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Catalogue of Insect Bio-Diversity in High Density Guava after Trash Mulching

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Trash mulching in crops increases yield and conserve the insect biodiversity. An experiment on mulching with leaf litters was conducted in high density guava with an idea of conserving. The results showed more insect diversity in mulched than non-mulched trees. The insect species catalogued in the study were 9 herbivores and 24 natural enemies. A total of 33 insect species were thus catalogued. A new white grub species was first time documented in HDP guava from Tamil Nadu. The Shannon Index of the insect herbivores were 1.21 and 1.24 in mulched and non-mulched plot, respectively. The Simpson index of the insect herbivores was 0.64 and 0.65 in mulched and non-mulched plots, respectively. Higher species diversity of the insect predators was achieved with the shannon Index (0.23) and Simpson's Index (0.04) in mulched trees. A total of 12

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number of *Trichogramma* sp, wer also recorded. From the mealybug *Paracoccus marginatus*, parasitoids such as *Acerophagus papayae*, *Pseudleptomastix mexicana* , *Prochiloneurus pulchellus* and *Allotropa* sp. were recorded.

Keywords: High density guava; mulching; herbivore; natural enemy diversity.

1. INTRODUCTION

Guava (*Psidium guajava* L.) is the poor man's fruit rich in nutrients and is the fourth significant fruit in terms of area and production after mango, banana and citrus crops in India. It occupies an area of about 27,600 ha with the production of 5.59 MT in India [1]. Though several insect pests have been observed on guava at different stages of growth, only a few pose a serious threat to guava production. Over 80 insects and mite species have been identified on guava trees, influencing the growth and yield [2]. Mulching offers a multitude of benefits in agricultural systems. Mulching i.e. application of any organic / synthetic material to the soil, suppresses insect pests, improves soil health by providing shelter to natural enemies and exhibited enhanced biodiversity [3]. Mulching promotes the increase in population of pollinators by offering a source of nectar, pollen and nesting sites, as well as protection from predators [4]. The inhabitants of the organic mulch material are numerous invertebrates, including insects, mites, arachnids, nematodes, isopods and centipedes which promotes soil fertility [5,6]. Additionally, organic mulches increases the abundance of detritivores such as collembolans, which serves as food for predators like spiders further enhancing biological control [7]. Thus, mulching not only suppresses pests and weeds, but also promotes beneficial insects, soil health and crop yields.

2. MATERIALS AND METHODS

The experimental study was carried out in 10 years old HDP guava orchard, Horticultural College and Research Institute for Women, Tiruchirappalli, Tamil Nadu, India in 2024 (latitude 10° 48' 55.80" N and longitude 78° 41' 47.44" E). The guava variety, Lucknow 49 was maintained at a spacing of 3 m x 1.5 m. The study was conducted on a total of 120 guava trees. The topography, mean maximum and minimum temperature (°C), relative humidity (%), annual precipitation (mm) and sunshine (hours) were assessed. Two treatments *viz., mulched and non-mulched* with three replications were maintained. Two treatments were randomized with in the field using student's 't' Test. Each replication constitutes 20 trees, hence, totally 60 mulched plants constituted mulched treatment and compared with 60 non-mulched trees. The mulching material such as leaf litters were collected from the college orchard and incorporated. The mulching materials were applied at a depth of 10 cm with the width of one Feet around the tree. Twenty trees were randomly selected and the observation for insect pests and natural enemy diversity was carried out. Daily data of minimum and maximum temperature, relative humidity, sunshine hours and average rainfall data was obtained from the Department of Agronomy, Anbil Dharmalingam Agricultural College and Research Institute, Trichy. The data collected were used to correlate the incidence of pests and natural enemies collected from HDP guava. Observations on the incidence of insect pests and entomophages were recorded at five days interval from 20 randomly selected trees. The major insect pests observed in the study area were mealybug, thrips and leafhoppers. The average number of thrips per fruit, the per cent damage of thrips and mealybug on fruits and the number of leafhoppers per leaf was calculated. Considering the entomophages, each tree and the surrounding mulch was inspected for predators at 5 days interval. For parasitoids, 20 guava leaf samples infested with mealybug were collected once in 5 days and transferred to the laboratory for parasitoid emergence. The emerged parasitoids preserved in 70 % ethanol and collected predators were identified by Dr. J. Poorani, Insect taxonomist, National Research Centre for banana, Trichy. The yellow sticky traps were installed to monitor the insect diversity in guava crop, surrounding weeds including adjacent crops both aerially and soil premises.

