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ESI - BEST Ph.D. THESIS AWARD 2021

1. Name of the applicant: **K.R. MANIKANDAN**
2. Year of the award: **2021**
3. Date of birth: **13.05.1989**
4. Field of specialization: **Biosystematics**
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7. Educational qualifications beginning with the first-degree or equivalent (in a tabular form)

S.No.	Degree	Institution	Year
1.	B.Sc. (Agriculture)	Annamalai University	2006 - 2010
2.	M.Sc. (Agricultural Entomology)	Annamalai University	2010 - 2012
3.	Ph.D. (Entomology)	Tamil Nadu Agricultural University	2016 - 2019
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8. Date on which qualifying examination passed: **29.12.2017**
9. Transcript of the course work done, if any, as part of the Ph.D. degree programme (enclose photocopy): **Yes**
10. Was the thesis submitted in partial fulfillment of the requirement of the Degree? **Yes**
11. Date on which successfully completed thesis viva-voce examination: **23.09.2019**
12. Date of the Degree/Provisional Certificate: **01.11.2019**
13. Have you received best thesis award earlier? **No**

14. **Details of the thesis**

(i) Title of the thesis

Insect diversity of major horticultural crops ecosystem and, Management of coffee white stem borer at Thadiyankudisai region.

(ii) Department/Division/Institution where research work was done

Department of Agricultural Entomology, Horticultural Research Station, Tamil Nadu Agricultural University (TNAU), Thadiyankudisai, Dindigul, Tamil Nadu, India

(iii) Institution/University to which thesis was submitted as a part of the Ph.D. degree programme

Department of Agricultural Entomology, Agricultural College and Research Institute, Tamil Nadu Agricultural University (TNAU), Madurai, Tamil Nadu, India.

(iv) Name and designation of the thesis supervisor

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(v) Research problem: Hypothesis, brief description, scientific, technological, socio-economic relevance and priority (limit to 1 page)

The use of pesticides in agricultural/horticultural ecosystems decreases the arthropod diversity, the indicators of ecosystem health. The study suggested the presence of a wide array of natural enemies which may be of great value as potential biological control agents. Therefore, great emphasis is required for the conservation and augmentation of rich natural enemy fauna in the coffee ecosystem at Thadiyankudisai, Tamil Nadu.

The selected region is a major hotspot for various insects diversity, so we can easily identify the insects present in that particular area Major horticultural crops such as banana, pepper, avocado, mandarin orange, jack and coffee are grown in this area, and among those, coffee is a major cultivated crop and coffee white stem borer is a prevalent insect which causes huge damage. In order to manage the coffee stem borer and various other insects which are available in the location, the genetic diversity needs to be carried out.

(vi) What standard methods and modern procedures were used in the experimental work? (limit to one page)

Insect diversity study and field trials related to coffee white stem borer were conducted at Horticultural Research Station (HRS), Thadiyankudisai. This region is a part of the Lower Palani hills which comes under the eastern part of Western Ghats of Dindigul district in Tamil Nadu. Palani Hills is in the south-eastern part of the Western Ghats Hotspot in Tamil Nadu. It lies between 10.10-10.26 ^{0} N and 77.14 -77.52 ^{0} E with an area of 2400 km^{2}. It is one of the important global biodiversity hotspots with high endemism. The site contains mostly red soil and peat soil with average rainfall of 1400 mm. The total area in the farm

was 54 acres of which cultivated area was 45 acres (Plate 1). The crop cafeteria include plantation crops: pepper, coffee and avocado; fruits and vegetables: jack, mandarin orange, hill banana and chow-chow.

Insect Collection

Quantitative sampling of insects was undertaken from August 2017 to April 2019 by net sweeping, light trap, pitfall trap and yellow pan trap.

Net sweeping

Net sweeping with standard sweep nets (30 cm diameter of the hoop and collection bag length 60 cm) at weekly intervals was undertaken for flying and jumping arthropods at the ground level and under storey vegetation from four plots of size 10 x 10 m at random between 10.00 h and 12.00 h. Collected insects were transferred into polythene bags containing cotton dipped in chloroform (99.4%). Soft bodied insects were later separated from the bag and preserved in vials containing 70 per cent alcohol while the other insects were placed on filter paper and sorted out.

Yellow pan traps

Yellow pan traps consisted of circular plastic container placed in the soil surface. Five yellow pan traps were placed in each of five randomly chosen 10 m x 10 m plots at different elevations. The pan was filled with water to trap the insects. The insects were collected after 24 h after the placement of the traps. Soap oil (2-3 drops) in water was kept in the traps as trapping fluid. The traps were placed at the rate of 10 per plot. The trapping fluid was changed every week. Observations were recorded daily on the number and type of arthropods trapped in each container.

Pitfall traps

This method was adopted to collect ground dwelling insects. Pitfall traps were set out using a plastic container (15 cm height and 10 cm width) buried into the soil to a depth of 20 cm. Ten pitfall traps were placed in each of five randomly chosen 10 m x 10 m plots. The traps were set up between 6.00 am and 5.00 pm and specimens were collected the next morning. In order to stop the receptacle from filling with water or leaf litter and to deter some larger predators like mice, the trap was covered with a flat stone supported by four smaller stones. Soap oil (2-3 drops) in water was kept in the traps as trapping fluid. The traps were placed at the rate of 10 per plot. The trapping fluid was changed every week. Observations were recorded daily on the number and type of arthropods trapped in each container.

Light traps

The method was adopted to collect the insects such as lepidopterans, coleopterans, hymenopterans, orthopterans, etc. which were attracted to light. These traps were set under field conditions or at locations where vegetation is in abundance. A light trap consists of a central light source below the Kada cloth to be fixed. This setup is for attracting the insect to stick on the Kada cloth. The traps are normally set during night hours and the insects are collected at late evening to next morning. The light source which is used in these traps also have a role on the types of insects collected. Usually a blue-white 160-W mercury vapour

lamp is used for collection purposes. Traps that use a 15 watt UV fluorescent tubes are more effective and is estimated to attract ten times more number of insects than a mercury vapour lamp.

Weather parameter

Weather parameters like maximum and minimum temperature, relative humidity and rainfall were recorded. Correlation between these weather parameters and the monthly collection of arthropods from the plantation crops: pepper, coffee and avocado; fruits and vegetables: jack, mandarin orange, hill banana and chow-chow field were worked out.

