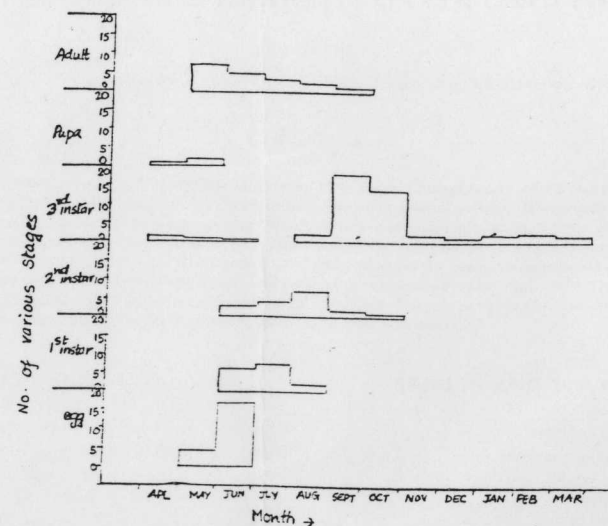


Fig. 4 Seasonal phenology of *L. coneophora* (per palm population)

coconut root, whereas the 3rd instar which lasts for a period of 175 days, consumes about 180g of coconut root.

The seasonal phenology of *L. coneophora* studied for a two years period is presented in Fig. 4. This clearly indicated that this species has a one year life cycle under field conditions which is in conformity with the findings of Abraham and Mohandas (1988). There is preponderance of 1st and 2nd instar grubs from the month of June till September. The 3rd instar appears in field samples from August in small numbers and its presence continues upto April. It overlaps with other early instars and reaches a peak in the month of September.

The results indicated the possibility of forecasting adult emergence and trapping the adults by light trap, food plants etc., for inclusion in the integrated pest management schedule. Detailed account on seasonal phenology has clearly shown the distribution of grub stages in the season. This will help in formulation of better chemical control schedules against the pest.

REFERENCES

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DISCUSSION

C.K. SARASWATHY AMMA : How long will the adult beetle survive?

CHANDRIKA MOHAN : The adult survives for 29 days (range 19-36 days).

K.R. VIJAYAKUMAR : If the pest is serious in coconut, why such a study was not undertaken earlier?

CHANDRIKA MOHAN : Biology of this pest was worked out by previous workers. However, the detailed biology work was not carried out.

A. MANOHAR RAO : Only rainfall has been taken into study, why other weather parameters not taken into account because irrespective of rainfall the adults have emerged?

CHANDRIKA MOHAN : Adults will not emerge irrespective of rainfall. Some 3-5 rainy days are required to trigger the mechanism of emergence. Apart from rainfall, soil temperature was also considered in this study. Other weather parameters like atmospheric temperature and humidity did not show any correlation to emergence.

D.P. VERMA : The maximum population of male and female was observed in June. Whether you suggest to resort to chemical control to be adopted in June. Whether spraying of pesticides around the coconut root will help to prevent the damage by this pest?

CHANDRIKA MOHAN : Only adult beetle population was found in peak in June. We cannot apply chemical control for adults as the beetles are not congregating on any food plant. Moreover, the adults remain buried in soil during day time, and so chemical control of adults is not feasible. Chemical spraying of pesticides around the root zone is not very effective and economical. For soil treatments granular formulations of systemic insecticides are better than spray formulation for the white grub control.

ROLE OF PREDACIOUS MITES AND INSECTS IN THE BIOLOGICAL SUPPRESSION OF SPIDER MITES ON COCONUT FOLIAGE

B. SATHIAMMA

Central Plantation Crops Research Institute, Regional Station, Kayangulam, Krishnapuram - 690 533, Kerala

ABSTRACT

Mite, insect and spider predators exerted biological suppression of the spider mites *Oligonychus isilemae* and *Tetranychus ludeni* infesting the coconut foliage. Six species of mites, four species of insects and one species of spider were observed as natural predators. *A. (A.) paraaerialis*, *A. (T.) eucalypticus*, *Cunaxa setirostris* and *Agistemus* were the mite predators recorded in association with colonies of *O. isilemae*. The immature and adult stages of the predators consumed different stages of the prey. The predator potential and seasonal occurrence were also studied. The role of the predacious insects and seasonal occurrence were also studied. The role of the predacious insects and spiders in the natural suppression of the spider mites is also discussed.