3. RESULTS AND DISCUSSION

Experiments was conducted in high density guava to catalogue the herbivores and natural enemies after trash mulching. The recorded Insects pests and were used to calculate species diversity indices in HDP mulched and non-mulched crop. In the mulched plot, the population of aerial pests, subterranean pests, insect predators, non-insect predators and parasitoids

were counted through visual observation and yellow sticky traps. Considering the herbivores, totally eight herbivores were catalogued *viz.,* five hemipteran insects [Coccidae - *Chloropulvinaria psidii,* Diaspididae - *Aonidiella aurantii,* Pseudococcidae - *Paracoccus marginatus,* Aphididae - *Aphis gossypii* and Cicadellidae - *Amarasca* sp.], one thysanopteran pest [Thripidae - *Selenothrips rubrocinctus*], one coleopteran pest [Scarabaeidae - white grub] and one ephemeropteran pest [Ephemeridae - May fly]. The population of the herbivore was comparatively higher in non-mulched plot than mulched plot (Table 1). The Shannon Index of the insect herbivore was 1.24 and 1.21 in mulched and non-mulched plot respectively. The Simpson Index of the insect herbivore was 0.64 and 0.65 in non-mulched and mulched plot respectively (Table 3). This implies that the mulched plot had higher species diversity than non-mulched plot.

Considering the entomophages, totally, 24 numbers were documented in the mulched plot, which included 15 insect predators from hymenopteran order [Braconidae family - *Apanteles* sp., Vespidae - *Polistes carolina,* Formicidae - *Lasius niger* and Apidae - *Xylocopa violacea*] Diptera order [Sarcophagidae-Flesh flies, Dolichophodidae-*Dolichopus* sp*.,* Asilidae-Robber fly, Syrphidae- Syrphid fly], Dictyopteran order [Mantidae= Preying mantis], Odonata order [Libellulidae-*Orthetrum sabina,* Coenagrionidae-*Ischnura* sp.] Neuropteran order [Chrysopidae-*Chrysoperla zastrowi*], Coleopteran order [Coccinellidae-*Cheilomenes sexmaculata, Pentilia egena, Scymnus* sp] and Hemipteran orders [Reduviidae- Reduviid bug], 7 non-insect predators from the orders Araneae (spiders) [Araneidae - Orb weaver, Therididae - Tangle web spider, Thomisidae - Crab spider, Tetragnathidae - Long jawed spider, Oxyopidae - *Oxyopes* sp.,Salticidae -*Opisthoncus* sp. and Jumping spider] including six parasitoids from the order Hymenopteran order [Ichneumonidae-*Xamthopimpla* sp., Trichogrammatidae-*Trichograma chilonis,* Encyrtidae-*Acerophagus papayae, Pseudoleptomastix mexicana* and *Prochiloneurus pulchellus*], Platygasteridae - *Allotropa* sp.] (Table 2).

