Studies on Relative Abundance and Diversity of Insect fauna in cotton in Rajendranagar, Telangana

Abstract

The accurate documentation of insects is crucial for studying biodiversity and population dynamics. Given the resilience of the majority of insect species, proper sampling necessitates the utilization of suitable strategies for capturing specific insects. However, the diversity and types of insect species present in major crops cultivated in Rajendranagar remain poorly understood. Consequently, a comprehensive investigation of the diversity of different insect species in cotton crop was conducted during the period from September 2021 to February 2022 at College Farm. A total of 10,233 individuals from 47 families and 10 orders were documented. Among the orders, Hemiptera recorded the highest number of 4,256 individuals followed by Coleoptera (2,567), while the minimum number of individuals was observed in the order Neuroptera (12). Notably, the order Hemiptera exhibited the highest Shannon-Weiner index value (H = 1.78) and species richness (R = 0.963). However, evenness was found to be highest in Orthoptera (e = 0.826). Furthermore, the order Hemiptera displayed the highest relative abundance (RA) with a value of 41.59%, whereas Neuroptera exhibited the lowest relative abundance with a value of 0.12%.

Key words: Diversity, Cotton, Insects, Relative Abundance, Species richness.

Introduction

Insects are the most dominating and diversified group of animals, comprising over 66% of known species (Zhang, 2011). In India, 658 insect families under 27 orders and three classes were recorded. The major orders, including Coleoptera, Lepidoptera, Hemiptera, Diptera, Hymenoptera, Orthoptera, Odonata and Thysanoptera accounting upto 94% of the insect fauna. Among these, Coleoptera shows the greatest diversity with 114 families, followed by Hemiptera (92 families), Diptera (87 families), Lepidoptera (84 families) and Hymenoptera (65 families) (Chandra, 2011).Insect diversity is influenced by environmental conditions (Yi *et al*, 2012) and they inhabit various habitats, playing crucial roles in terrestrial and aquatic ecosystems (Godfray, 2002). Insects are important due to their diversity, ecological roles and impact on agriculture (Adetundan *et al.*, 2005; Premalatha *et al*., 2011). Despite documented diversity in insect species within agroecosystems (Mokam *et al.*, 2014; Emmanuel and Anuluwa, 2019), studying ecosystem interactions remains challenging as farming practices aimed at improving yield can lead to phytotoxicity and declines in beneficial organisms such as predators, parasitoids, microorganisms, and pollinators especially with indiscriminate use of fertilizers and chemical insecticides (Tilman *et al*, 2006).

In India, insect pests cause losses of about 17.5% in eight major field crops such as rice, wheat, maize, sugarcane, groundnut, rapeseed-mustard, pulses, coarse cereals and cotton (Dhaliwal *et al*., 2004, 2010). With decreasing crop diversity and increasing occurrence of insect pests due to global warming, losses from insect damage are expected to increase (Sharma, 2014).In South India, cotton (*Gossypium hirsutum* L) holds significant importance as a *Kharif* crop and is often referred to as the "white gold" due to its status as the primary fibre crop. Cotton cultivation was subjected to challenges posed by a diverse array of 96 insect and mite pests (Wilson, 1972) causing yield losses up to 16.55, 8.45, and 17.35 quintal/ha (Satpute *et al*, 1988). The introduction of *Bt* cotton since 2002 has been successful in combating the bollworm complex, but its impact on the sucking pest complex remains uncertain. Contrarily, reduced insecticide usage in *Bt* cotton has led to an increase in sucking pests (Krishna and Qaim, 2012). As a result, *Bt* cotton is more susceptible to sucking pests (leafhoppers, Aphids, Whitefly, Thrips, and Mealybug) compared to desi cotton (Nath *et al.*, 2000).

No comprehensive investigation has been conducted on the diversity of insect species in cotton in Rajendranagar, Hyderabad, Telangana state. Research on insect community makeup has

been limited, but understanding insect diversity in different habitats is crucial for biodiversity conservation. Detailed data on insect diversity and abundance on cotton is lacking in this area. Hece, attempt was made to address this gap by describing insect composition and abundance in cotton.

