Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

E-ISSN: 2320-7078
P-ISSN: 2349-6800
JEZS 2018; 6(1): 82-90

Received: 13-11-2017
Accepted: 15-12-2017

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Susceptible clusters and trophic structure of various insects' order among okra (*Abelmoschus esculentus*) and bean (*Phaseolus vulgaris*) fields

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Abstract
The present study was conducted under the ecological conditions of district Rahim Yar Khan (Punjab), Pakistan. After completing the whole research trials, maximum population was recorded from bean fields 54.56% (N=329) and least population was recorded from okra fields i.e. 45.44% (N=274). Where in case of bean fields, maximum population was recorded during 6th sampling (52±13.51), followed by 37±2.90 (7th and 9th sampling), 36±2.19 (3rd sampling) and least values were recorded during 4th sampling (18±10.54); whereas, species abundance was recorded utmost during 6th sampling (31 species) at temperature and humidity of 32.4 ºC, 30.5 ºC and 32%, 55%, respectively; however, least species abundance was recorded during 4th sampling i.e. 14 species at 26 ºC (temperature) and 33% (humidity). In case of okra fields, maximum population was recorded during 6th sampling (39±8.20), followed by 29±1.13 (9th sampling), 28±0.42 (10th sampling) and least value was recorded during 4th sampling (24±2.40); whereas species abundance was recorded utmost in 6th sampling (24 species) at temperature and humidity 26 ºC and 36%, respectively; however, least species abundance was recorded during 3rd sampling i.e. 13 species at 24ºC temperature and 30% humidity. Form okra fields, maximum relative abundance 4.38% (N=12) was recorded for *Alysinae* spp. andin bean fields maximum relative abundance 3.34% (N=11) was recorded for *Dinocampus coccinellae*. Form Okra fields higher ratio was recoded for genus *Musca* (Family Muscidae) 5.47% (N= 15). From bean fields, *Apis* was recorded as an extraordinary contributing genus with relative abundance of (4.8%; N=16). Diversity (H') was recorded maximum among bean fields (0.0823) and least was recorded among okra fields (0.0685). Evenness ratio was also recorded in same context (0.0327 and 0.0281, respectively). Dominance was recorded maximum from bean fields (1.0281) and least from okra fields (1.0327). However, richness was a little bit recorded high among okra fields (15.9602) and least among bean fields (15.1457). Analysis of Variance (ANOVA) among both vegetable fields (okra and bean) showed non-significant results (F=0.07; P=0.7942).

Keywords: Susceptible clusters, Trophic Structure, Insects' orders, okra, bean

Introduction
Vegetables are very cheap and dominant source of vitamins and minerals for Human health. They also provide a source of many nutrients including potassium fiber folate (folic acid) and vitamins A, E and C. Nutritionists suggest that a mature person should eat at least 285 g of vegetables per day for maintaining good health. In human life, they are a valuable tool for all biotic and abiotic races; they have much natural healing power. From ancient times, India is far-advanced in health knowledge than other country of the world. The medicinal importance of legumes is well known from the time of immemorial. However, people totally ignore the hidden power of vegetables, the main advantage of these vegetable medicines is accurate and have no side effects like antibiotics of modern medicines. Okra (*Abelmoschus esculentus)* is used as tonics, antioxidants, cooling, digestive, laxative, diuretic etc. It is used as a medicine and cooking purpose for centuries [8, 15, 16].

Okra (*Abelmoschus esculentus*) is a member of family Malvaceae also knownas ladyfinger contains essential minerals for human growth and development. It is grown in Nigeria as well as other tropical countries. Inspite of its economic importance, its production is inhibited by severe pest and disease attacks. Eminent insect pests reported on this vegetable are; flea beetles (*Podagrica* spp.), cotton stainer (*Dysdercus superstitus*), white fly *(Bemisia tabaci*),

and green stink bug (*Nezera viridula*) [17]. Among these pests, flea beetles (*Podagrica* spp.*)* are accounted the sever pest in Ghana [12]. It is rich in Ca, Mg, P, K, vitamin B3, vitamin B2, vitamin B1, protein retinol, ascorbic acid, phylloquinone, pyridoxine, and micro-minerals like Fe, Zn, and Cu. Moreover, its paste increases the quantity of red body fluid. However, its cultivation is vigorously impeded by the insect damages [18]. They ruin its foliage at every phase of development [2] e.g. flea beetles produce injuries by tearing the foliage by minimizing the food producing region of plant and mylabris beetles produce overall severe destruction [20].