INTRODUCTION

The spider mite *Oligonychus isilemae* (Hirst) infests the coconut foliage and sucks plant sap. Though it occurs as an occasional pest, under congenial conditions sporadic outbreak can cause substantial loss to the crop. A number of predators occur in association with this phytophagous mites on coconut. Among these, the predacious mites play an important role in the natural biological suppression of the phytophagous mites. Sathiamma (1991, 1993) observed that weather parameters and associated natural enemies govern the seasonal abundance of *O. isilemae* under field conditions. The present paper reports on the role of these predacious mites in the biological suppression of the spider mite.

MATERIALS AND METHODS

Ten 3-5 years old coconut palms were selected for the study and two leaves each were examined at fortnightly interval. A count of the mites, insects and spiders actually feeding on *O. isilemae* was made. Data on the seasonal incidence of the predators and the predator-prey ratio of the dominant species of predators were also recorded. Observations on prey consumption and biology of the important species of mite predators were also carried out, using petriplate cages, under laboratory conditions.

RESULTS AND DISCUSSION

Six species of mites, two species of insects and one species of spider were observed as natural predators of *O. isilemae* under field conditions. The predators co-existed with the colonies of *O. isilemae* on the adaxial surface of the coconut foliage.

Two species of Phytoseiidae *Amblyseius (Amblyseius) paraaerialis* Muma and *A. (Typhlodromalus) eucalypticus* Gupta; one species of Cunaxidae *Cunaxa setirostris* Hermann and one species of Stigmaeidae *Agistemus* sp. were observed as predators on *O. isilemae*. In addition, species of Ascidae (*Lasioseius*) and Cheyletidae also prey upon the phytophagous mite.

Adults and immature stages of *A. (A.) paraaerialis* feed on the eggs and motile stages of the prey.

A. (A.) paraaerialis and *A. (T.) eucalypticus* fed on all stages of *O. isilemae* while *C. setirostris* was an active predator on motile stages. It has been observed that the prey consumption by cunaxid mites was much higher than phytoseiid mites (Table I).

The females of *A. (A.) paraaerialis*, *A. (T.) eucalypticus* and *C. setirostris* laid 22.3 ± 1.2, 5-8 and 2-12 eggs, respectively.

A SAMPLING TECHNIQUE TO ESTIMATE WHITE GRUB POPULATION IN COCONUT GARDEN

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 Central Plantation Crops Research Institute,
 Kasaragod-671 124, Kerala.

(Manuscript received : 28.11.95. revised: 21.06.96; accepted: 07.10.96)

ABSTRACT

A sampling technique was standardised for the population estimation of *Leucopholis coneophora* around the palm basin in irrigated coconut gardens. The total number of white grubs present in the root zone of a palm can be estimated by the regression equation $Y = 3.78x + 1.7938$, where Y is the total population of white grubs found around a palm and x is the number of insect stages found upto a depth of 40 cm at a distance of 50 to 100 cm away from the trunk of the palm.

INTRODUCTION

The white grub *Leucopholis coneophora* Burm., is a major pest of coconut in the coastal areas of Kerala and Karnataka. The grub feeds voraciously on the roots of

coconut palm, resulting in substantial yield losses. *L. coneophora* was reported to have an annual life cycle with three larval instars (Nirula 1958; Abraham and Mohandas 1988). White grubs are polyphagous with a variety

