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Satya Chandrika Gandamalla
M.Sc. Scholar, Department of Entomology, College of Agriculture, Latur, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra, India

Dr. Dayanand Govindrao More
Associate Professor, Department of Entomology, College of Agriculture, Latur, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra, India

Gunke Mohammad Sohel Mohammad Sharif
M.Sc. Scholar, Department of Entomology, College of Agriculture, Latur, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra, India

Hajare Suraj Ramesh
M.Sc. Scholar, Department of Entomology, College of Agriculture, Latur, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra, India

Ashwini Yogeeswaran
M.Sc. Scholar, Department of Entomology, College of Agriculture, Latur, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra, India

Corresponding Author:
Satya Chandrika Gandamalla
M.Sc. Scholar, Department of Entomology, College of Agriculture, Latur, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra, India

Diversity and abundance of insect species associated with summer Okra

Satya Chandrika Gandamalla, Dr. Dayanand Govindrao More, Gunke Mohammad Sohel Mohammad Sharif, Hajare Suraj Ramesh and Ashwini Yogeeswaran

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Abstract
Okra (*Abelmoschus esculentus* L. Moench) is a vital vegetable crop cultivated widely across India, valued not only for its nutritional richness but also for its important role in supporting livelihoods and food security. Despite its relevance, okra production faces major challenges from a diverse range of insect pests, which cause significant yield losses and reduce market quality. The predominance of sap-sucking pests and fruit borers, combined with changing agro-climatic conditions, necessitates ongoing research into insect species diversity for the development of economically and ecologically sound management strategies. The study on diversity and abundance of insect species associated with summer okra (variety NOH-7070) under field conditions at the College of Agriculture, Latur, Maharashtra, during the summer of 2025, revealed a highly diverse community with 52 arthropod species comprising 34 insect pests, 16 predatory arthropods, and two parasitoids across 34 families and 10 orders. Among pests, Hemiptera was the most species-rich order (13 species), followed by Coleoptera (9), Lepidoptera (6), Orthoptera (4), and minor groups. The dusky cotton bug (*Oxycarenus hyalinipennis*) dominated the pest complex (36.36%), followed by leafhopper (Amrasca biguttula biguttula, 21.16%), whitefly (*Bemisia tabaci*, 9.46%), aphid (Aphis gossypii, 6.18%), with notable contributions from shoot and fruit borer (*Earias vittella*, 2.14%), and fruit borer (Helicoverpa armigera, 3.45%). Ladybird beetles and spiders were major predators, with Brumoides suturalis (8.96%) and *Menochilus sexmaculata* (8.60%) being the most abundant. Parasitoid diversity was low, comprising Habrobracon hebetor and Trichogramma spp. being the most abundant. Diversity indices revealed moderate pest species richness (Shannon-Wiener H′ = 0.97) and higher predator evenness (H′ = 1.15). The parasitoid community was species-poor and uneven.

Keywords: Summer okra, insect species diversity, pest, predators, parasitoids

1. Introduction
Okra, *Abelmoschus esculentus* L. Moench, a quick growing and green vegetable is cultivated in almost all the states throughout India including Maharashtra. Okra is the sixth important vegetable crop cultivated throughout the country in *Kharif* and Summer seasons. Though it is reported to be originated from tropical and sub-tropical Africa, existence of a large number of related species with wide variability and dominant characters suggest possible role of India as a secondary centre of origin (Eagri, 2023) [12]. Okra is an important medicinal plant of tropical and subtropical India. It plays a vital role in the human diet as it is a rich source of carbohydrates, proteins, Vitamin C (Adeboye and Opunta, 1996) [1], fats, calcium, phosphorous, iron, and other minerals like potassium, magnesium, and iodine (Baloch *et al*., 1990) [7]. Grubben (1977) [15] reported that 100g consumable unripe okra fruits contain 10.4 g dry-matter, 3,100 calorie energy, 1.8 g protein, 90 mg calcium, l.0 mg iron, 0.1mg carotene, 0.07mg Thiamin, 0.08mg riboflavin, 0.08 mg niacin and 18 mg vitamin C with almost comparable constituents, barring a few, in the leaves.
In India, area under okra cultivation is 5,55,110 hectares and production is 7,308,710 metric tonnes and productivity 13.14 metric tonnes per hectare during the year 202425. In Maharashtra, area under okra cultivation is 13,990 hectares, production is 1,75,440 metric tonnes and productivity is 12.54 metric tonnes per hectare during the year 2024-25.