Common bean (*Phaseolus vulgaris*) is widely consumed throughout the world [6]. It is very important vegetable in Mexico and constitutes the diet of a large part of the Mexican population, providing the largest part of the protein [14]. Archeological findings in the state of Puebla have indicated that the bean has been known for roughly 7,000 years before our era, which ranks as oldest cultures in Mesoamerica. Over the years, Tanzanian farmers have observed increasing foliar damage by *Otheca bennigseni* to their young bean plants, but they were ignorant of the larval damage by them on the roots of the bean. The *Ootheca bennigseni*beetles produce injuries by tearing the foliage by lessen the food producing region of plant; while mylabris beetles produce overall severe destruction [20].

Order Diptera (true flies) is one of the largest groups of insects, and thus forms one of the largest assemblies of organisms on the okra and bean planet. There are more than 125,000 described species of flies, with 128 families and 124,000 individuals [1] They use a large range of crops for their nourishment [7]. Member of family Agromyzidae disperse swiftly. They causes severe damage to foliage at several stages e.g. Tephritidae family. Inside of the canopy of the many plants is being damaged by muscoidea flies as they suck gall gnats and cause damage above ETL (economic threshold level) viz. bean, conifers etc. Their foliage parts also damaged by the oviposition of female as they make small cuts to the plant for attaching eggs, that consequently release plant sap being sucked by males and females [21].

Bugs (order Hemiptera) have over 2,000 described species pertaining to 290 genera: among them mealy bug cause yellowing and falling of leaves, wherein *Phenacoccus solenopsis* lead to plant death. Commonly found flies include crane flies (*Tipuloidea*), Simuliidae (black flies), mosquitoes (Culicidae) and fungus gnats (Sciaridae and Mycetophilidae) [4].

Order Coleoptera usually consists of predators over three million known species cosmopolitan and experience their habitat in all types of ecosystem except central Antarctica – they live in foliage parts and quickly respond toward fluctuations in their habitat, and showed indications accordingly. They also play role to buffer the agrarian yield (ladybeetles act as predator) [13] and Coccinellids control prey densities, sustain ecological equilibrium and ultimately, reduces the demand of insecticides [9].

Order Hymenoptera, is a most diverse group of insects on earth biosphere as per their forms, numbers, structure, food preference as well as habitat. Their role as socio-economic services is much vulnerable e.g honey bees have recently been used as indicators of biodiversity or landscape structure in ecological studies due to their high habitat requirements. They need habitats rich in flowering plants, as a large part of their population only collect pollen from specific plants. Overall, their response toward climatic successions, agronomic and horticultural practices showed their uniqueness and importance for humanity [15, 17].

Order Diptera (Agromyzidae, Bean flies) is one of the most destructive pests of food legumes, especially during the crops' seedling stage. They occur in Asia, Africa, Australia and Oceania. Their larvae feed on legumes and causes extensive damage. Although! The seasonal occurrence of *Ophiomyia centrosematis* and the nature of damage is similar to the predominant *O. phaseoli*, *O. spencerella* is (widespread in East Africa), and more dominant than *O. phaseoli* on beans. *Melanagromyza sojae* is a common pest of soybean in Asia. The adult females of *O. phaseoli* lay eggs in unifoliate or defoliate leaves, in the cotyledon of the newly germinated soybean plant and on the upper leaf surfaces, often near the midrib close to the petiole. While, emerging larvae starts feeding inside a mine directed toward the vein of the leaf and cause plant abnormalities [17]. Hence, keeping in view the overall socio-economic importance of okra and bean, and ecological concern of individual insects the present study was designed the pervasiveness susceptible strains of order Diptera, Coleoptera, Hemiptera and Hymenoptera among okra and bean fields.

Materials and Methods

This research was done to find the prevalence of order Diptera, Hymenoptera Coleoptera and Hemeptera under ecological conditions of district Rahim Yar Khan (Tehsil Khan Pur) Punjab, Pakistan among okra and bean fields.

Study area

Tehsil Khan purr, district Rahim Yar Khan is located at an elevation of 710 ft. above sea level and situated at the latitude of 31° 25 N and at longitude of 73° 20 E. The boundary of tehsil Khan pur is joined on the eastern side with the tehsil Liaqut Pur and in the west with the tehsil Rahim Yar Khan. Its north boundary is joined with the tehsil Koat Methan and in the south with Indian boarder.

Collection of Data

The fields of okra and been were surveyed after 7 day intervals right from the pre-harvest stage. The specimens were collected by selecting an area of $100m^2$ of each vegetable by following methods: i) Direct hand picking Method, ii) By using Sweep Net and iii) By using Forceps. The collected specimens were preserved in70:30% alcohol and glycerin solution and were be identified up to species level. The identified data was analyesed statistically to overcome the objectives specification.