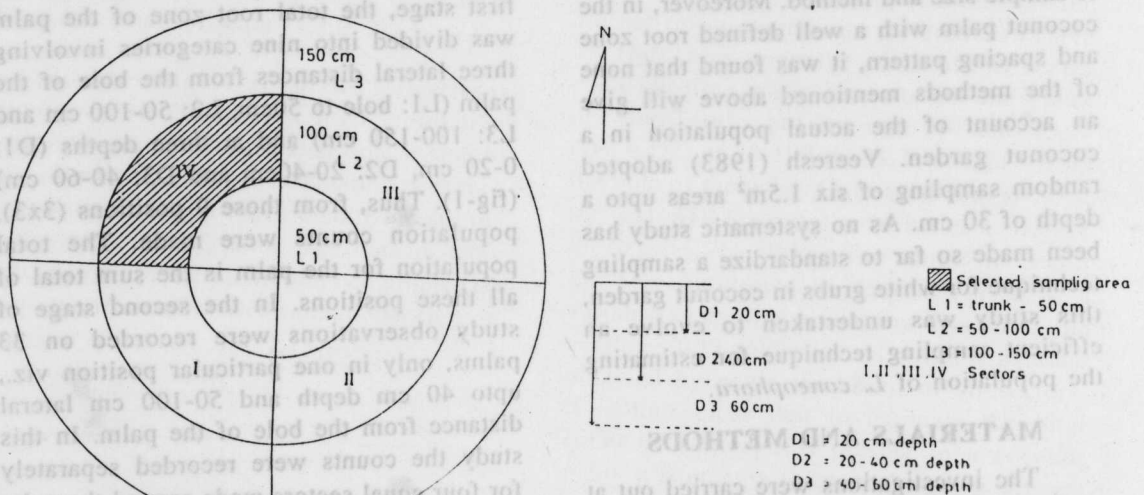


Fig. 1. Diagrammatic view of regions and sectors

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 Contribution No. 925, Central Plantation Crops Research Institute, Kasaragod, Kerala.

Table 1. Population distribution of *L. Coneophora* in different areas around the Palm. (Mean of 30 palms).

Depth (cm)	Distance from the bole (cm)		
	0-50	50-100	100-150
0-20	2.07 (0-10)	3.60 (0-16)	1.93 (0-13)
20-40	1.40 (0-7)	3.43 (0-14)	1.90 (0-8)
40-60	0.53 (0-2)	0.87 (0-4)	0.67 (0-4)

(The values in parenthesis indicate the range)

of host plants such as arecanut, cocoa, banana, groundnut, sugarcane, vegetables and many tuber crops apart from coconut (Nirula 1958, Veeresh 1977, Abraham and Mohandas 1991). To understand the seasonal phenology of the pest, knowledge of its population distribution is needed for which a valid sampling procedure has to be developed. Though sampling techniques have been formulated for the white grubs attacking cabbage, chickpea (Sharma and Shinde 1973) and groundnut (Yadava *et al.* 1977), there was no uniformity among them with regard to sample size and method. Moreover, in the coconut palm with a well defined root zone and spacing pattern, it was found that none of the methods mentioned above will give an account of the actual population in a coconut garden. Veeresh (1983) adopted random sampling of six 1.5m² areas upto a depth of 30 cm. As no systematic study has been made so far to standardize a sampling technique for white grubs in coconut garden, this study was undertaken to evolve an efficient sampling technique for estimating the population of *L. coneophora*.

MATERIALS AND METHODS

The investigations were carried out at C.P.C.R.I., Kasaragod (12°38'NL, 78°EL), Kerala in an irrigated coconut monocrop with a spacing of 7m x 7m for the palms. The soil type is sandy loam. Thirty palms selected at random in different age groups (6 to 20

Table 2. Correlation between Population in different positions and the total population (Y)

Sl. No.	Depth	Distance	correlation coefficient(r)
1.	0-20 cm	0-50 cm	0.7409**
2.		50-100 cm	0.7089**
3.		100-150 cm	0.4108*
4.	20-40 cm	0-50 cm	0.5425**
5.		50-100 cm	0.5438**
6.		100-150 cm	0.3857*
7.	40-60 cm	0-50 cm	0.2439**
8.		50-100 cm	0.0699*
9.		100-150 cm	0.5226**
10.	0-20cm	upto 100 cm	0.7741**
11.		upto 150 cm	0.8451**
12.	0-40cm	50-150 cm	0.7938**
13.		0-50 cm	0.7891**
14.		50-100 cm	0.8613**
15.		100-150 cm	0.6591**

* Significant at 5%; **Significant at 1%; (n=30)

years) were sampled for population counts. All stages of the pest viz., egg, larvae, pupae and adults were counted by visually examining the extracted soil in the field. The experiment was done in two stages. In the first stage, the total root zone of the palm was divided into nine categories involving three lateral distances from the bole of the palm (L1: bole to 50cm, L2: 50-100 cm and L3: 100-150 cm) and at three depths (D1: 0-20 cm, D2: 20-40cm and D3: 40-60 cm) (fig-1). Thus, from those 9 positions (3x3), population counts were made. The total population for the palm is the sum total of all these positions. In the second stage of study observations were recorded on 33 palms, only in one particular position viz., upto 40 cm depth and 50-100 cm lateral distance from the bole of the palm. In this study the counts were recorded separately for four equal sectors made around the palm viz., Sector I: South to West, Sector II: South to East, Sector III: North to East and Sector IV: North to West. Correlations were worked out between the counts for each position or a few combination of positions with the