Materials and Methods

Experiment

Present study was conducted during September 2021 to February 2022 at the College Farm of Professor Jayashankar Telangana State Agricultural University (PJTSAU) in Rajendranagar, Hyderabad. The farm encompasses diverse vegetation, including agricultural crops, shrubs, herbs, trees, and orchards, situated at 17°19'19.64" N latitude and 78°24'29.89" E longitude, with an elevation of 542.6 MSL (Fig.1). At weekly intervals, Insects were collected using four different sampling methods: pitfall traps (5 per acre), light traps (1 per hectare), yellow sticky traps (10 per acre), and sweep net. Pit fall traps and Sticky traps were inspected 24 hours after installation at weekly intervals and the trapped insects preserved in 70% alcohol. Active sweepings are done randomly every week from 9 am to 12 noon, covering different points across the entire area using a sweep net. Light traps, equipped with containers filled with soap water, operated during evening hours (6 to 9 pm) to capture nocturnal insects. Hard-bodied insects were preserved by pinning in insect boxes. Diversity indices, including Shannon-Wiener diversity index, Margalef's species richness index, and Pielou's evenness index, were calculated using PAST (Paleontological Statistics Tool) version 3.25 software. Additionally, the relative abundance (RA) was determined using the formula: Relative abundance (%) = $n_i \times 100/ N$, where N represents the total number of individuals across all families and ni indicates the number of individuals in the i^{th} family.

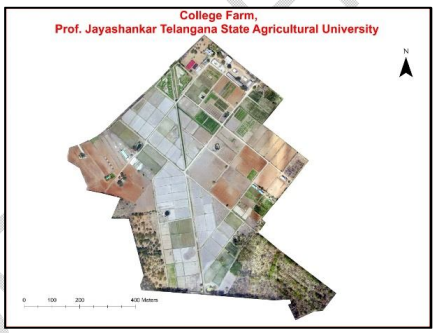

Fig.1 College farm, PJTSAU, Hyderabad

Results and Discussion

In the study area, a total of 10,233 individuals were documented from 47 families and 10 orders (Table1). The trend of insect orders resulting from the total count are as follows: Hemiptera (4256) > Coleoptera (2567) > Hymenoptera (1035) > Diptera (990) > Lepidoptera (915) > Orthoptera (361) > Dermaptera (64) > Odonata (19) > Mantodea (14) > Neuroptera (12) (Table. 1). Four different trapping methods were used for collection in which Light trap catches more number of individuals (4285) followed by Yellow sticky trap (2433), Sweep net (2114) and least by Pitfall trap (1401) (Table1).Danielle *et al*. (2010) conducted a similar study on cotton, identifying 39

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species across 10 orders and 25 families. In contrast, Harit and Dhawan (2006) recorded 54 species of insects and mites pertaining to cotton across 12 orders.

In order Odonata, 19 specimens under family Libellulidae was reported in sweep net (17) light trap (2). Under Orthoptera, 361 specimens were found under three families *i.e.* gryllidae (284), Tettigonidae (39) and Acrididae (38). Light trap (176) documented more number of insects than Pitfall trap (147) and Sweep net (38). Findings are in contrast to Paulraj *et al* (2009) who found only two species of orthoptera under only two families (Acrididae and Tettigonidae). Order Demaptera

Table 1: Insect composition with total number of individuals and methods of collection