Statistical analysis

Thereafter, all the observed specimens were arranged in table form according to their morphological and taxanomic characters e.g. order, family, genus and species. To determine the various aspects of diversity, Shannon Diversity Index was used.

Results and Discussion

The present study was conducted to record "Prevalence of order Hemeptera, Diptera, Hymenoptera and Coleoptera among okra (*Abelmoschusesculentus*) and bean (*Phaseolusvulgaris*) fields" under the ecological conditions of district Rahim yar Khan (Punjab), Pakistan. After completing the whole research trials as per lay down under procedure mentioned in the chapter of methodology, taxa composition was recorded as follow: among okra fields, total 53 species were recorded belonging to 04 orders, 26 families and 52

genera; whereas among bean fields, total 52 species were counted pertaining to 04 orders, 29 families and 45 generas (Table – 01). Among both fields, total 603 specimens were collected during entire sampling (10 sampling from each category) and maximum population was recorded from bean fields 54.56% (N=329) and least population was recorded from okra fields i.e. 45.44% (N=274) (Table – 02). Wherein the population means per sampling was also calculated along with standard deviation (SD) (Table 03). In case of bean fields, maximum population was recorded during 6th sampling (52±13.51), followed by 37±2.90 (7th and 9th sampling), 36±2.19 (3rd sampling) and so on. While, least values were recorded during 4th sampling (18±10.54). Whereas, species abundance was recorded utmost during 6th sampling (31 species) at temperature and humidity of 32.4 ºC and 30.5 ºC and 32% & 55%, respectively. However, least species abundance was recorded during 4th sampling i.e. 14 species at 26 ºC (temperature) and 33% (humidity).In case of okra fields, maximum population was recorded during 6th sampling (39±8.20), followed by 29±1.13 (9th sampling), 28±0.42 (10th sampling), and so on. While, least value was recorded during 4th sampling (24±2.40); whereas species abundance was recorded utmost in 6th sampling (24 species, respectively) at temperature and humidity 26 ºC, 36% respectively. However, least species abundance was recorded during 3rd sampling i.e. 13 species at 24 ºC temperature and 30% humidity. Keeping in view the findings of previous studies [15, 17, 12, 20], the results of present study was quite analogous with them.

Table 1: Population Mean±SD and Species Abundance of recorded Taxa from Okra and Bean fields

Sampling No.	Okra		Bean	
	N±SD	Species	N±SD	Species
1	26±0.99	16	28±3.46	16
2	26±0.99	15	26±4.88	17
3	26±0.99	13	36±2.19	22
4	24±2.40	16	18±10.54	14
5	26±0.99	17	34±0.78	21
6	39±8.20	24	52±13.51	31
7	25±1.70	19	37±2.90	24
8	25±1.70	16	30±2.05	18
9	29±1.13	19	37±2.90	24
10	28±0.42	19	31±1.34	23

However, from the overall findings, significant results were recorded in case of order Diptera from both orchards over the entire study period. Furthermore, diversity of any ecosystem depends upon the relative abundance of that ecosystem; hence, relative abundance of entire population taxa viz. sampling wise, genera wise, family wise and order wise as well as overall was recorded. The relative abundance was recorded maximum from Okra orchards for order Diptera (34.31%) and least for order Hymenoptera (13.50%). Moreover, it is to state from the entire observations that population of order Diptera was high among both orchards. Wherein, Hymenopterans population densities were recorded in conflicting contribution. However, impacts of climatic changes (temperature and humidity) were not significant over the occurrence of both orders in these two vegetable fields.

Whereas, comparative relative abundance of each species from each orchard was recorded heterogeneously (Table 2), because overall relative abundance of each species varied from each other and between each fields; some species were recorded more abundantly in one field while other fields were devoid off by them or exist with very lest abundance. Wherein, a lot of species representing one vegetable instead of overall representation. For example, *Alysinae* spp. (Braconidae) was recorded as an extraordinary contributing species with relative abundance of 4.38% (N=12). Thereafter, *Geminatus australias* (Reduviidae) was recorded with utmost relative abundance 3.5% (N=10), followed by *Crysomya ruffacies* (Caliphoridae), *Neottiglossa undata* (Pentatomidae) 3.28% (N=09). However, least relative abundance (N≤05) was recorded for *Rosalia alpina* (Cerambycidae), *Hoplasoma unicolor* (Byturidae), *Byturus ochraceus* (Byturidae), *Myllocerus undatus* (Curculionidae), *Dinocampus coccinellae*, *Harmonia* spp., *Brumoides suturalis,Cheilomenes sexmaculata* (Coccinellidae) *Tentyria latreillei*, *Gonocephalum elderi* (Teebrioidae), *Cymindis axillaris* (Carabidae), *Hypselonotus punctiventris* (Coreidae), *Arocatus longiceps* (Lygaeidae), *Corizus hyoscyami* (Rhopalidae), *Geocoris punctipes* (Geocoris), *Trialeurodes vaporariorum* (Aleyrodidae), *Eristalinus megacephalus*, *Episyrphus viridaureus*, *Melagyana labiatrum* (Syrphidae), *Calliphora vomitoria* (Caliphoridae), *Muscina levida* (Muscidae), *Clogmia albipunctata* (Psychodidae), *Trupanea stellate*, *Rhagoletis meigenii* (Tephritidae), *Fannia canicularis* (Fanniidae), *Nomada fuctula*, *Apis mellifera*, *Apis dorsata* (Apidae), and *Polistes watti* (Vespidae). Previously, it was confessed that living entities show diversity which in turn contributes to ecosystem variance and abundance of class Insecta noted from cultivation sites fluctuate depending on cultivation system, crop thickness, level of pesticides used, and controlling methods along with affect of biotic and abiotic factors; and their findings are acknowledged about our present findings [3, 10, 11].