Table 3. Some promising regression equations for estimating total population

Regression equation		R ²	Quantity of soil to be excavated
Y = 6.79 + 1.96 D1L1 + 1.00 D1(L2+L3)		(0.75)	1.4143 M ³
Y = 6.94 + 1.25 D1(L1 + L2 +L3)		(0.73)	1.4143 M ³
Y = 3.90 + 1.94 D1L2 + 1.62 D2L2		(0.75)	0.9429 M ³
*Y = 3.78 + 1.79 (D1 + D2) L2		(0.75)	0.9429 M ³

* Selected equation; Y = Total number of grubs per palm
L1, L2, L3, D1 and D2 see Materials and method for details.

total count for the palm, to identify the most suitable position which gives good correlation with the total count.

RESULTS AND DISCUSSION

Maximum population counts were observed in the area between 50-100 cm lateral distance upto 40 cm depth (Table 1). Studies on the correlation between counts for each position and few combination of positions with the total counts indicated that all the positions, except those at the last depths (40-60 cm depth and upto 100cm lateral distance) gave significant positive correlation with total count of palm (Table 2).

Ideal variable to predict the total population should have a high correlation with total count. At the same time it should be a physically convenient position to record observation without much disturbance to the root system of the palm. The data in table 3 give some of the prediction equations with their coefficient of determinations (R²). It

was found that the populations of grubs present in the soil upto 40 cm depth around the palm at 50-100 cm lateral distance gave high correlation. The amount of soil to be excavated for counting also was found to be the minimum (0.94m³) in this position. Hence this variable was found to be the suitable to predict the total count of the grubs affecting a palm. This variable (x) used for prediction explains about 75% of the variation existing in the total count of a palm.

Analysis of variance for the counts in the second stage of study in different sectors did not reveal significant differences (Table 4). Thus, four times the count of any sector could be used as an estimate for the count of white grubs present upto 40 cm depth (D1 + D2) at 50-100 cm (L2) distance from the bole of the palm. Out of the four sectors, the sector IV appeared to be better as it gave the least CV%. When the counts in sector IV were multiplied by four and used as a variable(x) in the prediction equation, the average of 33 palms agreed with the average obtained by using the count of all sectors. It is thus clear that to estimate the total count of white grubs present in a coconut palm, it is enough to count the grubs present in the North-West sector of the palm between 50-100 cm away from the bole and upto 40 cm deep and use it in the regression equation Y = 3.78 + 1.79X, where Y is the total count for the palm and X is four times the count in the IVth sector at 50-100 cm away from

Table 4. Table of sector means

Sector	Mean(x)	$\sqrt{(x+0.5)}$	SE	correlation between total
I	7.76	2.69	0.15	0.876
II	5.90	2.40	0.15	0.774
III	6.00	2.42	0.15	0.893
IV	6.67	2.56	0.15	0.866
Gen. mean	6.59	2.52	0.08	
F. value		0.77		

the trunk upto 40 cm depth. For the population estimation of *Holotrichia consanguinea*, 1m³ pits were sampled at random in the fields of cabbage and chickpea (Sharma and Shinde 1973) and groundnut (Nigam and Awasthi 1978) and pits of 30 cm³ in groundnut (Prasad 1975) and 1m² upto 30cm depth in groundnut and chillies (Yadava et al. 1977). But in the case of coconut since the active root zone is restricted to the basin of 1.8 m around the bole, general field pits will not yield a true population estimation. In arecanut for the population estimation of *Leucopholis burmeisteri*, 50 cm³ volume of soil was drawn 30 cm away from the base of the palm (Premkumar 1974). Veeresh (1983) reported that 1.5 m² area upto 30 cm depth was sampled for white grub population in coconut.

In sugarcane, groundnut and wheat, Nath and Janardhan Singh (1987) sampled 1m x 1m x 30 cm volume of soil for all species of white grubs. The present sampling method evolved involves only 0.24m³ of soil with least disturbance to root system and minimum of labour requirement.

Accurate monitoring of population levels of any pest is essential for an effective pest management system. With the present method developed, the distribution of different stages of *L. coneophora* in soil can be described. The seasonal phenology of the pest can be studied by this technique and based on the information an Integrated Pest Management strategy for *L. coneophora* can be formulated.