(Anonymous, 2025) [5]. In Maharashtra, Bhendi is grown throughout the year providing continuous and good source of income to the farmers. During Summer season, it fetches lucrative price due to shortage of other vegetables in the market. It is extensively grown in the districts *viz*., Pune, Jalgaon, Thane, Nashik, Satara, Aurangabad, Solapur, Dhule and Osmanabad (Anonymous, 2018) [4]. Despite large area and quite a good number of cultivars, the supply of okra in Indian market is not matching to its demand. Lower productivity would be a major reason for such unmatching demand and supply. Critical analysis for such low productivity revealed that major portion of fruits produced is being damaged by dreaded insect pests. Okra is attacked by a number of insect pests, which are the major problems in getting higher yields (Kumar *et al.*, 2002) [17].

The cultivation of summer season okra however, is not free from constraints. The damage by the key insect pests has been recognised as one of the major constraints in okra production (Butani and Jotwani, 1983) [9]. The major insect pests are shoot and fruit borer, *Earias insulana* (Boisd.), *Earias vittella* (Fab.); leafhopper, *Amrasca biguttula biguttula* (Ishida); leaf roller, *Sylepta derogata* Fab; whitefly, *Bemisia tabaci* (Genn.); aphid, *Aphis gossypii* (Glov); dusky cotton bug, *Oxycarenus hyalinipennis* and mite, *Tetranychus cinnabarinus* (Boisd.) and considered as major restraining biotic factors in okra cultivation (Meena and Kanwat, 2005) [19]. Besides, red cotton bug, *Dysdercus cingulatus* (Fabricius) and blister beetle, *Mylabris pustulata* (Thunberg) are also most important damaging pests of okra in many regions of the country (Sharma *et al.*, 1964) [22]. It is important to study the insect diversity of the crop as it gives the knowledge about the number of insects, different types of insects that occur on plant, nature of damage of insect pests, also helps in knowing about parasitoids, predators, pollinators which are beneficial to the plants. The species diversity of insects and their pest status varies from region to region with the variation in agro-climatic conditions. This study is useful for taking proper pest management practices when the pest attacks the crop.

2. Material and methods / experimental details / methodology

The experiment was carried out to document the diversity and abundance of insect species in okra ecosystem at the research farm of Department of Entomology, College of Agriculture, Latur, Maharashtra during summer 2025. Okra crop variety NOH-7070 was raised on an area of 10 m x10 m with all recommended agronomical practices except insecticidal sprays for pest management.

Observation

The 10 m x 10 m plot was divided into four quadrate and the observations on number of insect species visiting okra plant were recorded from five plants from each quadrate at weekly interval. For this, selected plants will be carefully examined. Insects found were identified, counted and recorded in morning hours.

Data Analysis

The diversity of insect- pests were analysed by widely used indices *viz*., the Shannon-Wiener index, which is sensitive to changes in the abundance of rare species in a community (Solow, 1993) [23]. Shannon diversity index was calculated to support the study.

Relative abundance

To measure the percentage of individuals of a particular species, over all the species, relative abundance was worked out. It is calculated according to the following formula:

$$AR (\%) = ni/N*100$$

Where,
ni = number of individuals of species "i"
N = total number of individuals of all species

Shannon-Wiener index

It simultaneously takes into account the specific richness and abundance of the different insect families found on a plot. This index is calculated according to the following formula:

$$H' = - \sum (Pi*\ln Pi)$$
$$Pi = ni/N$$
H' = Shannon Diversity Index

Evenness index

The Evenness index is measure of how evenly species are distributed in sample. When all species in a sample are equally abundant, an Evenness index will be at its maximum decreasing towards zero as the relative abundance of the species diverges away from evenness.

$$E = H'/\ln S$$
H' = Shannon Diversity Index
S = Total number of species

3. Results and discussion

Extensive field surveys conducted during the Summer of 2025 revealed a highly diverse arthropod community associated with okra. The study catalogued a total of 52 arthropod species, comprising 34 insect pests, 16 arthropod natural enemies (predators), and two parasitoid species. These species were distributed among 34 families across 10 orders, reflecting the ecological complexity of the okra agroecosystem.