Hymenopteran predators encountered in mulched and non-mulched trees are *Apanteles* sp. with 0.38, 0.00, *Polistes carolina* 5.42 3.50, *Lasius niger* 445, 475 and *Xylocopa violacea* 3.25 2.4 numbers/20 trees respectively. Predators from Diptera includes flesh flies 1.84, 0.92, *Dolichopus* sp*.,* 0.53, 0.27, Robber fly 0.07, 0.35, Syrphid fly-1.38, 0.69 numbers from mulched and non-mulched trees respectively. Dictyopteran predator, preying mantis with 0.36, 0.18 numbers / 20 trees of mulched and non-mulched trees respectively. From Odonata, *Orthetrum sabina* with 0.46, 0.23, *Ischnura* sp. with 0.35, 0.175 number of predators / 20 trees of mulched and non-mulched were seen. *Chrysoperla zastrowi* predator from Neuroptera in mulched and non-mulched was 0.15 and 0.075 number respectively. Considering Coleoptera, *Cheilomenes sexmaculata*, *Pentilia egena*, *Scymnus* sp*.,* were seen at the level of 0.16 and 0.08, 0.46 and 0.23, 1.84 and 0.92 numbers / 20 trees respectively. In Hemiptera, reduviid bug was seen with 0.15 numbers /20 mulched trees while there was no bug in non-mulched trees. Considering non-insect predator like spider was comparatively checked in both mulched and non-mulched field. Orb weaver with 0.12 and 0.30, Tangle web spider with 0.00 and 6.92, Crab spider with 0.10, 0.30, Long jawed spider with 0.05 and 0.23, *Oxyopes* sp

Table 1. Population of herbivorous insects in HDP Guava during June, 2024 to August, 2024 at Experimental farm, HC&RI(W), Trichy

Order	Family	Herbivores Common name / Scientific name	Mean insect population per 20 trees +SE	
			Mulched	Non-mulched
Hemiptera	Coccidae	*Chloropulvinaria psidii*	8.45±0.04	10.22±0.10
	Diaspididae	*Aonidiella aurantii*	10.32±0.06	15.45±0.11
	Pseudococcidae	*Paracoccus marginatus*	443±0.10	625±0.14
	Aphididae	*Aphis gossypii*	240±0.09	320±0.11
	Cicadellidae	*Amarasca sp.*	84±0.05	125±0.03
Thysanoptera	Thripidae	*Selenothrips rubrocinctus*	843±0.06	1025±0.02
Coleoptera	Scarabaeidae	White grub	0.15±0.07	0.07±0.07
Ephemeroptera	Ephemeridae	Mayfly	6.8±0.04	4.3±0.05

Mean of ten observations

Table 2. Population of natural enemies in HDP Guava during June, 2024 to August, 2024 at Experimental farm, HC&RI(W), Trichy

Order	Family	Natural enemies Common name / Scientific name	Mean insect population per 20 trees	
			Mulched	Non-mulched
Insect Predators				
Hymenoptera	Braconidae	*Apanteles* sp.	0.38±0.14	0.00±0.03
	Vespidae	*Polistes carolina*	5.42±0.25	3.50±0.02
	Formicidae	*Lasius niger*	445±0.06	475±0.04
	Apidae	*Xylocopa violacea*	3.25±0.23	2.4±0.06
Diptera	Sarcophagidae	Flesh flies	1.84±0.12	0.92±0.01
	Dolichophodidae	*Dolichopus* sp.	0.53±0.07	0.27±0.02
	Asilidae	Robber fly	0.07±0.05	0.35±0.06
	Syrphidae	Syrphid fly	1.38±0.03	0.69±0.03
Dictyoptera	Mantidae	Preying mantis	0.36±0.02	0.18±0.06
Odonata	Libellulidae	*Orthetrum sabina*	0.46±0.06	0.23±0.07
	Coenagrionidae	*Ischnura* sp.	0.35±0.06	0.175±0.03
Neuroptera	Chrysopidae	*Chrysoperla zastrowi*	0.15±0.07	0.075±0.05
Coleoptera	Coccinellidae	*Cheilomenes sexmaculata*	0.16±0.03	0.08±0.03
		Pentilia egena	0.46±0.03	0.23±0.09
		Scymnus sp.	1.84±0.02	0.92±0.08
Hemiptera	Reduviidae	Reduviid bug	0.15±0.07	0.00±0.07
Non-insect predators				
Araneae	Araneidae	Orb weaver	0.12±0.04	0.30±0.06
	Therrididae	Tangle web spider	0.00±0.05	6.92±0.08
	Thomisidae	Crab spider	0.10±0.06	0.30±0.09
	Tetragnathidae	Long jawed spider	0.05±0.08	0.23±0.04
	Oxyopidae	*Oxyopes* sp.	0.00±0.09	0.23±0.03
	Salticidae	*Opisthoncus* sp.	0.00±0.03	0.15±0.05
		Jumping spider	0.03±0.03	0.46±0.09
Insect parasitoids				
Hymenoptera	Ichneumonidae	*Xanthopimpla* sp.	0.25±0.06	0.05±0.04
	Trichogrammatidae	*Trichograma chilonis*	1.25±0.07	0.15±0.04
	Encyrtidae	*Acerophagus papayae*	0.16±0.03	0.00±0.04
		Pseudoleptomastix mexicana	0.53±0.05	0.00±0.04
		Prochiloneurus pulchellus	0.45±0.06	0.12±0.04
	Platygasteridae	*Allotropa* sp.	2.13±0.04	0.03±0.04