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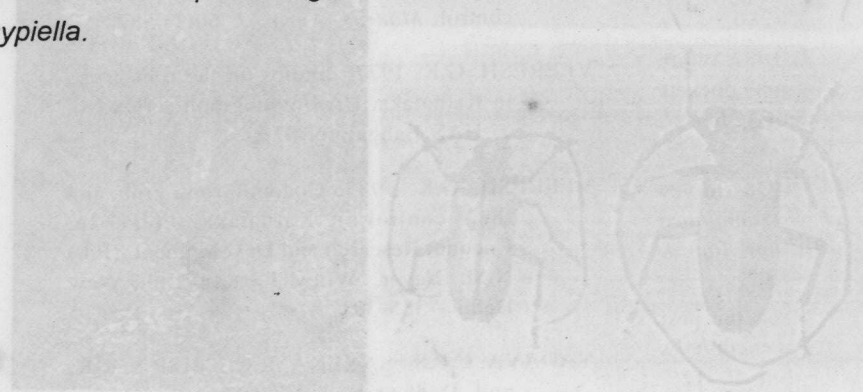
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Investigations made to monitor the cotton bollworm moths activity for the last five years is discussed. Observations made on *Helicoverpa armigera* indicated that the moth appeared in the month of August itself and the peak activity was in November-December (260 moths/month) in winter cotton and in June-July in summer cotton. In general the moths trapped were low as compared to the larval density indicating the pheromone has to be improved to get more moths.

Both the species of *Earias vitella* and *E. insulana* were trapped in the same trap. However, the catches of *E. insulana* was high as compared to *E. vitella*. But under field condition the larval density of the latter was more pronounced. Maximum number of catches of both the species was at peak during December to February.

P. gossypiella activity was more in October and declined in November-December probably due to high rainfall and again reached the peak (230 moths/month) in the month of March.

Among the different types of traps (Funnel, Sleeve, Dalda tin, Plastic container) maximum number of catches was obtained in locally fabricated plastic container trap followed by dalda tin trap. The commercially available sleeve type of trap attracted very few moths (only 25%) as compared to plastic container trap showing its inferiority in trapping the male moth of *P. gossypiella*.



Introduction

Plantation crops viz., coconut and arecanut palms are infested by host of insect pests. Among them the white grub, *Leucopholis* spp. (Table) is a serious pest causing considerable damage. In the areca palm damage to the extent of 22.4 to 67.8% was reported. However, satisfactory control of this pest is not achieved. Vulnerable immature stages of this pest is more prevalent during rainy season, where the plant protection operations are difficult to undertake. Therefore it is imperative to find out alternate methods for the management of this serious pest. Adult beetle collection during emergence is the most reliable method by which the pest can be brought below economic threshold level. To achieve this identification of pheromone is essential. An attempt has been made in this to review the pheromone studies on other scarabaeids as follows (i) pheromone identified (ii) evidence for sex attraction and (iii) aromatic compounds used as sex attractants.

Review of pheromone studies on other scarabaeids

(1969) Pheromone identification in scarab beetles has been restricted to only a few species, mainly the Japanese beetle, *Popillia japonica* and chafin beetle, *Anomala* spp. Among the scarabaeids, much work has been reported on the Japanese beetle by various workers on aspects like the evidence of sex pheromone (Smith and Hadley, 1926), sex attraction (Ladd 1970) identification of sex pheromone and aromatic compounds as attractants (Fleming 1969, Schwartz et al., 1966, McGovern 1970).

Whereas among *Anomala* spp. evidence of sex pheromone in *A. schonfeldti* has been reported (Leal *et al.*, 1992), identification of sex pheromones in *Anomala* spp. have been reported by various workers (Table 1). Tenax columns are used for collection of volatiles, charcoal and porapak are being used for clean up and the pheromone components are recovered with hexane and several components have been identified (Leal 1991, Leal *et al.*, 1991, 1992,). GC-EAG technique in the pheromone studies of lamellate antenna has been reported for the first time by Leal *et al.*, (1992). An air entrainment method for the collection of volatiles from plants as well as insect has been reported (Blight 1990,).