Insect identification

The collected specimens were preserved in 70% ethyl alcohol. Specimens were also mounted on pointed triangular cards and studied under a stereozoom microscope (Stemi-Zeiss DV4) and photographed in stereozoom microscope (Leica M205C). These were identified following the keys by Narendran and Achterberg (2016). Further, identification was confirmed by Dr. K. Gunathilagaraj, Dr. N. Chitra, V.V.Ramamoorthy, Dr. A. Rameshkumar (Chalcidoidea), Dr.K. Rajmohana (Platygastroidea), Ms. Nabasri Basak (Chalcididae) and Mr. Arnab Mandi (Formicidae) of the Zoological Survey of India, Kolkata. The parasitoid collections were deposited at the Insect Biosystematics laboratory, Department of Agricultural Entomology, Tamil Nadu Agricultural University, Coimbatore. The hymenopterans diversity was quantified based on indices of species richness (α) (Margalef, 1958), species diversity: Shannon-Wiener Index (H') (Shannon and Wiener, 1949); Simpson's Index Diversity (SID) (Simpson, 1949) and species evenness (EI) (Pielou, 1966) with biodiversity calculator.

Management practice for coffee white stem borer

Two field experiments for the damage assessment based management of CWSB (Trial I and Trial II) were conducted from January, 2018 to January, 2019 at Kodai Nursery Estate, Thadiyankudisai, Dindigul, Tamil Nadu, India. The efficacy of bio-agents Beauveria bassiana, Bacillus subtilis, azadirachtin and chemical insecticides viz., chlorpyriphos, chlorantraniliprole and fipronil 40% + imidacloprid 40% WG were evaluated at the dosages. The experiments were laid out in randomized block design and replicated three times. Each replication comprised 20 year old arabica coffee plants 10 in numbers.

The treatments were imposed three times: I spray (first week of April, 2018), II spray (first week of October, 2018) and III spray (last week of October, 2018) coinciding with the adult emergence. CWSB larvae damaged the coffee stem by making galleries that appeared like ridges made in a circular manner around the main stem and primary branches. Subsequently, the larvae tunneled into the stem feeding from within. Sometimes they bored down to the root resulting in yellowing of leaves and wilting of the plants.

The damage by CWSB was recorded by observing the ridge formation on the main stem and thick primary branches. The pre-treatment spray count on damage by CWSB was recorded one day before spray and the post treatment count was recorded on 10, 20, 30, 40, 50 and 60 days after spray (DAS) for the I and III spray only, the post treatment count was

limited to 10 and 20 DAS for the second spray so as to impose the II round of treatment during the first week of October, 2018. The coffee yield in different treatments was quantified separately in terms of kg per 30 plants.

(vii) Briefly describe the significant results obtained? (Not more than 3 pages)

The salient findings of the investigations conducted from August 2017- April 2019 on the insect diversity in major horticultural cropping ecosystem viz., plantation crops: pepper, coffee and avocado; fruits and vegetables: jack, mandarin orange, hill banana and chow-chow, their seasonal abundance, impact of weather and management of coffee white stem borer at Thadiyankudisai are summarized as below.

- A total of 16,188 insects were collected at the horticultural ecosystem. Insect assemblage comprised 509 insect species under 426 genera, 149 families and 17 orders.
- Lepidoptera was the most diverse with 238 species followed by Coleoptera (80 species), Hemiptera (54 species), Hymenoptera (46 species), Orthoptera (33 species), Dictyoptera (14 Species), Diptera (13 species), Neuroptera (12 species), Odonata (10 species), Phasmatodea (2 species) and 1 species each under Archaeognatha, Dermaptera, Ephemeroptera, Isoptera, Plecoptera, Strepsiptera and Trichoptera.
- The most speciose families of major and economically important orders include Erebidae (55 species), Cerambycidae (16 species), Formicdae (9 species), Pentatomidae (9 species), Libellulidae (5 species), Diptera (13 species) and Mantispidae (7 species).
- The maximum diversity of different orders varied: during summer (Diptera), summer and South West Monsoon (Odonata, Dictyoptera, Hymenoptera) summer, winter and North East Monsoon (Lepidoptera, Neuroptera, Coleoptera), winter and South West Monsoon (Orthoptera). Coffee grasshopper *Aularches miliaris* listed under near threatened status by IUCN was recorded in this study; Banana skipper *Erionota torus* was recorded on hill banana. *Phyllium bioculatum* was collected from guava.
- Correlation co-efficient between weather parameters and insect fauna indicated Odonata had a significant positive correlation with rainfall (0.73 and rainy days (0.73). Dermaptera was negatively correlated with rainy days (-0.78) while Neuroptera was positively (0.62). Incidence of Orthoptera was positively associated with the maximum temperature (0.57). Minimum temperature had a positive impact on the abundance of Plecoptera (0.62), Orthoptera (0.66), Dictyoptera (0.68), Hemiptera (0.57), Strepsiptera (0.59), Coleoptera (0.60), Lepidoptera (0.57) and Diptera (0.55). Ephemeroptera, Phasmida, Isoptera, Hymenoptera and Trichoptera had no significant correlation with any of the studied weather parameters.
- In the inventory of insect fauna, it was found that the diversity functional groups were recorded in horticultural ecosystem. The highest population was recorded in herbivores (69.00 %) (6 order, 53 families, 328 species) followed by predators (14.00 %) (10 order, 26 families, 66 species), parasitoids (4.00 %) (2 order, 16 families, 21 species), pollinators (2.00 %) (4 order, 5 families, 10 species) and Scavenger (6.00 %) (3 order, 8

families, 26 species) and Omnivores (3.00 %) (3 order, 4 families, 12 species) while the least population were recorded in Detrivores (2.00 %) (6 order, 7 families, 9 species).

- Among the herbivores the seasonal occurrence of coffee white stem borer (CWSB) was recorded during different flight periods (April to May and October to November) under the laboratory condition. In pre monsoon, the emergence of beetles started from 2nd week of April (15 beetles) to the last week of May (19 beetles). Emergence was observed throughout the October reaching a maximum of 25 beetles during second week of October and decreased in the fourth week of November (14 beetles). There was no emergence from July to September, 2018. In June 2018 emergence of three beetles was observed and in September 2018, 25 beetles emerged.
- For the management of CWSB, in the two field trials spraying of chlorpyriphos 20 EC + azadirachtin 1% EC three times coinciding with adult emergence was found to be effective in minimizing the damage by 45.56 and 38.33 percent as against the control with 84.44 and 80.56 per cent respectively.
- Higher yields were recorded in plots treated with chlorpyriphos 20 EC + azadirachtin 1% EC had the highest yield, (52.58 and 51.32 kg/30plants), followed by chlorpyriphos 20EC (51.86 and 50.86kg/30plants) and *Beauveria bassiana* 2% A.S. (47.47 and 46.94 kg/plants). In both field trials the lower yield was recorded in fipronil 40% + imidacloprid 40% WG (28.68 and 27.85 kg/30 plants) over the untreated control.