Table 1: Diversity of insect pests associated with summer okra at Latur, Maharashtra

Sr. No.	Order	Family	Common name	Scientific name	No. of specimens	Relative abundance (%)	Pi	Log Pi
1	Hemiptera	Aphididae	Aphid	*Aphis gossypii* (Glover)	332	6.18	0.0618	-1.2088
2		Cicadellidae	Leafhopper	*Amrasca biguttula biguttula* (ishida)	1136	21.16	0.2116	-0.6745
3		Cicadellidae	Maize orange Leafhopper	*Cicadulina bipunctata* (Melichar)	23	0.43	0.0043	-2.3682
4		Aleyrodidae	Whitefly	*Bemisia tabaci* (Gennadius)	508	9.46	0.0946	-1.024
5		Thripidae	Thrips	*Thrips tabaci* (Lindeman)	170	3.17	0.0317	-1.4994
6		Pentatomidae	Stink bug	*Plautia crossota* (Dallas)	132	2.46	0.0246	-1.6093

7		Pyrrhocoridae	Red Cotton Bug	*Dysdercus cingulatus* (Fabricius)	120	2.24	0.0224	-1.6507
8		Pseudococcidae	Cotton mealybug	*Phenacoccus solenopsis* (Tinsley)	35	0.65	0.0065	-2.1858
9		Eurybrachidae	Eurybrachys	*Eurybrachys tomentosa* (Fabricius)	40	0.75	0.0075	-2.1278
10		Miridae	Green mirid bug	*Creontiades dilutus*	107	1.99	0.0199	-1.7005
11		Pentatomidae	Shield bug	*Dolycoris baccarum*	23	0.43	0.0043	-2.3682
12		Membracidae	Cow bug	*Leptocentrus taurus* (Fabricius)	32	0.60	0.0060	-2.2247
13		Lygaeidae	Dusky cotton bug	*Oxycarenus hyalinipennis*	1952	36.36	0.3636	-0.4394
14	Lepidoptera	Noctuidae	Shoot and fruit borer	*Earias vittella (*Fabricius)	115	2.14	0.0214	-1.6692
15		Noctuidae	Shoot and fruit borer	*Earias insulana* (Boisduval)	21	0.39	0.0039	-2.4077
16		Noctuidae	Shoot and fruit borer	*Earias cupreoviridis* (walker)	12	0.22	0.0022	-2.6507
17		Noctuidae	Fruit borer	*Helicoverpa armigera (*Hubner)	185	3.45	0.0345	-1.4627
18		Noctuidae	Tobacco caterpillar	*Spodoptera litura* (Fabricius)	46	0.86	0.0086	-2.0671
19		Crambidae	Cotton leaf roller	*Syllepte derogata* (Fabricius)	34	0.63	0.0063	-2.1984
20	Coleoptera	Chrysomelidae	White spotted leaf beetle	*Monolepta signata* (Olivier)	24	0.45	0.0045	-2.3497
21		Chrysomelidae	Leaf eating beetle	*Podagrica* sp.	15	0.28	0.0028	-2.5538
22		Chrysomelidae	Palestriped flea beetle	*Systena blanda* (Melsheimer)	19	0.35	0.0035	-2.4511
23		Chrysomelidae	Red pumpkin beetle	*Aulacophora foveicollis* (Lucas)	75	1.40	0.0140	-1.8548
24		Scarabaeidae	Flower chaffer beetle	*Gametis versicolor* (Fabricius)	10	0.19	0.0019	-2.7299
25		Meloidae	Blister beetle	*Mylabris pustulata* (Thunberg)	11	0.20	0.0020	-2.6885
26		Staphylinidae	Rove beetle	*Aleochara bilineata*	39	0.73	0.0073	-2.1388
27		-	Unidentified	-	2	0.04	0.0004	-3.4289
28		Curculionidae	Ash weevil	*Myllocerus subfasciatus* (Guerin)	43	0.80	0.0080	-2.0964
29	Orthoptera	Acrididae	Surface grasshopper	*Atractomorpha* sp.	19	0.35	0.0035	-2.4511
30		Acrididae	Blue-winged grasshopper	*Trimerotropis cyaneipennis*	12	0.22	0.0022	-2.6507
31		Acrididae	Brown spotted locust	*Cyrtacanthacris tatarica* (Linnaeus)	5	0.09	0.0009	-3.0309
32		Tettigoniidae	Katydid	*Phaneroptera falcata* (Poda)	20	0.37	0.0037	-2.4289
33	Diptera	Agromyzidae	Serpentine leaf miner	*Liriomyza trifoli*	39	0.73	0.0073	-2.1388
34	Trombidiformes	Tetranychidae	Red spider mite	*Tetranychus utricae* (koch)	13	0.24	0.0024	-2.616
Shannon Wiener Diversity Index (H') =			0.973					
Evenness (J) =			0.636					
Richness (Number of species) S =			34					
Total No. of Individuals =			5369					
Average population size =			157.91					