From bean fields, *Dinocampus coccinellae* (Curculionidae) was recorded abundantly with relative abundance of 3.34% (N=11). Thereafter, *Piezodorus lituratus* (Pentatomidae), *Anthepiscopus* spp. (Empididae) was recorded with maximum relative abundance 3.04% (N=10), followed by *Apis mellifera* (Apidae) 2.74% (N=9). However, least relative abundance (N≤05) was recorded for *Rosalia alpina* (Cerambycidae), *Myllocerus undatus* (Curculionidae), *Coccinella magnifica* (Coccinellidae), *Cymindis axillaris* (Carabidae), *Trifurcata cerfoma* (Crysomelidae), *Formical pendu* (Formicidae), *Arocatus longiceps* (Lygaeidae), *Corizus hyoscyami* (Rhopalidae), *Eupeodes americanus*, *Eupodes latifasctids* (Syrphidae), *Physilphoral alceae* (Uldidae), *Trupanea stellate*, *Rhagoletis meigenii* (Tephritidae), *Fannia canicularis*(Fanniidea), *Cmmaeyia aridella* (Chamaemyiidae), *Bombus terestres* (Apidae), *Alysinae* spp. (Braconidae). These findings were again an accordance with previous studies [3, 10, 15, 16, 17].

After calculating the species/ taxa wise relative abundance, it was also documented for each genus (Table 2) to highlight their distribution for pertinent inferences among both orchards (okra and bean fields). Relative abundance was recorded extraordinary for genus *Musca* 5.47% (N=15). Then, *Alysinae* and *Byturus* were recorded with utmost and equal relative abundance 4.38% (N=12), followed by *Geminatus* (3.65%; N=10). However, least relative abundance (N≤05) was recorded for *Rosalia, Hoplasoma, undatusDinocampus, Harmonia, Brumoides, Cheilomenes, latreilis, Gonocephalum, Cymindis, Hypselonotus, Arocatus, Corizus, Geocoris, Trialeurodes, Eristalinus, Episyrphus, Melagyana, Calliphora, Physilphoral, Muscina, Trupanea, Rhagoletis, Nomada,* and *Polistes*. Wherein, from total of the 52 recorded genra, (17) genera were not recorded from okra fields.

However, from bean fields, genus *Apis* was recorded as an extraordinary contributing genus with relative abundance of (4.8%; N=16). Thereafter, genus *Eupeodes* was recorded with utmost relative abundance 3.95% (N=13), followed by *Coccinella* (3.65%; N=12), However,least relative abundance (N≤05) was recorded for *Rosalia, Myllocerus, Axillaris, Trifurcata, Arocatus, Corizus, Physilphoral Trupanea, Rhagoletis, Cmmaeyia,* and *Alysinae*. While from total of the 45 recorded genras, (21) genras were not recorded from bean fields.