(viii) In what way these results have made an original contribution to science and have impact

Given the awareness regarding various types of insects to the farmers and researches in hilly areas like Thadiyankudisai (Insect hot spot of Western Ghats).

- Huge collection of insects in this particular hotpot under Western Ghats.
- Rare insects such as leaf insect and large sized stick insect (Order: Phasmidae) and Moth insects (Atlas moth, Luna moth and Silkworm moth) were collected unlike normal places.
- The highest population of natural enemies such as predators, parasitoids, pollinators and Scavenger were recorded, in my observation this much of variability was not able to seen in agricultural crops which are growing in plain area.
- More trials need to be conducted for collection of insects and molecular work need to be carried out for further diagnosing and characterization of collected insects.

(ix) Publications (in journals/along with NAAS rating as on 1.1.2021, Seminar proceedings, University/Institute Newsletter, Lecture delivered, Book chapter etc. (publications only from the thesis to be included, only those publications in published/accepted/proof stage will be considered, no marks will be given for other publications not related with thesis works)

S. No	Name of the Seminar/Conference	Title of the paper presented	Organized by	Period
1.	XVII AZRA International Conference on "Frontier Research in Applied Zoology and Insect Pest management Strategies: A way Forward for Food and Nutritional Security"	Management of coffee white stem borer in the lower palani hills	UAS, Raichur, Karnataka and Applied Zoologists Research Association (AZRA) Bhubaneswar, Odisha & Entomological Society of India, IARI, New Delhi.	12 to 14 Feb, 2020
2.	International Seminar on Transboundary Pest Management (ISTPM 2020)"	Population dynamics of coffee berry borer, *Hypothenemus hampei* (Ferrari) on *Coffea arebica* L.	Department of Agricultural Entomology, Centre for Plant Protection Studies, Tamil Nadu Agricultural University, Coimbatore and Entomological Society of India, New Delhi.	4 to 5 March, 2020

S. No	Title of the Article	Details of NAAS Rating			Article status
		Journal ID	Name of the Journal	NAAS rating	
1.	Diversity of Hymenoptera in Coffee in Tamil Nadu	ISSN: 0367-8288 & ISSN: 0974-8172	Indian Journal of Entomology	5.89	Published
2.	Management of Coffee White Stem borer *Xylotrechus quadripes* (Chevrolat, 1863) (Coleoptera: Cerambycidae) in the Lower Pulney Hills, India.	ISSN: 2319-7706	International journal of current microbiology and applied sciences	5.38	Published
3.	Diversity of Chalcid Parasitoids (Chalcidoidea: Hymenoptera) in Horticultural Ecosystem at Thadiyankudisai, Tamil Nadu, India	ISSN: 0975-3710 & E-ISSN: 0975-9107	International Journal of Agriculture Sciences	4.20	Published

(x) Soft copy in PDF format needs to be submitted for the above including whole thesis
Yes

15. Whether any patents have been taken/applied for, if yes, attach evidence
(No)

16. Professional recognition, awards, fellowships received (In a separate sheet give full particulars such as the agency/ organization which gave the award, purpose, the nature of the award, etc.).:
No

17. A concise statement (about 150 words) highlighting the most significant aspects of the research work done that you would like to see in your citation of award, if chosen.

Dr.K.R.MANIKANDAN did his Ph.D in Agricultural College & Research Institute, TNAU, Madurai. His Ph.D research topic was "Insect Diversity of Major Horticultural Crops Ecosystem and, Management of Coffee White Stem Borer at Thadiyankudisai Region". In this, insect diversity in horticultural cropping system comprising plantation crops: pepper, coffee and avocado, fruits and vegetables: jack, mandarin orange, hill banana and chow-chow was studied at Horticultural Research Station, Thadiyankudisai from August 2017 to April 2019. A total of 16,188 insects were collected and the insect faunal guild consisted of 507 species under 424 genera, 149 families and 17 orders. Lepidoptera was the most diverse insect order with 237 species followed by Coleoptera (80 species), Hemiptera (53 species), Hymenoptera (46 species), Orthoptera (33 species), Dictyoptera (14 species), Diptera (13 species), Neuroptera (12 species), Odonata (10 species), Phasmatodea (2 species) and one species each under Archaeognatha, Dermaptera, Ephemeroptera, Isoptera, Plecoptera, Strepsiptera and Trichoptera. Spraying chlorpyriphos 20 EC (3ml/l) + azadirachtin 1% EC (1ml/l) for three times was found to effective in the management of CWSB, which recorded a higher yield.

18. Certificate by the student that all the details given are true

Signature

19. Certificate by the supervisor/guide that the information submitted has been verified and true

Signature

20. Forwarding note by the Head of the Department/Professor

Name and Designation

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Seal

21. Annexures

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List of self-attested scanned documents to be enclosed:

1. Publications (**First page alone**)
2. Photo copy of PhD degree
3. Age proof
4. Best passport size photograph
5. Thesis (soft copy)
6. Completeness of the application rests with applicant and no further additions/alterations will be entertained.
7. Complete nominations are to be submitted online at www.entosocindia.com awards section by using member login and password on or before **11.59 PM of the 21 October 2021.** No correspondence will be entertained in this regard.
8. This year we are also considering applications through email **in single PDF (not more than 50 pages)** including application form and with all enclosures must reach by email: esiaward@gmail.com (hardcopy will not be entertained) on or before **11.59 PM of the 21 October 2021.** No correspondence will be entertained in this regard.

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DIVERSITY OF HYMENOPTERA IN COFFEE IN TAMIL NADU

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ABSTRACT

A total of 2334 hymenopterans of 24 families under 14 superfamilies were collected in the coffee ecosystem at Horticultural Research Station, Thadiyankudisai, Dindigul, Tamil Nadu. The hymenopteran diversity comprised predominantly Ichneumonidae (14.7%) followed by Diapriidae (13.4%), Platygastridae (13.0%), Braconidae (12.0%) and Scelionidae (11.3%). Ceraphronidae, Eulophidae, Ampulicidae, Figitidae (0.7%) and Eupelmidae (0.6%) were observed to be the least in diversity.