Table 2: Diversity of predators associated with summer okra at Latur, Maharashtra

S. No.	Order	Family	Common name	Scientific name	No. of specimens	Relative abundance (%)	Pi	Log Pi
1	Araneae	Thomisidae	Crab spider	*Misumenops* sp.	15	5.38	0.0538	-1.2695
2		Anyphaenidae	Tiny green Spider	*Wulfila* sp.	10	3.58	0.0358	-1.4456
3		Araneidae	Orb weaver spider	*Neoscona arabesca* (Walckenaer)	13	4.66	0.0466	-1.3317
4		Oxyopidae	Commonlynx spider	*Oxyopes* sp.	8	2.87	0.0287	-1.5425
5		Salticidae	Magnolia green spider	*Lyssomanes viridis* (Walckenaer)	2	0.72	0.0072	-2.1446
6	Coleoptera	Coccinellidae	Ladybird beetle	*Coccinella transversalis* (Fabricius)	22	7.89	0.0789	-1.1032
7		Coccinellidae	Ladybird beetle	*Cheilomenes sexmaculata* (Fabricius)	12	4.30	0.0430	-1.3664
8		Coccinellidae	Ladybird beetle	*Menochilus sexmaculatus* (Fabricius)	24	8.60	0.0860	-1.0654
9		Coccinellidae	Ladybird beetle	*Illeis cincta* (Fabricius)	18	6.45	0.0645	-1.1903
10		Coccinellidae	Ladybird beetle	*Brumoides suturalis* (Fabricius)	25	8.96	0.0896	-1.0477
11	Hemiptera	Pentatomidae	Pentatomid bug	*Eocanthecona furcellata* (Wolff)	23	8.24	0.0824	-1.0839
12		Miridae	Tomato bug	*Nesidiocoris tenuis* (Reuter)	21	7.53	0.0753	-1.1234
13	Thysanoptera	Aeolothripidae	Banded-wing thrips	*Aeolothrips fasciatus* (Linnaeus)	26	9.32	0.0932	-1.0306
14	Neuroptera	Chrysopidae	Green lacewing	*Chrysoperla carnea* (stephens)	20	7.17	0.0717	-1.1446
15	Hymenoptera	Formicidae	Ant	*Camponotus compressus*	35	12.54	0.1254	-0.9015
16	Diptera	Syrphidae	Syrphidfly	*Ischipdon scutallaris* (Sack)	5	1.79	0.0179	-1.7466
Shannon Wiener Diversity Index (H') =			1.146					
Evenness (J) =			0.952					
Richness (Number of species) S =			16					
Total No. of Individuals =			279					
Average population size =			17.4375					

Table 3: Insect parasitoids associated with summer okra at Latur, Maharashtra

S. No.	Order	Family	Common name	Scientific name	No. of specimens	Relative abundance (%)	Pi	Log Pi
1	Hymenoptera	Braconidae	-	*Habrobracon hebetor*	5	71.43	0.7143	-0.1461
2	Hymenoptera	Trichogrammatidae	Trichogramma Wasps	*Trichogramma* sp.	2	28.57	0.2857	-0.5441
Shannon Wiener Diversity Index (H') =				0.25983				
Evenness (J) =				0.86312				
Richness (Number of species) S =				2				
Total No. of Individuals =				7				
Average population size =				3.5				

1. Diversity and abundance of insect pests associated with okra

The diversity of 34 insect pest species, spread across Hemiptera, Lepidoptera, Coleoptera, Orthoptera, Diptera, and Trombidiformes(Table 1). Hemipteran (13 species) insects were the most species-rich group among the pests, followed by Coleoptera (9 species), Lepidoptera (6 species), Orthoptera (4 species) Diptera (1 species) and Trombidiformes (1 species). Among the pests, the dusky cotton bug (*Oxycarenus hyalinipennis)* dominated the population, accounting for more than a third of the total pest specimens collected (36.36%). Other prevalent pests included the leafhopper (*Amrasca biguttula biguttula*) (21.16%), whitefly (*Bemisia tabaci*) (9.46%), and aphid (*Aphis gossypii*) (6.18%). Major lepidopteran borers such as *Helicoverpa armigera* (3.45%) and *Earias vittella (*2.14%) were also frequently observed, even though with lower abundance compared to sucking pests. Overall species diversity indices showed moderate richness (Shannon-Wiener H′ = 0.97; Evenness J = 0.64; Richness S = 34).