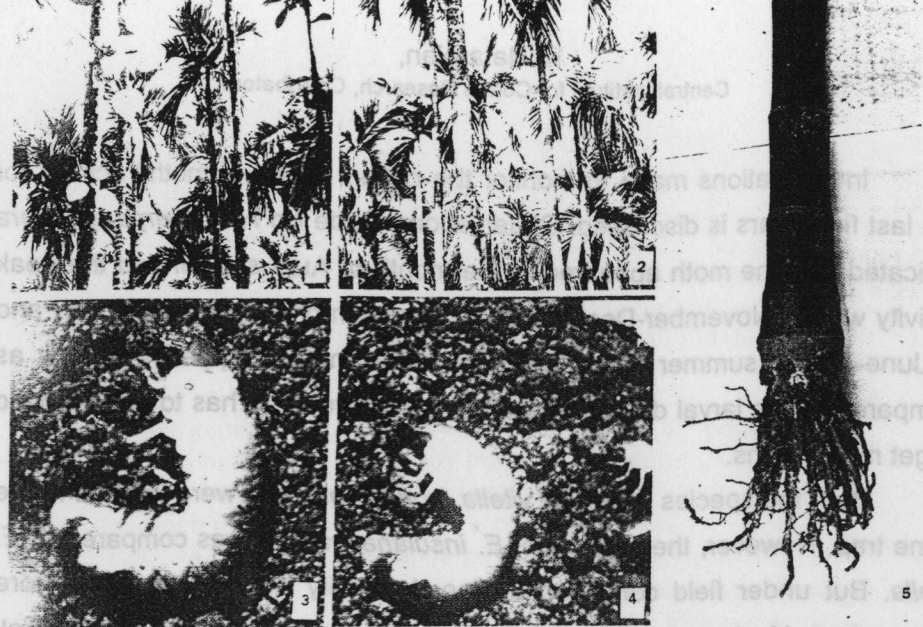
Table 1 Palm grubs and thier host plants

Pest*	Host plant	Reference
Areca cockchafer <i>Leucopholis burmeisteri</i> Brens	arecanut, cocoa, banana, coconut and grasses	Nair and Daniel (1981)
<i>Leucopholis lepidophora</i> Blan.	arecanut, coconut, tubercrops, sugarcane, coffee, paddy, maize and groundnut	Veersh <i>et al.</i> (1982) Veeresh (1984) Patil <i>et al</i> (1986) Patil and Hapase (1986)
Coconut cockchafer <i>L. coneophora</i> Burn	coconut, tubercrops, cumhemp, sweet potato	Abraham (1981)

* Assam, Kerala, Karnataka and Maharashtra

Conclusion

Identification of pheromone component(s) of the key pest of scarabaeids as well as the major host plant volatiles of these pest may enable to understand the chemical communication of insect, which in turn helps in developing lures for mass trapping.

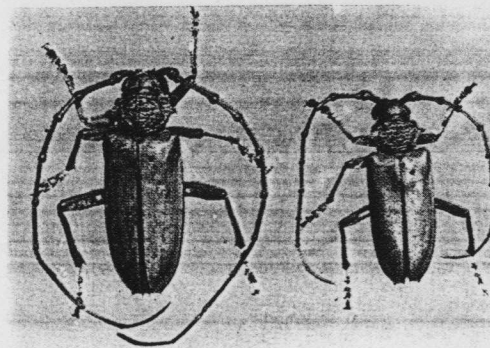
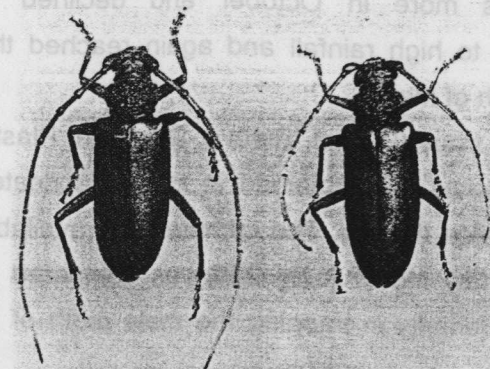


Healthy areca palms

Infested areca palms

White grub, *L. Burmeisteri*

Infested palm showing root damage



Plocaederus ferrugineus Linn.