Key words: Coffee, Hymenoptera, diversity, parasitoids, Ichneumonidae, Diapriidae, Platygastridae, Braconidae, Scelionidae, diversity indices

Hymenoptera is the third largest insect order, comprising over 1,50,000 species (Janke et al., 2013). Collectively, Hymenoptera are the most important group because they act as pollinators of wild and cultivated flowering plants, natural enemies (predator and parasitoids) of destructive insects and as makers of honey (Taye et al., 2017). Many environmental and social problems result from the overuse of insecticides (Wei and Yu, 1998). Indiscriminate usage of pesticides causes the loss of biodiversity of beneficial organisms. Recently, biodiversity in agricultural land has received growing attention (Dudley et al., 2005). Coffee is the most important perennial beverage with national productivity of 765 kg/ha while it is 519 kg/ha in Tamil Nadu (Central Coffee Research Institute CCRI, 2018). More than 100 insects had been recorded as pests in coffee (Le Pelley, 1968). Hymenoptera from the coffee ecosystem has been of least concern comparatively in the past creating a void in biological control of the coffee pests. In the study area of Thadiyankudisai, coffee is cultivated in an area of 13,436 ha, and insect pests are a major constraint in achieving higher yield. Basic study on hymenopteran diversity is a prerequisite for the success of any biological control and IPM, and hence the present study.

MATERIALS AND METHODS

The hymenopteran diversity in coffee ecosystem at the Horticultural Research Station, Thadiyankudisai (10.29°N, 77.71°E 1098 masl) was studied from January to December, 2018. Thadiyankudisai region has a winter (from December to February), summer (from March to May), south west monsoon (SWM) (from June to August) and north east monsoon (NEM) (from September to November) seasons. Coffee is intercropped with silver oak, pepper, avocado, mandarin orange, macadamia nut, Indian coral tree, silk cotton, jack and banana. Need based application of chlorpyriphos and quinalphos in recommended doses is the common plant protection measure followed here. Sampling was taken at weekly intervals with yellow pan traps (30cm dia) (@ 20 traps/ plot of 10x 10 m) at four points. The traps were filled with water along with a few drops of detergent (soap oil) and pinch of salt. The hymenopterans were filtered with a fine mesh filter after 24 hr. Relative abundance of the hymenopterans during the prevailing four seasons was recorded.

The collected specimens were preserved in 70% ethyl alcohol. Specimens were also mounted on pointed triangular cards and studied under a stereozoom microscope (Stemi- Zeiss DV4) and photographed in stereozoom microscope (Leica M205C). These were identified following the keys by Narendran and Achterberg (2016). Further, identification was confirmed by Dr. A. Rameshkumar (Chalcidoidea), Dr. K. Rajmohana (Platygastroidea), Ms. Nabasri Basak (Chalcididae) and Mr. Arnab Mandi (Formicidae) of the Zoological Survey of India, Kolkata. The parasitoid collections were deposited at the Insect Biosystematics laboratory, Department of Agricultural Entomology,

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IMPACT VALIDATION OF HEAT-TOLERANT *TRICHOGRAMMA CHILONIS* STRAIN AGAINST SUGARCANE EARLY SHOOT BORER IN TAMIL NADU

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ABSTRACT

The Heat Tolerant (HT) strain of *Trichogramma chilonis* Ishii developed (NBAII) was assessed for field impact against the sugar cane early shoot borer (ESB)- *Chilo infuscatellus* Snellen. Three treatments were compared *viz*. *Trichogramma* HT strain release twice a week @ 5cc/ha/release/ during nine continuous weeks (T1), compared with local farmers' practice of two malathion sprays (T2) and no release (T3). ESB ('deadhearts') was significantly reduced in the block with the HT strain releases (T1) compared to the 'no release' (T3) block. The overall reduction was 66 and 19% in T1 and T2 respectively, over no release (T3). Further, the ESB infestation in T3 block was on par with the block under local practice of insecticide-spray (T2). The scope for adopting the use of HT strain as a cost effective alternative to insecticide use for ESB management in sugar factory areas is discussed.

Key words: Early shoot borer, Sugarcane, *Trichogramma chilonis*, heat tolerant strain, augmentation, field impact, malathion.

Trichogrammatid egg parasitoids are widely used for biological control of egg stages of insect pests, especially the Lepidoptera (Sithanantham *et.al.,* 2013). The importance of selecting and deploying climatically well adapted strains of *Trichogramma* for successful impact of biological control was pointed out by Hassan (1993). One of the major constraints to inundative field release of most trichogrammatid species is their inability to tolerate temperatures above 30-32^{0}C, whereas in the tropics summer temperatures often touch or even exceed 40^{0}C. More recently, Jalali and Venkatesan (2005) reported the high temperature tolerant (HT) strain of *Trichogramma chilonis* and *T. japonicum*. In the last few years, field testing of these strains is being undertaken (NBAII, 2012). The sugarcane early shoot borer, *Chilo infuscatellus* Snellen is an important cause for yield loss and generally becomes more severe during the summer months. Hence, the high-temperature tolerant strain of *T. chilonis* is expected to survive better in such hostile crop environment and offer effective control of the target lepidopteran pests (Jalali *et al.,* 2009). Field testing of the impact of the heat-tolerant (HT) strain of *T.chilonis* was reported promising in Assam and Punjab (NBAII, 2010), while not much is known of its impact potential in South India. There is need to also locally validate their economic benefit in comparison with the current practice of chemical insecticide application in sugar factory areas.

Hence, the present study was taken up to empirically validate the economic benefit of augmentative releases of the HT strain (weekly two releases @2cc/release, over a nine week period) by assessing the impact on *C. infuscatellus*, in comparison with the local farmers' practice of spraying synthetic insecticide, in the SV Sugars area, Kancheepuram District, Tamil Nadu. Three fields 1 ha of each with crop age of four weeks and the variety Co.86032 were chosen at the S.V. Sugars farm, to test the following:

T1- Inundative release of *T. chilonis* HT strain (@ 2 releases per week @2cc/acre for nine weeks.

T2- Farmers' local practice of 2 sprays of malathion @ 2lit/acre during 4th & 8th week age.

T3- Control (no spray).