Okra: After calculating thespecies/ taxa wise relative abundance, it was also documented for each genus (Table 2) to highlight their distribution for pertinent inferences among both orchards (okra and beanfields). Relative abundance was recorded extraordinary for genus *Musca* 5.47% (N=15). Then, *Alysinae* and *Byturus*were recorded with utmost and equal relative abundance 4.38% (N=12), followed by *Geminatus* (3.65%; N=10). However, least relative abundance (N≤05) was recorded for *Rosalia, Hoplasoma, undatus Dinocampus, Harmonia, Brumoides, Cheilomenes, latreilis, Gonocephalum, Cymindis, Hypselonotus, Arocatus, Corizus, Geocoris, Trialeurodes, Eristalinus, Episyrphus, Melagyana, Calliphora, Physilphoral, Muscina, Trupanea, Rhagoletis, Nomada,* and *Polistes*. Wherein, from total of the 52 recorded genra, (17) genera were not recorded from okra fields. From bean fields, genus *Apis*was recorded as an extraordinary contributing genus with relative abundance of (4.8%; N=16). Thereafter, genus *Eupeodes* was recorded with utmost relative abundance 3.95% (N=13), followed by *Coccinella*(3.65%; N=12), However, least relative abundance (N≤05) was recorded for *Rosalia, Myllocerus, Axillaris, Trifurcata, Arocatus, Corizus, Physilphoral Trupanea, Rhagoletis, Cmmaeyia,* and *Alysinae*. While fromtotal of the45recorded genras, (21) genras were not recorded from bean fields.

During present research work susceptibility of recoded taxa were also determined as susceptible strains according to their occureing frequency and following species of order Diptera were found to be more susceptible for Okra fields; *Syrphus vitripennis, Melanostomascalare, Eristalinus megacephalus, Melangyana arctica, Episyrphus viridaureus,* (Family Syrphidae); *Melagyana labiatrum, Lucilia coeruleiviridis, Calliphora vomitoria, Crysomya ruffacies* (Family Caliphoridae); *Physilphoral alceae* (Family Uldidae); *Musca domestica, Muscina levida, Musca autumnalis* (Family Musccidae)*; Liriomyza huidobrensis* (Family Agromyzidae); *Clogmia albipunctata, Dicranosepsis emiliae* (Family Psychodidae); *Trupanea stellate, Rhagoletis meigenii* (Family Tephritidae); *Fannia spathiophora, Fannia canicularis* (Family Fanniidae).

While in bean field following species of order Diptera were more succeptible: *Eupeodes americanus, Eupodes corellae, Episyrphus netoligatus, Eupodes latifasctids, Melangyana arctica* (Family Syrphidae); *Musca domestica* (Family Muscidae); *Opomyza florum* (Family Opomyzidi); *Mycodrosophila* spp. (Family Drosophilidae); *Cmmaeyia aridella* (Family Chamaemyiidae); *Hermetia llucens*(Family Stratiomyidae); *Physilphoral alceae* (Family Uldidae); *Trupanea stellate, Rhagoletis meigenii* (Family Tephritidae); Fannia spathiophora, Fannia canicularis (Family Fanniidae); Crysomya rufifacies (Family Calliphoridae); Anthepiscopus spp. Hilaracornicula (Family Empididae). While, these vegetable field was proved non- susceptible for all other specimens which were found to be related with other vegetables under observation (Table 3).

Table 3: Susceptibility of recorded Taxa regarding order Diptera in Okra and Bean fields

		Relative Abundance (%)	
Family	**Species**	**Okra**	**Bean**
Syrphidae	*Syrphus vitripennis*	+	-
	Melanostomascalare	+	-
	Eristalinus megacephalus	+	-
	Melangyana arctica	+	+
	Episyrphus viridaureus	+	-
	Melagyana labiatrum	+	-
	Eupeodes americanus	-	+
	Eupodes corellae	-	+
	Eupodes latifasctids	-	+
	Episyrphus netoligatus	-	+
Caliphoridae	*Lucilia coeruleiviridis*	+	-
	Calliphora vomitoria	+	-
	Crysomya ruffacies	+	+
Uldidae	*Physilphoral alceae*	+	+
Musccidae	*Musca domestica*	+	+
	Muscina levida	+	-
	Musca autumnalis	+	-
Agromyzidae	*Liriomyzahuidobrensis*	+	-
Psychodidae	*Clogmia albipunctata*	+	-
	Dicranosepsis emiliae	+	-
Tephritidae	*Trupanea stellate*	+	+
	Rhagoletis meigenii	+	+
Fanniidae	*Fannia spathiophora*	+	+
	Fannia canicularis	+	+
Opomyzidi	*Opomyza florum*	-	+
Drosophilidae	*Mycodrosophilaspp*	-	+
Chamaemyiidae	*Cmmaeyia aridella*	-	+
Stratiomyidae	*Hermetia llucens*	-	+
Empididae	*Anthepiscopusspp*	-	+
	Hilaracornicula	-	+

To check out the susceptibility of order Coleoptera in okra fields was accessed and following species were recorded: *Rosalia alpina, Disonycha caroliniana,* (Family Cerambycidae); Onthophagus Taurus, (Family Scarabaeidae), *Hoplasoma unicolor, Byturus ochraceus, Byturus unicolor* (Family Byturidae); *Orchestes fagi, Myllocerusundatus, Dinocampuscoccinellae* (Family Curculionidae); *Coccinella septempunctata, Harmonia* spp., *Coelophora inaequalis, Brumoides suturalis, Cheilomenes sexmaculata, Coccinella sanyriddis, Coccinella magnifica* (Family Coccinellidae); *Tentyria latreillei, Gonocephalumelderi, Trinolium castaneum* (Family Tenebrionidae); *Cymindisaxillaris* (Family Carabidae). While, all other recorded specimens were found non- susceptible for this vegetable field.