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Evaluation of Plant, Plant Products, and Oil Cakes Against Arecanut White Grub, *Leucopholis burmeisteri*

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Certain plant and plant products and oil cakes were evaluated against the second- and third-instar grubs, respectively of the arecanut white grub, *Leucopholis burmeisteri* in pot experiments. In the first experiment, fresh leaves, dry leaves, an dried-leaf powder of *Vitex negundo*, and plant products such as Vitoxyl 2%, Nimbecidine 2%, and Achook 2% were evaluated against second-instar grubs. In the second experiment, oil cakes of *Karanj* (*Pongamia glabra*), neem (*Azadirachta indica*), and *Mahua* (*Madhuca indica*) @ 1000, 1500, 2000, 2500 kg/ha were tried against third-instar grubs. Observations on the mortality of grubs were recorded 30 days after application. *Vitex* dried leaf-powder in the first experiment, and *Karanj* oil cake in the second experiment were comparatively better than the other plant products and oil cakes.

Insecticidal Properties of Some Botanicals on *Earias vittella* Infesting *Bhendi*

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Seven azadirachtin based formulations; azadirachtin (NTGCF) 0.2, 0.4 and 0.6%, Neemark 1%, Achook 1%, Margoside 0.1%, Nimbecidine 0.2%, Repelin 1%, and Parasmani 0.2% were evaluated for their biological properties in comparison with neem seed kernel suspension (NSKS) and neem leaf extract suspension 5% against shoot and fruit borer, *Earias vittella* infesting *bhendi* during 1992-93 at the Gujarat Agricultural University Campus, Anand. *Bhendi* sprayed with Neemark 1% showed highest ovipositional deterrent effect on *E. vittella*. None of the treatments showed significant ovicidal effect. NSKS 5% had highest ovicidal effect. Neemark 1% and NSKS 5% showed higher effectiveness by causing higher larval mortality and minimizing fruit damage by *E. vittella*.

Management of Mite, *Polyphagotarsonemus latus* on Potato by Regulating Planting Dates in Western Gangetic Plains

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With preponement of potato planting towards mid-September for increased profitability in North-Western plains of India, *Polyphagotarsonemus latus* has established as a major pest of early sown crop. Studies conducted at Modipuram (Meerut) on the effect of five planting dates on two potato varieties, K. Bahar and K. Badshah, in a factorial design during 1989 to 1993 revealed that

PPB: Symposium on the potato pest mite and environment
2-4 Feb 1995, organized by ICRP in collaboration with FAO & D.M. P. Modipuram
Shree Anand Agr. Univ. TN. Held at Madras.

The emergence of adult beetles took place between 18.45 to 19.15 hrs. Feeding behaviour of adult beetles indicated maximum feeding on Ficus glomerata followed by Anacardium occidentale. Maximum assimilation efficacy was observed on cashew leaves.

Certain plant and plant products and oil cakes were evaluated against the second and third instar grubs of arecanut white grub L. burmeisteri. Analysis of the data showed that Vitex dried leaf powder in the first experiment and Karanj oil cake in the second experiment was comparatively better than the other plant products and oil cakes.

The following insecticides viz., phorate 10g, Lindane 6g, Chlorpyrifos 20 EC were evaluated against the arecanut white grub L. burmeisteri. Observations on grub population and the yield data was recorded during 1995 to 1997. Results indicated that among the insecticides evaluated phorate followed by Chlorpyrifos was effective in terms of grub control and the yield.

The following sugars viz., sucrose, glucose, maltose, fructose, arabinose, xylose, galactose, melibiose and raffinose at 0.1 M conc., aminoacids viz., glutamic acid, proline, glycine, tryptophan, methionine and phenylalanine at 0.01 M conc., were tested by moistening 25 mm diameter cellulose acetate filter discs with 70 μ l of an aqueous solution of the test compound. Maximum phagostimulatory activity was recorded in glucose and glutamic acid.

Phorate (15 g/palm) applied to the soil for the control of white grub gets dissipated completely after 60 days of application.

In the field, the following natural enemies were recorded on white grubs (1) scolid wasp, campsomeriella collaris (2) ants - Pheidologeton diversus (Jerdon), Leptogenys processionalis (Jerdon), (3) Bacillus sp. (4) Myrothecium sp. (5) Metarhizium sp. and entomopathogenic nematodes.

Heterorhabditid and steinernematid entomopathogenic nematodes (Heterorhabditis sp. steinernema feltiae) were tested against III instar grubs of L. burmeisteri and the pathogenicity was proved.