In each treatment block, there were 12 sample plots each of 9 m (x) 14 m. The non-infested tillers were

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Hexapoda (*Insecta indica*)

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Comparing two pheromone lures for trap catches of sugarcane internode borer adults

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Abstract: The sugarcane internode borer, *Chilo sacchariphagus indicus* (Crambidae: Lepidoptera) is a major pest on sugarcane in the tropics affecting cane yield and sugar recovery. The female sex pheromone components ((Z) -13- octadeconyl acetate and (Z)-13-octadecan-1-ol) have been identified, synthesized and formulated for use in traps systems for monitoring of this pest.

The present field study was taken up to compare the adult catches for two alternative pheromone dispensers-polyethylene vials and rubber septa - using standard water traps in six sugarcane farms fields near Kancheepuram Dist., T.N. India. The relative catches of male moths though showed some variations, but overall the two lures were on par. For instance, the rubber septa lures caught over all more moths in July-August, while in the following month (September) polythene vials tended to catch slightly more moths. Significant inter-farm differences in trap catches were also seen over the observation period. The possible agro-ecological factors associated with the inter-farm differences in internodes borer adult abundance are being studied.

Key Words: Sugarcane, Internode Borer, Pheromone trap, Lure types.

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Techniques for Determining Mechanisms of Resistance: Antixenosis for Oviposition

K. R. Manikandan and A. Arasu

Abstract In the host selection process, oviposition by adult female is a crucial step. It establishes the fact that the insect can utilize the plant for reproduction. The ovipositional preference of an adult can be tested under choice/no-choice conditions. Nonparametric and parametric statistical tools can be deployed to deduce inferences from the experiments.

Keywords Ovipositional preference · Choice conditions · No-choice conditions · Reproduction

1 Introduction

The ovipositional preference of adult insects can be measured by both free-choice and no-choice/confinement conditions. Laboratory choice experiments may use filter papers soaked in plant extracts, whole plants or plant parts. Studies on oviposition are conducted with a simultaneous choice, and preferences are estimated on the basis of relative number of eggs laid on the test plants.

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A. Kumar Chakravarthy, V. Selvanarayanan (eds.), *Experimental Techniques in Host-Plant Resistance*, https://doi.org/10.1007/978-981-13-2652-3_15

Using back cross a tool of hybridization, an attempt to screen the insect pests of tomato like fruit borer, leaf caterpillar, leaf miner and whitefly against the developed hybrids was evaluated. The evaluation consisted of the semi field experiments to investigate the various mechanisms of resistance viz., preference/non preference of larvae for feeding, antibiosis of the plants on the insect development and biophysical and biochemical bases of resistance operative in the selected tomato accessions and their hybrid derivatives. The laboratory experiments included the determination of biophysical and biochemical fruit traits which induce antixenosis and antibiosis in tomato against tomato selected insect pests. The fruit length, fruit diameter, number of fruit/plants were found to be most important biophysical fruit character, which contributed antixenosis in tomato against selected insect pests in the same way, the quantity of phenols and reducing sugar the major role in inducing biochemical based antixenosis and antibiosis. The findings of endeavor persuade the utilization of identified sources of resistance in hybridization techniques of tomato against selected insect pests.

Author graduated in 2010 and completed his master degree in 2012 from Annamalai University, Chidambaram. Possessed with a robust research and working experience at SABRC, Chennai (RA) 2012 to 2014, E.I.D Parry (India) Ltd., Cuddalore (RA), 2014 to 2015 and TNAU (SRF), 2015 to 2016. Awarded Doctoral degree in Entomology at AC & RI, TNAU, Madurai.

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Evaluation of Resistance in Lycopersicon Hybrids Selected Insect Pests

K.R., V.

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Management of Coffee White Stem borer *Xylotrechus quadripes* (Chevrolat, 1863) (Coleoptera: Cerambycidae) in the Lower Pulney Hills, India

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Keywords

Coffee, white stem borer, bio-efficacy, bio-agents, synthetic insecticides, coffee yield

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A B S T R A C T

The bio-efficacy of bio-agents *viz., Beauveria bassiana* 2% A.S. @ 10ml/lit, *Bacillus subtilis* @ 10/lit and azadirachtin 1% EC @ 1ml/lit and chemical insecticide *viz.,* chlorpyriphos 20 EC @ 3ml/lit, chlorantraniliprole 20 SC @ 0.5ml/lit and fipronil 40% + imidacloprid 40% WG @ 0.5g/lit were assessed against coffee white stem borer *Xylotrechus quadripes* (Chevrolat, 1863) (Cerambycidae: Coleoptera) in lower Pulney hills, Tamil Nadu. Coinciding with the adult emergence, three sprays were given: I spray (first week of April, 2018), II spray (first week of October, 2018) and III spray (last week of October, 2018) in two field trials, compared with untreated control. In both field trials the maximum control was observed in chlorpyriphos 20 EC + azadirachtin 1% EC @ 3ml + 1ml (45.56 % and 36.67 %) followed by chlorpyriphos 20 EC @ 3ml/lit (45.56% and 37.72%), *Beauveria bassiana* 2% A.S. @ 10ml/lit (48.89% and 43.33%) and chlorantraniliprole 20 SC @ 0.5ml/lit (51.67% and 46.11%) as against control (84.44% and 80.56%).

Introduction

Coffee (*Coffea arabica*) the most important perennial beverage plant is believed to have been introduced into India in the Chikmagalur hills in 1600 AD by a Muslim pilgrim, Bababudan from Yemen (Central Coffee Research Institute (CCRI, 2003). In the late 1820's coffee plantations were established in South India by the British. At present in India, coffee (*arabica* and *robusta*) cultivation is mainly confined to the states of Karnataka (53.8%), Kerala (18.9%), Tamil Nadu (7.8%) and other parts of North Eastern India (1.8%). The global coffee bean production is surplus against consumption accounting to 99.11 lakh tonnes/ year with 3.38 per cent share from India. The productivity of coffee in India is 765kg/ha. In Tamil Nadu, coffee is mainly produced in the Nilgiris, Shevroy hills, Pulney hills and Anamalai hills in 13,436 ha.