Sr.No	Orders	Families	Methods of collection				Total no. of individuals
			LT	SN	PT	YST	
1	Odonata	Libellulidae	2	17	0	0	19
2	Orthoptera	Acrididae	0	38	0	0	38
		Gryllidae	164	0	120	0	284
		Tettigoniidae	12	0	27	0	39
3	Dermaptera	Labiduridae	0	0	64	0	64
4	Mantodea	Mantidae	4	10	0	0	14
5	Hemiptera	Aleyrodidae	0	0	0	404	404
		Aphididae	0	0	0	546	546
		Cicadellidae	879	0	0	840	1719
		Coridae	42	22	0	10	74
		Lygaeidae	0	190	0	0	190
		Membracidae	0	22	0	0	22
		Pentatomidae	430	162	0	56	648
		Pyrrhocoridae	133	344	0	18	495
		Reduvidae	26	128	0	4	158
6	Neuroptera	Chrysopidae	8	4	0	0	12
7	Lepidoptera	Erebidae	140	36	0	0	176
		Hesperidae	28	0	0	0	28
		Noctuidae	205	85	0	0	290
		Gelichidae	36	190	0	146	372
		Sphingidae	8	0	0	0	8
		Lycaenidae	0	41	0	0	41
8	Diptera	Dolichopodidae	317	68	0	30	415
		Sarcophagidae	60	12	124	28	224
		Stratiomyidae	45	21	25	24	115
		Calliphoridae	19	15	16	0	50
		Muscidae	16	0	10	48	74
		Tephritidae	9	11	0	32	52
		Tipulidae	12	0	0	48	60
9	Hymenoptera	Formicidae	8	0	387	21	416
		Ichneumonidae	165	16	0	15	196
		Apidae	14	31	0	28	73
		Braconidae	82	37	4	0	123
		Chalcididae	31	0	0	22	53
		Diapiridae	27	0	0	18	45
		Pompilidae	28	0	31	0	59
		Mymaridae	34	0	0	11	45
		Xylocopidae	4	0	8	0	12
		Scoliidae	0	13	0	0	13
10	Coleoptera	Carabidae	40	0	285	0	325
		Coccinellidae	221	314	0	61	596
		Chrysomelidae	21	134	31	0	186

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		Scarabidae	315	0	141	0	456
		Staphylinidae	684	83	128	23	918
		Meloidea	0	18	0	0	18
		Curculionidae	0	20	0	0	20
		Zygogrammatidae	16	32	0	0	48
	Total		**4285**	**2114**	**1401**	**2433**	**10233**

Sl. No- Serial number, LT – Light trap, SN-Sweep net, PT – Pitfall trap, YST- Yellow Sticky trap

represented by only one family Labiduridae (64) found in Pitfall trap as mostly they are found in soil. Mantodea was predominantly represented by the family Mantidae. A combined total of 14 individuals were captured using both the sweep net and light trap method with sweep net catching most effectively. Twelve individuals from Neuroptera under one family Chrysopidae was recorded from two traps viz., Light trap (8) and Sweep net (4) showing the efficiency of light trap collection of green lace wings.A total of 4,256 individuals were collected from four traps at College Farm. The trend of decreasing order in the number of individuals documented in each family was as follows: Cicadellidae (1,719) > Pentatomidae (648) > Aphididae (546) > Pyrrhocoridae (495) > Aleyrodidae (404) > Lygaeidae (190) > Reduvidae (158) > Coridae (74) > Membracidae (22). The Sticky trap (1,878) recorded a higher number of individuals compared to both the Light trap and the Sweep net (1,510 each). Cicadellidae is the most common family found in all traps, capturing a large number of leafhoppers. Among these leafhoppers is the cotton pest known as *Amrasca biguttula bigittula*. Other pest which recorded were, Red cotton bug *Dysdercus cingulatus* (Pyrrhocoridae), Dusky cotton bug *Oxycarenus laetus* (Lygaeidae), Whitefly *Bemisia tabaci (*Lygaeidae), *Aphis gossypii* (Aphididae).

A total of 915 specimens were documented from six families through four distinct trapping methods. The distribution of individuals across families, ordered in descending abundance, was as follows: Gelichidae (372) > Noctuidae (290) >Erebidae (176) > Lycanidae (41) > Hesperidae (28) > Sphingidae (8).Light trap caught more number of insects (417), followed by the Sweep net (352) and Sticky trap (146). Pink bollworm *Pectinophora gossypiella* (Gelichidae)is major pest mostly found in study area followed by *Spodoptera* and *Helicoverpa armigera* from family Noctuidae. In order Diptera, 990 insect specimens in total were recorded, belonging to seven families. The families, ranked by abundance, were Dolichopodidae (415), Sarcophagidae (224), Stratiomyidae (115), Muscidae (74), Tipulidae (60), Tephritidae (52), and the lowest count was from Calliphoridae (50). Highest number of specimens were recorded in Light trap (478 followed by the Sticky trap (210), Pitfall trap (175) and Sweep net (127).Altogether 1035 individuals from Hymenoptera were recorded under ten families. The distribution of families by the number of individuals recorded is as follows: Formicidae (416) > Ichneumonidae (196) > Braconidae (123) > Apidae (73) > Pompilidae (59) > Chalcididae (53) > Diapiridae (45) = Mymaridae (45) > Scoliidae (13) > Xylocopidae (12). Among the trapping methods, the Pitfall trap recorded the highest number of individuals (430), followed by the Light trap (393), Sticky trap (115), and Sweep net (97).Order Coleoptera includes 2567 insect specimens and eight families. The order based on the number of individuals recorded within each family is as follows: Staphylinidae (918) > Coccinellidae (596) > Scarabidae (456) > Carabidae (325) > Chrysomelidae (186) > Zygogrammatidae (48) > Curculionidae (20) > Meloidae (18). Regarding the collection methods, the highest number of individuals was observed in the Light trap (1297), followed by the Sweep net (601) and the Pitfall trap (585), while the Sticky trap recorded the lowest count with 84 individuals.