Mean of ten observations.

with 0.00 and 0.23, *Opisthoncus* sp. with 0.00 and 0.15, Jumping spider with 0.03 and 0.46 numbers /20 mulched and non-mulched trees respectively. Considering parasitoid population from Hymenopteran order, *Xanthopimpla* sp., with 0.25 and 0.05, *Trichograma chilonis* with 1.25 and 0.15, *Acerophagus papayae* with 0.16 and 0.00, *Pseudoleptomastix mexicana* with 0.53 and 0.00, *Prochiloneurus pulchellus* with 0.45 and 0.12 and *Allotropa* sp. with 2.13 and 0.03 numbers / 20 mulched and non-mulched trees. The Shannon and Simpson's Index showed higher insect predator diversity in mulched trees (0.23, 0.04) than non-mulched trees 0.14 0.07 (Table 3). Among the natural enemies, Shannon and Simpson's Index for the parasitoid group was found to be maximum in both mulched [1.45 and 0.89] and non-mulched [1.22 and 0.67] trees than predator groups.

Table 3. Comparison of diversity indices of insect pests and natural enemies in HDP guava in mulched and non muched guava plants

Treatments	Insect Groups	Shannon Index	Simpson Index
Treated (Mulched)	Insect herbivores	1.24	0.65
	Insect predators	0.23	0.04
	Non-insect predators	1.18	0.67
	Parasitoids	1.45	0.89
Control (Non mulched)	Insect herbivores	1.21	0.64
	Insect predators	0.14	0.07
	Non-insect predators	0.83	0.39
	Parasitoids	1.22	0.67

Yellow sticky trap installed at monthly intervals in mulched and non-mulched trees attracted a greater number of pests and natural enemies in mulched trees than mulched trees (Table 4). An average number of 206.14 insect catches per trap were seen in mulched than 181.43 numbers / trap were seen in non-mulched plots. The egg parasitoid, *Trichogramma* sp, an average of 12 numbers/trap was recorded. The adjacent field was daincha where more lepidopteran pests occurs. Hence, the *Trichogramma* parasitoid would have reached the trap from adjacent daincha field since guava doesn't have any lepidopteran pests.

The changes in the properties of soil and plant parameters after trash mulching was analysed. The pH of the non-mulched soil was 8.54 which then reduced to 8.24 in mulched soil and the EC of the mulched soil similarly got reduced to 1.45 dSm^{-1} from 1.62 in non-mulched soil. The soil moisture increased to 16.03 per cent from 9.57 per cent after mulching. Mulching also increased the organic matter in the soil from 1.23 per cent to 1.66 per cent (Table 5). Similarly, the change in the reproductive structures such as buds and fruits were compared. The raise in the mean number of buds and fruits per tree was noticed in mulched than non-mulched trees (Table 6). Data on the insect pests diversity in HDP guava after trash mulching for a period of one year was less in number. Highest abundance of insect pests was found in non-mulched weeded plots than the rice straw, gliricidia and weed residues mulched plots[7]. Data collected on the population of natural enemies in HDP Guava before and after trash mulching for the period of one year showed more number of natural enemies in mulched plot more than the non mulched plot. Highest abundance of natural enemies in rice straw mulch plots than the black polythene mulch [8]. Comparison of diversity indices of insect pests and natural enemies in HDP Guava implies that mulched plot had higher species diversity than the non-mulched plot and similar results found that the total species diversity in both natural enemies and pests was seen higher in weed residues followed by rice straw mulch, glyricidia mulch, non-mulched unweeded plots and non-mulched weeded plots[7]. Data collected on the number of fruit thrips on mulched and non-mulched trees showed that there was no significant difference between the population of thrips in mulched and non-mulched trees however, thrips population were found to be high in non-mulched trees than the mulched trees. This is in accordance with the results which showed that weed growth in non-mulched control of cow pea plots may led to increased populations of small plant feeders such as aphids, thrips and whiteflies [9].