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Research Article

DIVERSITY OF CHALCID PARASITOIDS (CHALCIDOIDEA: HYMENOPTERA) IN HORTICULTURAL ECOSYSTEM AT THADIYANKUDISAI, TAMIL NADU, INDIA

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Abstract: The present investigation was carried out to study the chalidid species diversity in Horticultural ecosystem at Horticultural Research Station, Thadiyankudisai, Dindigul, Tamil Nadu from January, 2018 to January, 2019. A total of 257 numbers of individuals were recorded under 4 families, 9 genera and 10 species. The seasonal abundance studies revealed that the highest population of species was recorded in South West Monsoon (SWM) (52.9%) followed by winter season (32.7%) and the least number of species during North East Monsoon (NEM) (5.8%). The species diversity comprised of *Copidosoma floridamum* (24.5%) followed by *Dipara* sp. (13.2%), *Brachymeria jambolana* (10.9%), *Agarwalencyrtus citri* (10.5%), *Gonatocerus* sp. (10.1%) and (*Lymaenon delhiensis* and *Epitranus* sp.) (7.8%). The least population was recorded in *Haltichella* sp (3.5%). Insect pests are a major constraint in achieving higher yields in Horticulture, hence, the studies of Chalcidoidea diversity is crucial for success in biological control.

Keywords: *Chalcidoidea, Horticulture, Diversity, Indices, Parasitoids, Seasons*

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Introduction

Hymenopterans are the most successful biological control agents under the super family Chalcidoidea. The Chalcid families are predominantly primary endoparasitoids of Diptera and Lepidoptera and Coleoptera, though a few species attack Neuroptera [4]. Most of the species are parasitoids attacking egg or larval stage of the host. It has a significant major role in ecosystem balance [5]. The Chalcidoidea parasitoids belong to 90 genera and 1530 species globally where only 29 genera and 214 species are reported from India [10]. Despite the surplus production of food production, insects are a major constraint in achieving higher yields. More than 100 insects have been recorded as pests in coffee [7]. Indiscriminate usage of pesticides causes the loss of biodiversity of beneficial organisms. Recently, biodiversity in agricultural land has received growing attention because it plays a significant role in agro-ecosystem function [3]. Chalcidoidea from coffee ecosystem has been of least concern in the past creating a void in biological control of the coffee pests. The area of coffee plantations in Thadiyankudisai is about 13,436 ha [1]. Insect pests are a major constraint in achieving higher yields in coffee. Chalcidoidea diversity is necessary for the achievement of biological control. Hence, this study was undertaken.

Materials and Methods

The present study was carried out to study the Chalcidoidea species diversity in Horticultural ecosystem at Horticultural Research Station, Thadiyankudisai from January, 2018 to January, 2019.

Study area

Survey sites were chosen based on accessibility. Dindigul district is located at latitude 10.29°N and longitude 77.71°E and has an average elevation of 1098 meters above (MSL) with soil types red and peat with average rainfall of 1400 mm. The climatic seasons recognized at Thadiyankudisai region were winter season (December to February), summer season (March to May), South West Monsoon (SWM) (June to August) and North East Monsoon (NEM) (September to November).

Experimental sites

The area falls under Lower Pulney hills where coffee is inter- cropped with silver oak, pepper, avocado, mandarin orange, macadamia nut, Kalyana Murungai, silk cotton, jack and banana. Coffee variety (*Coffea arabica*) S 382 (Coc x S 759 x cuttura).

Sampling and identification of Hymenopterans

Sampling was carried out weekly using yellow pan traps at different elevation plots. Four such elevation plots were chosen at random with each plot size of 10 × 10 m.

Yellow pan trap

This trap is based on the principle that many insects are attracted to bright yellow colour. 20 such traps were placed in four elevation plots. The traps were placed around the coffee plantations randomly at intervals of about 1.0 - 1.5 m. The traps were filled with water to which a few drops of detergent (soap oil) and pinch of salt were added to break the surface tension and to reduce the rate of evaporation. The samples were filtered with a fine mesh filter after 24h from the yellow pan trap. The relative abundance of the hymenopterans was recorded at weekly intervals.

Preservation and identification of the specimens

The hymenopteran specimens thus collected were preserved in 70 % ethyl alcohol. The dried specimens were mounted on pointed triangular cards and studied under a Stereo zoom (Stemi- zeiss DV4), photographed in stereo zoom microscope (Leica M 205 C) and identified through conventional taxonomic techniques by following the keys of [9].

SAFETY

POD BORERS

TO ASSESS THE SAFETY OF BOTANICALS AND ENTOMOGENOUS FUNGI ON MAJOR POD BORERS

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ABSTRACT

Azadirachtin 0.03% and Neem seed kernel extract 5% were found to be effective and resulted in maximum mortality of *Maruca vitrata* (53.33%) at 72 hours after treatment. Neem oil 2% recorded 53.3 per cent mortality against *Euchrysops cnejus* at 72 hours after treatment followed by *Beauveria bassiana* 1 x 10^8 spores/ml and azadirachtin 0.03% both were on par with each other at 72 hours after treatment. Among botanicals and entomogenous fungi, the lowest mortality of *Cheilomenes sexmaculata* was recorded in *Calotropis* Leaf extract 10% (13.33%) and it was found to be the safest treatment. Next in order of safety was *Aadathoda* Leaf extract (18.00%).

KEY WORDS: **Black gram, *Maruca vitrata*, *Euchrysops cnejus*, Coccinellids, Biopesticides.**

Introduction

The pulse crop *viz., Vigna mungo* (L.) Hepper [Synonym: *Phaseolus mungo* L. (1753)], is also noted as black gram which is native to India and Central Asia. It is highly suitable for Asian climatic regions and considered as high valued legume crop in India (Vavilov, 1926).

In India, black gram occupies an area of about 13.10 lakh hectares with a total production of about 38.14 lakh tonnes (Anon., 2017).

Black gram is grown in low annual rainfall areas and named as dry land crop. It is adapted to deficiency soil due to its root nodules symbiotic association with bacteria called *Mycorrhiza* (Kasiamdari *et al*., 2002) and also cultivated as relay crop, playing an important role in environmental conservation and food security, respectively. It is an important source of human food mainly due to its high level of protein content (26.2 %). Besides this, it also contains 350 calories /100 grams with vitamins *viz.,* B_1, B_2 and Miyacin (0.42, 0.37 and 2.0 mg/100g). Apart from being major source of protein, it is a rich source of minerals *viz*., calcium, iron and phosphorus (185, 8.7 and 345 mg/100g). It also contains 56.6 per cent carbohydrates and 1.2 per cent fat.

It is an important part in human diet and animal feed because of its rich protein and phosphoric acid contents. In addition to that it helps in maintaining soil fertility and nourishing the soil structure, texture and nitrogen fixing bacteria (Parmar *et al.* 2015).