To inspect the susceptibility of order Coleoptera, in bean fields were accessed and following species found recorded: *Rosalia alpina, Disonycha caroliniana, Callipogon relicatus* (Family Cerambycidae); *Onthophagus Taurus, Dermolopida albonitrum* (Family Scarabaeidae); *Hoplasoma unicolor, Byturus ochraceus, Byturus unicolor* (Family Byturidae); *Orchestes fagi, Myllocerusundatus, Dinocampus coccinellae* (Family Curculionidae); *Coccinella septempunctata, Harmonia* spp., *Coelophora inaequalis, Brumoides suturalis, Cheilomenes sexmaculata, Coccinella sanyriddis, Coccinella magnifica* (Family Coccinellidae); *Tentyria latreillei, Gonocephalumelderi, Trinolium castaneum* (Family Tenebrionidae); *Cymindisaxillaris* (Family Carabidae); *Aphthona euphorbia, Trifurcata cerfoma* (Family Crysomelidae)*; Formical pendu, Solenopsis mandibularis, Campontus pensylvanica* (Family Formicidae). While, these vegetable field was proved non- susceptible for all other

specimens which were found to be related with other vegetables under observation (Table 4).

Table 4: Susceptibility of recorded Taxa regarding order Coleoptera in Okra and Bean fields

		Relative Abundance (%)	
Family	**species**	**okra**	**bean**
Cerambycidae	*Rosalia alpina*	+	+
	Disonycha caroliniana	+	+
	Callipogon relicatus	–	+
Scarabaeidae	*Onthophagus taurus*	+	–
	Dermolopida albonitrum	–	+
Byturidae	*Hoplasoma unicolor*	+	–
	Byturus ochraceus	+	–
	Byturus unicolor	+	–
Curculionidae	*Orchestes fagi*	+	+
	Mylloceruscundatus	+	+
	Dinocampuscoccinellae	+	+
Coccinellidae	*Coccinella septempunctata*	+	–
	Harmonia sp.	+	–
	Coelophora inaequalis	+	–
	Brumoides suturalis	+	–
	Cheilomenessexmaculata	+	–
	Coccinella sanyriddis	–	+
	Coccinella magnifica	–	+
Tenebrionidae	*Tentyria latreillei*	+	–
	Gonocephalumelderi	+	–
	Trinolium castaneum	–	+
Carabidae	*Cymindisaxillaris*	+	+
Crysomelidae	*Aphthona euphorbia*	–	+
	Trifurcata cerfoma	–	+
Formicidae	*Formical pendu*	–	+
	Solenopsis mandibularis	–	+

To check out the susceptibility of order Hemiptera bean fields were accessed and following specimens were recorded *Cletus* spp, *Hypselonotus punctiventris, Pentatomomorpha* (Family Coreida); *Arocatus longiceps* (Family Lygaeidae); *Corizus hyoscyami* (Family Rhopalidae); *Geocoris punctipes* (Family Geocoridae); *Trialeurodes vaporariorum* (Family Aleyrodidae); *Geminatus australias* (Family Reduviidae) *Neottiglossa undata, Piezodorus lituratus* (Family Pentatomidae) (Table 5).

Table 5: Susceptibility of recorded Taxa regarding order Hemiptera in Okra and Bean fields

		Relative Abundance (%)	
Family	**Speciea**	**Okra**	**bean**
Coreida	*Cletus* spp.	+	+
	Hypselonotus punctiventris	+	+
	Pentatomomorpha	+	+
Lygaeidae)	*Arocatus longiceps*	+	+
Rhopalidae	*Corizus hyoscyami*	+	+
Geocoridae	*Geocoris punctipes*	+	+
Aleyrodidae	*Trialeurodes vaporariorum*	+	+
Reduviidae	*Geminatus australias*	+	+
Pentatomidae	*Neottiglossa undata*	+	+
	Piezodorus lituratus	+	+

To check out the susceptibility of order Hymenoptera in okra fields were accessed and following specimens were recorded: *Nomada fuctula, Apismellifera, Apis dorsata* (Family Apidae); *Polistes watti* (Family Vespidae); *Alysinae* spp. (Family Braconidae); *Chalybion japonicum* (Family Sphecidae). While, all other recorded species were found non succeptible for this vegetable field.