In the current study, the order Hemiptera exhibited the highest Shannon-Weiner index value (H = 1.78), while the order Orthoptera displayed the lowest value (H = 0.907). Species richness was observed to be highest in Hemiptera (R = 0.963), whereas the lowest species richness was documented within the order Orthoptera (R = 0.327). Notably, evenness was highest in Orthoptera (e = 0.826) and lowest Coleoptera (e = 0.457). Highest relative abundance was observed in order Hemiptera with RA value 41.59% and lowest in Neuroptera with RA value 0.12% (Fig.3). Present study is in line with previous study conducted by Chitra (2009) who reported that order hemiptera is most abundant with 5141 followed by other taxonomic orders, which shows that leaf hoppers are

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dominating group of insects in cotton ecosystem. Similarly, Danielle *et al*. (2010) identified 39 species across 10 orders and 25 families in cotton and contrast to Harit and Dhawan (2006) studies who recorded 54 species of insects and mites pertaining to cotton across 12 orders. The current study aligns with previous research by Anusha and Swaminathan (2018), where they investigated natural enemy diversity in Cotton, reporting Shannon-Weiner index values of H=1.15 for natural enemies and H=1.64 for pests and evenness of arthropods on Cotton fields to be e=0.96 and e=0.99 for natural enemies and pests respectively. Findings also corroborate with those of Hatta *et al.* (2011), who identified Hemiptera as the order with the highest species richness.

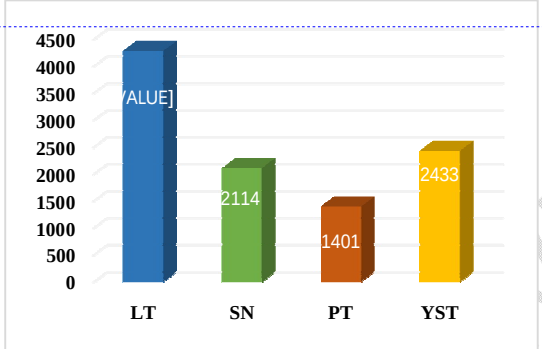

Fig 2. Insect Composition in trapping methods

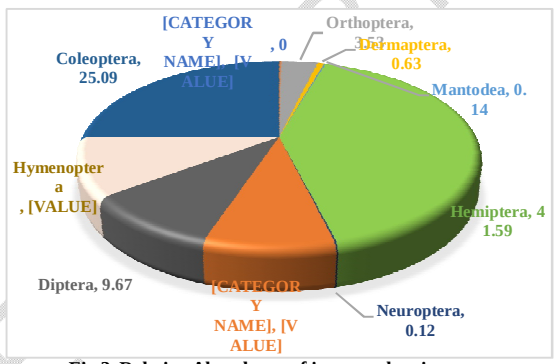

Fig 3. Relative Abundance of insect orders in cotton

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CONCLUSION

The study concluded that Order Hemiptera exhibited the highest dominance in terms of the total number of individuals collected compared to nine other orders, namely Coleoptera, Lepidoptera, Hymenoptera, Diptera, Orthoptera, Dermaptera, Odonata, Mantodea, and Neuroptera. Additionally, among the three sampling methods employed, Light trap emerged as one of the most efficient techniques for capturing diverse groups of insects at the studied location. These findings are critical for agricultural management, particularly in identifying potential pests and developing strategies for their control.