Among the several factors responsible for poor yield, undoubtedly, insect infestation is considered as one of the most important factors. Pest problem in pulse grain estimated to annual loss of two to three million tonnes (Rabindra *et al.,* 2004). In India, avoidable yield loss to the tune of 7-35 per cent and annual yield loss of 30 per cent has been estimated in black gram and green gram (Hamad and Dubey, 1983). About 200 insect pests belong to 48 families in Coleoptera, Diptera, Hemiptera, Hymenoptera, Isoptera, Lepidoptera, Orthoptera, Thysanoptera, and seven species of mites belonging to sub class Acari under several orders are known to infest black gram.

In India nearly 60 species of insect pests have

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The Field Efficacy of Newer Insecticide Molecules against Major Pod Borers of Black Gram

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Abstract

The purpose of this study is to observe newer insecticide molecules against pod borer complex such as *Maruca vitrata, Euchrysops cnejus*. Field experiments were conducted during 2017-2018 to study black gram under rainfed condition 6.20. Flubendiamide 480 SC recorded the lowest larval population of *Maruca vitrata* (2.40 larvae/plant) under field condition followed by thiodicarb (3.33 larvae/plant) whereas untreated check recorded (9.04 larvae/plant). Among the newer insecticide molecules, lowest gram blue butterfly larval population was recorded in thiodicarb 75 % WP (1.64 larvae/plant) followed by flubendiamide 480 (1.83). The standard check registered (11.75). Lowest *Maruca vitrata* pod damage was recorded in flubendiamide 480 SC (5.25 %) followed by thodicarb 75 % WP (5.55 %). Thiodicarb 75% recorded lowest percentage (3.8) of *Euchrysops cnejus* pod damage among newer insecticides molecules.

Keywords: Black Gram, *Euchrysops cnejus*, *Maruca vitrata,* Newer Insecticide Molecules

1. Introduction

The variety of legume crop, namely *Vigna mungo* (L.) Hepper [Synonyms: *Phaseolus mungo* L. (1753)] which is a major legume crop in India. Black gram occupies an area of about 13.10 lakh hectares with a total production of about 38.14 lakh tonnes[1].

Black gram is grown in low annual rainfall areas and named as dry land crop. It is adapted to deficiency soil due to its root nodules symbiotic association with bacteria called *Mycorrhiza*[2] and also cultivated as relay crop, playing an important role in environmental conservation and food security, respectively. It is an important source of human food mainly due to its high level of protein content (26.2 %). In addition, it contains 350 calories /100 grams with vitamins *viz.,* B_1, B_2 and Miyacin (0.42, 0.37 and 2.0 mg/100g). Being source of protein, it is a rich source of minerals namely calcium, iron and phosphorus (185, 8.7 and 345 mg/100g). It also contains 56.6 per cent carbohydrates and 1.2 per cent fat.

Rich in protein and phosphoric acid, it plays an important role in our diet and animal feed. It helps in maintaining soil fertility by improving the physical properties of the soil[3]. It is also a drought-resistant crop suitable for dry land agriculture .Of the many factors responsible for low yield, insect infestation is undoubtedly considered one of the most important factors. On average, two to three million tonnes are lost each year[4]. In India preventable yield losses in the range of 7 to 35 % due to pest infestation in black and green grams were recorded. The annual yield loss due to insect pests has been estimated at 30 % in black grams (Hamad and Dubey, 1983).

The species diversity or the population level of natural enemies may be influenced by the complex environment of the crops. Properly planned cropping system such as non-host crops are cost effective component of IPM.

*Author for correspondence

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Research Article

Diversity of Platygastroidea Species in Coffee Ecosystem at Thadiyankudisai, Tamil Nadu

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Keywords

Coffee, Diversity indices, Platygastroidae, Scelionidae, Seasonal abundance

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Abstract

A total of 550 individuals of platygastroide species were recorded under two family platygastridae (1 species) and scelionidae (9 species) during January, 2018 to January, 2019 from Horticultural Research Station, Thadiyankudisai, Tamil Nadu. Among the species diversity comprised of *Telenomus* sp. (52.0%) followed by *Scelio* sp. (11.4%), *Calliscelio* sp. (9.1%), *Sparasion* sp. (6.9%), *Idris* sp. (5.8%) and *Baryconus* sp. (4.0%). The least population was recorded in *Tritelia* sp. (2.2%). The seasonal abundance studies exposed that the highest population of species was recorded in winter season (32.55%) followed by South West Monsoon (SWM) (30.36%) and the least number of species during North East Monsoon (NEM) (16.54%). Insect pests are a major constraint in accomplishing higher yields in horticulture crops. Hence, the studies of Platygastroidea species diversity are crucial for success in biological control.

Introduction

Hymenoptera are known to parasitize insects are effective biocontrol agents since they can control the population of their hosts in a density dependent manner (LaSalle and Gauld, 1993). They occupy a high trophic position and are sensitive to environmental changes (Siemann, 1998; Tscharntke *et al.,* 1998). The superfamily Platygastroidea with four families (McKellar and Engel, 2012), 166 genera and around 2600 species, is one of the most diverse taxa in Hymenoptera (Johnson, 2016). Platygastridae is the sole family under Platygastroidea (Johnson, 2015), the third largest superfamily of parasitic Hymenoptera (Austin *et al.*, 2005) and has five subfamilies (Telenominae, Teleasinae, Scelioninae, Sceliotrachelinae and Platygastrinae) out of which the first three, are exclusive egg parasitoids (Austin *et al.*, 2005).

Despite the surplus production of food production, insects are a major constraint in achieving higher yields. More than 100 insects have been recorded as pests in coffee (Le Pelley, 1968). Indiscriminate usage of pesticides causes the loss of biodiversity of beneficial organisms. Recently, biodiversity in agricultural land has received growing attention because it plays a significant role in agro-ecosystem function (Dudley *et al.,* 2005). Platygastroidae from coffee ecosystem has been of least concern in the past creating a void in biological control of the coffee pests. The area of coffee plantations in Thadiyankudisai is about 13,436 ha (Central Coffee Research Institute - CCRI, 2018). Insect pests are a major constraint in achieving higher yields in coffee. Platygastroidae diversity is necessary for the achievement of biological control. Hence, this present study was undertaken.

Materials and Methods

The present study was carried out to study the Platygastroidea species diversity in Coffee ecosystem at Horticultural Research Station (HRS), Thadiyankudisai from January, 2018 to January,

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PROVISIONAL DEGREE CERTIFICATE

Certified that Thiru / Selvi Manikandan K R

I.D.No 2016810503 *has successfully completed the prescribed courses and credit requirements for the award of the Degree of* ***Doctor of Philosophy*** *in* Entomology *of this University during* 2019 *with an Overall Grade Point Average of* 8.05 *out of* **10.00** *(*80.50 *% Marks).*

REGISTRAR

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தேர்வர் MANIKANDAN K R APR.2004 இல்

பத்தாம் வகுப்புப் பொதுத் தேர்வெழுதிக் கீழ்க்காணும் விழுக்காட்டு மதிப்பெண்களைப் பெற்றுள்ளார் என்று சான்றளிக்கப்படுகிறது.