While in bean field following species of order Hymenoptera were more succeptible: *Nomada fuctula, Apis mellifera, Apis dorsata Bombus appositus, Bombus terestres* (Family Apidae); *Polistes watti, Ropalidae* (Family Vespidae); *Alysinae* (Family Braconidae). While, all other recorded specimens were found non succeptible for this vegetable field (Table 6).

Table 6: Susceptibility of recorded Taxa regarding orderHymenoptera in Okra and Bean fields

		Relative abundance (%)	
Family	**speacies**	**Okra**	**Bean**
Apidae	*Nomada fuctula*	+	+
	Apis mellifera	+	+
	Apis dorsata	+	+
	Bombus appositus	-	+
	Bombus terestres	-	+
Vespidae	*polistes watti*	+	+
	Ropalidae	-	+
Braconidae	*Alysinae* spp.	+	+
Sphecidae	*Chalybion japonicum*	+	-

Trophic Structure

Stability and integrity of nature need suitable action plan for smooth running of any biosphere and for that purpose, ecological niches as well as ecological pyramids of should worked in streamline manners. Owing to this, sustainablity and equilibrium of a particular ecosystem is always depending upon the energy flow in food chain. We say ideal and sustainable ecosystem to that which have balanced economy of energy. It can be possible only in the situation when all the abiotic and biotic components of that ecosystem working with idealistic approach for smooth flowing and constant outcomes pertaining to Law of Thermodynamics. The organisms those play role for above mentioned functions usually inhabited by: prey, pest, predator, parasite and pollinators etc. Enlisting of all these contributers is called "Trophic Structure" of that particular ecosystem and their overall role and rate of energy transferring in that particular ecosystem is called "ecological efficiency [22, 19, 23]. Presently trophic structure of foliage insects inhabiting vegetables orchards viz. okra and bean orchards (Table 7), was accessed during their flowering season because array of invading insects accelerate during this season with regard to many causes e.g. aromatic compounds, ideal temperature, less humidity, condence canopy, pest and prey densities etc. From the overall results, population densities pertaining to various represents were recorded non-significantly between each other:

From the total of recorded population, 18.61% (N= 51) was recorded as pollinators from okra orchards pertaining to following taxa: *Eupeodes latifasciatus, Melanostoma scalare, Melangyna arctica,* Syrphus *vitripennis, Calliphora vomitera, Bombus appositus,, Rosalia alpina,Episyrphus viridaureus, Episyrphus balteatus, Arocatus longiceps, Apis dorsata, Apis mellifera, Polistes wattii*.

Whereas, population density of pollinators among bean orchards were recorded maximum (22.79%;N= 75) and that population was consisting of; *Eupeodes corelllae, Eupeodes latifasciatus, Melanostoma scalare, Melangyna arctica, Calliphora vomitera, Bombus appositus, Bombus terrestris, Rosalia alpina, Episyrphus viridaureus, Episyrphus balteatus, Arocatus longiceps, Apis dorsata, Apis mellifera, Polistes watti.*

From the total of recorded population, 39.41% (N= 108) was recorded as pest from okra orchards comprising of following

taxa: *Certoma trifurcate, Piezodorus lituratus, Gminatus australis,* Cletus spp, *Physiphora alceae, Tentyria latreillei, Myllocerus undatus, Musca domestica, Chrysomya rufifacies,Musca autumnalis, Callipogon relictus,Aphthona euphorbiae, Formica rufa, Trialeurodes vaporariorum, Orchestes fagi, Hoplasoma unicolor, Chamaemyia aridella, Brumiodes suturalis, Tribe alysiini.* Whereas, population density of pest among bean orchards were recorded 32.52% (N=107)consisting of; *Certoma trifurcate*, *Piezodorus lituratus*, *Cletus spp*, *Physiphora alceae*, *Tentyria latreillei, Musca domestica, Chrysomya rufifacies, Musca autumnalis, Nomada fucata*, *Aphthona euphorbiae*, *Byturus ochraceus, Liriomyza huidobrensis, Formica rufa*, *Trialeurodes vaporariorum, Orchestes fagi, Hoplasoma unicolor*, *Chamaemyia aridella*, *Dermolepida albohirtum*, *Tribe alysiini*.