Metarhizium anisopliae and B. bassiana were grown on various media like PDA, MA, OMA, CMA, Coconut water and sorghum grain. Maximum sporulation of M. anisopliae was observed on Sorghum grain (4.3×10^8 spores/ml) followed by PDB (1.2×10^6 spores/ml). For B. bassiana mycelial suspension was used for pathogenicity studies. The pathogenicity of M. anisopliae was tested on white grubs of coconut and arecanut by spraying the spore suspensions prepared from PDB 10^4 , 10^5 and 10^6 spores/ml and sorghum grain (4.3×10^8 and 10^6 spores/ml). No mortality of white grub was observed with the spore suspension prepared from PDB whereas sorghum grain gave 16.2 to 100.0 percent mortality.

Contd.....3

Coconut

Collection and cataloguing of white grubs from different gardens from Kannur, Calicut, Malappuram and Thrissur in Kerala revealed that the White grub infesting coconut palms in these areas is Leucopholis coneophora Burm. and Anomala chlorocarpa.

Studies on feeding potential of second and third instar grubs of L. coneophora and full grown grubs of A. chlorocarpa showed that the consumption rate per day was 1.03 g and 0.52 g in the case of former species and 0.30 g in the case of the later species.

In search of entomopathogenic nematodes from white grub endemic areas of Kasaragod, Kannur, Calicut and Malappuram districts, soil samples were collected. Galleria baiting technique was adopted for trapping nematodes. Attempts are being made to identify the nematodes.

Similar to arecanut white grub, natural enemies such as scolid wasp, gregarine cysts were reported.

Adult emergence of L. coneophora adults started from last week of May, after 3-5 rainy days. Peak emergence was noticed between last week of May and first week of June and it continued till September.

The studies on the natural enemies associated with L. coneophora revealed the presence of gregarian protozoan cysts in the abdominal region of both male and female adults collected from field with a maximum of 18 cysts in a single beetle.

Soil samples were collected from the phorate applied plot at 15 and 30 cm depths at 15 days interval for the soil dissipation studies of phorate in sandy loam soil.

Under INSA visiting fellowship, pheromone studies of coconut white grub, L. coneophora was undertaken in collaboration with CAR, SPIC Science Foundation, Madras during June 1996 under the guidance of Dr. S. Narasimhan, results of the study as follows. Field studies during adult emergence indicated the attraction of male beetles towards females. Wind tunnel studies have indicated the attraction of male beetles towards female and vice-versa, GC-MS spectral studies indicated the volatiles as well as body wash contains an acetate of a long chain which could be an attractant,
 $\text{CH}_3 (\text{CH}_2)_x \text{CH} = \text{CH} (\text{CH}_2)_y \text{OAC}$, where $X + Y$ could be > 10 .

Semiochemical traps comprising of Geraniol (oil of citronella), Methyl Eugenol, Methyl Euganol + Geraniol were installed at the white grub infested garden in savanol, Kadeshwal and Kasaragod for evaluation, traps with water served as control. During the period of investigation none of the traps could attract beetles.

Contd.....4

A sampling technique was standardized for the population estimation of L. coneophora around the palm basin in irrigated coconut gardens. The total number of white grubs presented in the root zone of a palm can be estimated by the regression equation $Y = 3.78 + 1.7938 X$, where Y is the total population of white grubs found around a palm and X is the number of insect stages found upto a depth of 40 cm at a distance of 50 to 100 cm away from the trunk of the palm.

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Evaluation of plant, plant products and oil cakes against
arecanut white grub. L. burmeisteri. In : symposium
on Integrated pest management and environment, 2-4 Feb.,
1995.

Papers to be communicated

- (i) Biological studies on arecanut white grub, L. burmeisteri
Brenske.
- (ii) Testing of semiochemicals for adult beetle attraction
of Leucopholis spp.
- (iii) Evaluation of sugars, amino acids and ascorbic acid as
phagostimulants for larvae of Leucopholis burmeisteri.
- (iv) White grub survey in some arecanut growing areas of
Karnataka and Kerala.
- (v) Evaluation of insecticides against the arecanut white
grub, L. burmeisteri.

Popular articles

1. Integrated pest management in coconut by B. Padmanaban
and A.S. Sukumaran (communicated)

Seminars and Workshops :

- Entomology group meeting held at CPCRI, Kasaragod on 20.12.1995 (B.P. & M. Daniel).
- Tenth group meeting of AICRP on Palms, CPCRI, Kasaragod (26-28 Sept., 1991) (P.S.P.V.V & C.M).
- International Symposium on coconut research and development (ISOCRAD-II), CPCRI, Kasaragod (26-29 Nov. 1991) (PSPVV & C.M)

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