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REFERENCES

Adetundan, S.A., Ofuya, T.I., Fuwape, J.A., 2005. Environmental effects of insects herbivores and logging on tree species diversity in Akure Forest Reserve (Apomu). Nigeria Tropical Agriculture9(2), 12-18

Anusha, S., Swaminathan, R., 2018. Diversity of insect pests and natural enemies in *Bt* and non-Bt cotton. Green Farming9(2), 365-369.

Chandra., K., 2011. Insect fauna of states and Union Territories in India. Arthropods and their Conservation in India (Insects & Spiders). ENVIS Bulletin. 14(1), 189-218.

Chitra, P., 2009. ARTHROPOD DIVERSITY IN COTTON ECOSYSTEM. M.Sc. (Ag.) Thesis. Tamil Nadu Agricultural University, Coimbatore

Danielle, T., Paulo, E.D., Pierre, J.S., Odival, F., 2010. Impact of Bollgaurd genetically modified cotton on the biodiversity of arthropods under practical field condition in Brazil. African Journal of Biotechnology9(37), 6167-6176.

Dhaliwal, G.S., Arora, R., Dhawan, A.K., 2004. Crop losses due to insect pests in Indian agriculture: an update. Indian Journal of Ecology31(1), 1-7.

Dhaliwal, G.S., Jindal,V., Dhawan A.K., 2010. Insect pest problems and crop losses: changing trends. Indian Journal of Ecology37(1), 1-7.

Emmanuel, O., Anuoluwa, Y.O., 2019. A Study on the Diversity and Relative Abundance of Insect fauna in Wukari, Taraba State, Nigeria. International Journal of Advanced Biological and Biomedical Research**7**(2), 141-153.

Godfray, H.C., 2002. Challenges for taxonomy. Nature4(1), 17-19.

Harit, K.B., Dhawan, A.K., 2006. Arthropod fauna of cotton agroecosystem in Punjab. Indian Journal of Entomology**7**(1), 29-34.

Hatta, S.K.M., Nahrawi, N.A., Mansor, M.H., Kamarudin, S.N., 2011. Diversity and abundance of some insect fauna in Kuala Lompat, Krau Wildlife Reserve Forest. Proceedings of IEEE Colloquium on Humanities, Science and Engineering Research6(3), 702-705.

Krishna, V.V., Qaim, M., 2012. Bt cotton and sustainability of pesticide reductions in India. Agricultural Systems107, 47-55.

Mokam, D.G., Champlain, D.L., Bilong Bilong, C.F.B., 2014. Patterns of species richness and diversity of insects associated with cucurbit fruits in the southern part of Cameroon. Journal of Insect Science14(248), 1-9

Nath, P., Chaudhary, O.P., Sharma, P.D., Kaushik, H.D., 2000. The studies on the incidence of important insect pests of cotton with special reference to *Gossypiumarborium* (Desi) cotton. Indian Journal of Entomology62, 391–395.

Paulraj, M.G., Anbalagan, V., Ignacimuthu, S., 2009. Distribution of Grasshoppers (Insecta: Orthoptera) among different host plants and habitats in two districts of Tamil Nadu, India. Journal of threatened Taxa21(1), 230-233.

Prematatha, M., Abbasi, T., Abbasi, S.A., 2011. Energy efficient food production to reduce global warming ecodegradation: The use of edible insects. Renewable Sustainable Energy Review15(9), 4357-4360.

Satpute, U.S, Sarnaik, D.N., Bhalerao, P.D., 1988. Assessment of avoidable field losses in cotton yield due to sucking pests and bollworms. Indian Journal of Plant Protection16, 37-39.
Sharma, H.C., 2014. Climate change effects on insects: implications for crop protection and food security. Journal of crop improvement28(2), 229-259.
Tilman, D., Reich, P., Knops, J., 2006. Biodiversity and ecosystem stability in a decade-long grassland experiment. Nature441 (7093), 629-632
Wilson, A.G.L., Basinki, J.J., Thompson, N.J., 1972. Crop damage and control practices with irrigated cotton in a tropical environment. Journal of Cotton Research49 (2), 272-282
Yi, Z., Jinchao, F., Dayuan, X., Weiguo, S., Axmacher, J.C., 2012. A comparison of terrestrial arthropods sampling methods. Journal of Research Ecology 3, 174-182.
Zhang, Z.Q., 2011. Animal biodiversity: an introduction to higher-level classification and taxonomic richness. Zootaxa8, 7-12.