Certified that the above mentioned candidate appeared for the SSLC Public Examination and obtained the following percentage of marks :

பாடம் SUBJECT		மதிப்பெண் MARKS
மொழி LANGUAGE	TAMIL	59 FIVE NINE
	ஆங்கிலம் ENGLISH	62 SIX TWO
	கணிதம் MATHEMATICS	78 SEVEN EIGHT
	அறிவியல் SCIENCE	76 SEVEN SIX
	சமூக அறிவியல் SOCIAL SCIENCE	41 FOUR ONE
	மொத்தம் TOTAL	316 THREE ONE SIX

பிறந்த நாள் / DATE OF BIRTH	பதிவெண் / REGISTER NO.	ம.அ.ப.குறியீட்டெண்&நாள் /TMR CODE NO. & DATE
13.05.1989	514222	A482621 27.05.2004

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பத்தாம் வகுப்புத் தேர்வில் தேர்ச்சி பெற ஒவ்வொரு பாடத்திலும், 100க்குக் குறும அளவு முப்பத்தைந்து விழுக்காடு மதிப்பெண் பெறுதல் வேண்டும். இது பகுதி முறையில் தேர்வு எழுதித் தேர்ச்சி பெறுவதற்கும் பொருந்தும்.

A PASS IN THE SSLC (X STD.) EXAMINATION REQUIRES A MINIMUM OF THIRTY FIVE PERCENT OF MARKS IN EACH ONE OF THE FIVE SUBJECT. THIS INCLUDES PASSING UNDER THE COMPARTMENTAL SYSTEM ALSO.

K.R. மணிகண்டன்

தேர்வரின் ஒப்பம்
Candidate's Signature

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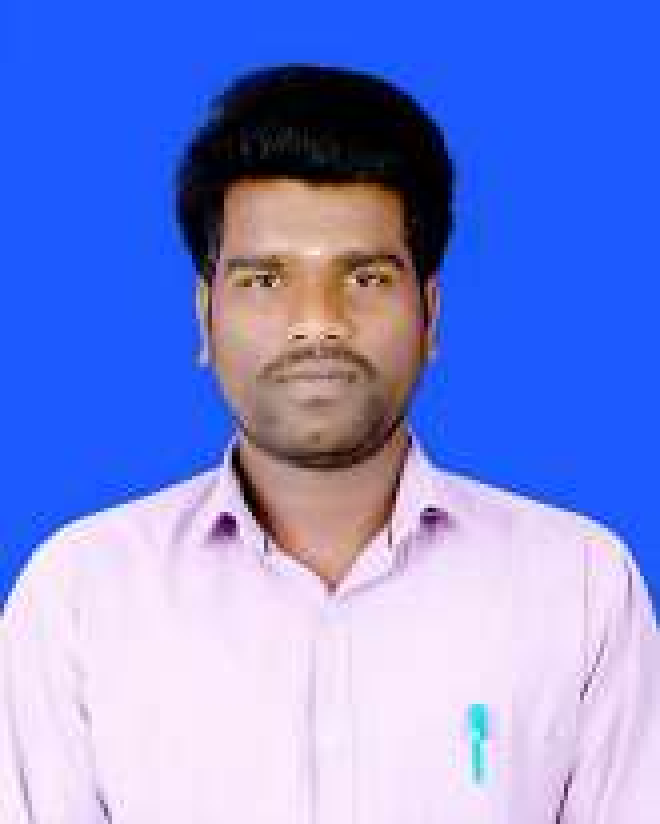

ABSTRACT

INSECT DIVERSITY OF MAJOR HORTICULTURAL CROPS ECOSYSTEM AND MANAGEMENT OF COFFEE WHITE STEM BORER IN THADIYANKUDISAI REGION

by

K.R.Manikandan

Degree : **Doctor of Philosophy in Entomology**
Chairman : **Dr. M. Muthuswami, Ph.D.**
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Coimbatore – 641003
Year : 2019

Insect diversity in horticultural cropping system comprising plantation crops: pepper, coffee and avocado, fruits and vegetables: jack, mandarin orange, hill banana and chow-chow was studied at Horticultural Research Station, Thadiyankudisai from August 2017 to April 2019. A total of 16,188 insects were collected and the insect faunal guild consisted of 507 species under 424 genera, 149 families and 17 orders. Lepidoptera was the most diverse insect order with 237 species followed by Coleoptera (80 species), Hemiptera (53 species), Hymenoptera (46 species), Orthoptera (33 species), Dictyoptera (14 species), Diptera (13 species), Neuroptera (12 species), Odonata (10 species), Phasmatodea (2 species) and one species each under Archaeognatha, Dermaptera, Ephemeroptera, Isoptera, Plecoptera, Strepsiptera and Trichoptera. The maximum diversity of different order was observed during summer (Diptera), summer and South West Monsoon (Odonata, Dictyoptera, Hymenoptera) summer, winter and North East Monsoon (Lepidoptera, Neuroptera, Coleoptera), winter and South West Monsoon (Orthoptera). Odonata had a significant positive correlation with rainfall and rainy days. Rainy days negatively influenced the occurrence of Dermapterans and positively for Neuropterans. Orthopterans had positive correlation with the maximum temperature. Minimum temperature had a positive impact on the abundance of Plecoptera, Orthoptera, Dictyoptera, Hemiptera, Strepsiptera, Coleoptera, Lepidoptera and Diptera. Functional feeding guild was dominated by herbivores (45.00 %) followed by predators (19.00 %), parasitoids (15.00 %), pollinators (4.00 %) scavengers (7.00 %), Detrivores (7.00 %) and omnivores (5.00 %). The seasonal occurrence of coffee white stem borer (CWSB) was recorded during different flight periods (April to May and October to November) under the laboratory condition. Emergence was observed throughout the October reaching a maximum of 25 beetles during second week of October and decreased in the fourth week of November (14 beetles). For the management of CWSB, spraying chlorpyriphos 20 EC (3ml/l) + azadirachtin 1% EC (1ml/l) for three times was found effective than the other treatments and a higher yield was recorded in this treatment.