During our study, white grub, *H. consanguinea* B. was encountered. Many white grub species such as *Adoretus* sp., *Anomala bengalensis* (Blanchard), *A. ruficapilla* (Burmeister), *Holotrichia consanguinea* (Blanchard), *H. longipennis* (Blanchard), *H. serrata* (F), *H. staudingeri*, *Lepidiota* sp., *Maladera* sp., *Popillia* sp. Brenske and *Schizonycha ruficollis* (F) have been observed on various fruit crops. Anisole based trap was evaluated in grapes and guava orchards in Punjab and a total of 805.22 and 1756.17 and 24.7 beetles were trapped in /trap in guava orchard during 2016, 2017 and 2018, respectively [10].

Results obtained from soil parameters analyzed showed that the pH of the non-mulched was higher than the mulched soil and the EC of the mulched soil lower than the non-mulched soil. The soil moisture increased to 16.03 per cent from 9.57 per cent after mulching. Mulching also increased the organic matter in the soil from 1.23 per cent to 1.66 per cent. These results are in persistent with the report of mulching with paddy straw recorded higher organic carbon content, high moisture regime and reduced soil pH (8.18), EC (3.01) and soil moisture [11]. Results from plant parameters analyzed showed that there was a difference in mean number of fruits and

Table 4. Insect catches on yellow sticky trap for a week at 24 h interval

Treatment	After 24 h	After 48 h	After 72 h	After 96 h	After 120 h	After 144 h	After 168 h	Mean
Mulched	122	176	190	211	235	242	267	206.14
Non-mulched	95	139	161	192	214	228	221	161.43

Mean of ten replications

Table 5. Characterisation of soil properties due to mulchings

Soil parameters	Mulched	Non mulched
pH	8.20	8.54
EC (dSm^{-1})	1.45	1.62
Organic matter (%)	On surface soil: 1.66 On subsurface: 2.41	On surface soil: 1.23 On subsurface: 1.78
Soil Moisture (%)	16.03	9.57

Table 6. Characterisation of reproductive fetue due to mulching

Plant parameters	Mulched	Non mulched
No. of buds / tree	8.45	5.8
No. of fruits/ tree	6.1	4.25

Mean of ten replications

buds per tree between mulched and non-mulched trees which was slightly higher in mulched plots. The yield of seed-cotton was significantly greater in plots with trash mulches and coconut leaflet mulches than control plots [12,13].

4. CONCLUSION

Trash mulching enhanced the insect diversity in the HDP guava. The insect species catalogued in the study were eight herbivores and24 natural enemies including the 15 insect predators seven non-insect predators and six parasitoids. Totally, 33 insect species were catalogued. New subterranean pest, white grub was the first record in HDP guava from Tamil Nadu. The Shannon Index of the insect herbivores were 1.21 and 1.24 in mulched and non-mulched plot respectively. The Simpson index of the insect herbivore was 0.64 and 0.65 in mulched and non-mulched plot respectively. Higher species diversity of the insect predators was achieved with the shannon Index (0.23) and simpson's Index (0.04) in mulched trees. An average number of 12 egg parasitoid, *Trichogramma* sp, / yellow sticky trap was recorded.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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