The present investigation highlights a highly diversified insect community associated with summer okra is in line with the findings of many researchers such as Amin *et al.* (2019) [2] reported 29 species, in 24 families under 10 different taxonomic orders, among the pests, aphid, white fly, and okra shoot and fruit borer were found as major pests. Patel *et al.* (2022) [20] documented over 70 insect species on okra crops, with sucking pests such as aphids (*A. gossypii*), jassids (*A. biguttula biguttula*), whiteflies (*B. tabaci*) are found to be major pests. Maqbool *et al.* (2024) [18] observed 19 species in Pakistan dominated by Hemiptera and Lepidoptera. Studies from Africa such as Rivers *et al.* (2024) [21] and Yao *et al.* (2020) [24] recorded 15 to 61 insect pest species on okra, reaffirming the global prevalence of sap-sucking pests like aphids (*A. gossypii*), leafhoppers (*A. biguttula biguttula*), and whiteflies (*B. tabaci*), along with chewing borers including *Earias* spp. and *H. armigera.*

2. Diversity and abundance of predators

The natural enemy community was equally diverse, with 16 predator species identified (Table 2). The highest number of predator species occurred in the order coleoptera (5 species) this was further followed by Araneae (spiders, 5 species), Hemiptera (2 species), Neuroptera (1 species), Thysanoptera (1 species), Hymenoptera (1 species), Diptera (1 species). Ladybird beetles, especially *Brumoides suturalis* (8.96%), *Menochilus sexmaculatus* (8.60%), and spider species such as *Neoscona arabesca* (4.66%) were among the most abundant and widespread predators. The distribution of predator species was found to be more balanced compared to pest populations (H′ = 1.14; Evenness = 0.95). Predator activity typically peaked alongside pest outbreaks, indicating their potential role in natural regulation of pest populations.

The current findings showed agreement with Chakraborty *et al.* (2014) [10] who reported that the diversity of the predators was maximum and comprised of 38 species followed by other arthropods. Anbalagan *et al.* (2016) [3] recorded the natural enemies of insect pests, totally 129 species of predatory and parasitic insects were recorded, also found that ladybird beetles, particularly *C. transversalis* and *M. sexmaculatus*, were most abundant in warmer months with moderate humidity and acted as major predators of aphids, jassids, and other common okra pests. Ghadge (2022) [14] recorded the presence of 49 natural enemy species belonging to 22 families across 8 taxonomic orders, including spiders, ladybird beetles, lacewings, and predatory mites. Studies in Assam by Bose *et al.* (2021) [8] and in Telangana by Kiran *et al.* (2023) [16] recorded a high number of coccinellid beetles and spider species in okra, with *I. cincta*, *C. sexmaculata*, and *Propylea dissecta* among the most abundant beetles. Aravinda *et al.* (2024) [6] found 11 species of ladybird beetles, 17 species of spiders, and other beneficial predators regularly feeding on major okra pests during both summer and *kharif* seasons.

3. Diversity and abundance of parasitoids:

In contrast, parasitoid diversity was limited, with only two species recorded *Habrobracon hebetor* and *Trichogramma* sp. presenting a highly uneven abundance pattern (Table 3). Parasitoids accounted for a minute fraction of the total arthropods sampled, with a diversity index (H′ = 0.26), evenness (J=0.86).

More or less similar results were reported by previous workers. The parasitoid species also varies according to the agro-ecological zones. Chakraborty *et al.* (2014) [10] recorded a total of 7 species of parasitoids which were found associated with the okra agroecosystem. El-Fakharany *et al.* (2017) [13] observed that while several parasitoid species could be detected with specific trapping methods, their actual numbers remained low compared to predatory insects. Amin *et al.* (2019) [2] reported that parasitoids made up a very small portion of the beneficial insect community in okra fields in Bangladesh, highlighting the dominance of predators. Dohouonan *et al.* (2025) [11] recorded the *Sarcophaga* spp. (Diptera: Sarcophagidae) parasitoid in okra field.

4. Conclusion

Comparative analysis with prior studies reported in India and abroad confirms the current findings, highlighting the predominance of Hemipteran pests and ladybird beetles as key predators in okra systems. Previous research also consistently notes lower parasitoid diversity relative to both pests and predators. These findings reinforce the importance

of monitoring species diversity and relative abundance of both pest and beneficial insects to design effective and ecologically sound pest management strategies.

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