From the total of recorded population, 25.91% (N=71) was recorded as predators from bean orchards with regard to following species:*Coelophora inaequalis, Coccinella magnifica, Coccinella sanyriddis, Harmonia spp, Dinocampus coccinellae*, *Solenopsis mandibularis, Byturus unicolor*, *Opomyza florum*, *Cheilomenses sexmaculata*, *Camponotus pensylvanica, Corizus hyoscyami*, *Pentatomomorpha*, *Geocoris punctipes*, *Eristalinus megacephalus*, *Lucilia coeruleiviridis, Chalybion japonicum*, *Trupanea stellate*. Whereas, population density of predators in bean orchards were recorded high 25.22% (N=83) and that population was consisting of;*Coelophora inaequalis, Coccinella sanyriddis, Coccinella septempunctata, Solenopsis mandibularis, Eupeodes americanus, Opomyza florum, Calliphora vomitera, Cheilomenses sexmaculata, Corizus hyoscyami, Neottiglossa undata, Pentatomomorpha, Geocoris punctipes, Eristalinus megacephalus, Lucilia coeruleiviridis, Chalybion japonicum, Rhagoletis meigenii.*

From the total of recorded population, 6.56% (N=18) was recorded as parasites from okra orchards pertaining to following species: *Musca levida, Disonycha caroliniana, Anthepiscopus spp, Fannia spathiophora, Fannia canicularis.* Whereas, population density of parasites among bean orchards were recorded very high 8.20% (N= 27) and that population was consisting of; *Disonycha caroliniana, Anthepiscopus spp, Fannia spathiophora, Fannia canicularis, Mycodrosophila spp.*

From the total of recorded population, 3.28% (N=9) was recorded as scavengers among okra orchards pertaining to following taxa: *Hypselonotus punctiventris* and *Cymindis axillaris.* Whereas, population density of scavenger among bean orchards were recorded high 6.07% (N=20) and that population was consisting of; *Hermetia illucens, Hypselonotus punctiventris* and *Cymindis axillaris.*

From the total of recorded population 6.20% (N=17) was recorded as saprophagous from okra orchards pertaining to species; *Gonocephalum elderi*, *Clogmia albipunctata*, *Trinolium castaneum*, *Onthophagus taurus*. Whereas, population density of scavenger among bean orchards were recorded as 5.16% (N=17) and that population was consisting of; *Gonocephalum elderi*, *Hilara interstincta*, *Clogmia albipunctata*, and *Trinolium castaneum*. Previously, itwas confessed the similar findings in their research orientations [5, 15, 17, 4].

Diversity (H') of an area "agricultural landscapes, vegetable field and any kind of orchard is referred to number of different species in that particular area and among them effective number of species is referred for equally abundant representatives. This diversity consists of two basic components i.e. richness of existing species and their evenness – richness is documented with formal account of species and their evenness is quantified by how equally species found abundantly. All these factors are pre-requisite to launch any ecological plan for better outcomes regarding that particular area. During the present study, these entire diversity indices were documented pertaining to both insects' orders and two vegetable fields. Diversity was recorded maximum among bean orchards (0.0823) and least was recorded among okra orchards (0.0685). Diversitymaximum was also higher among bean orchards (2.5172) and least was recorded again in okra orchard (2.4378). Evenness ratio was also recorded in same context (0.0327 and 0.0281, respectively). Dominance was recorded maximum from bean orchards (1.0327) and least from okra orchards (1.0281). However, richness was a little bit recorded high among okra orchards (15.9602) and least among bean orchards (15.1457). Hence, to compare the overall occurrence, density and diversity of insects in okra and bean fields, Analysis of Variance (ANOVA) was made. After completing the analysis and it was observed that population mean of recorded taxa among both orchards (okra and bean) showed non-significant results (F=0.07; P=0.7942). Wherein to further indicate and highlight the comparative significant between independent and dependent variables (foliage fauna, and okra and bean orchards) as well as to verify the predictions of ANOVA, Kruskal-Wallis test was applied on the collected and identified data. After completing the analysis, it was confirmed that prediction recorded in case of ANOVA were all right (F=0.43; P=0. 5142).

Table 13: Trophic Stracture of recorded Taxa from Okra and Bean fields

Species	Common name	Trophic Status	Food Habit	Okra	Bean
Coelophorainaequalis	striped beetle	Predator	Feeds on diversity of food, including plant sap, necter and other insects.	+	+
Coccinella magnifica	Australian lady beetle	Predator	Feed on aphids/scale insects,	+	-
Coccinellasanyriddis	lady beetle	Predator	eat many other pests such as soft-scale insects, spider mites, mealybugs, and the eggs	+	+
Coccinella septempunctata	small beetles	Predator	Feed on aphids/scale insects,	-	+
Harmonia sp	Seven spotted ladybird	Predator	Feed on aphids, thrips, fungal spores and pollens and greenhouse whitefly.	+	-
Dinocampus coccinellae	Ladybirds	Predator	Feed on aphids, thrips, fungal spores and pollens and greenhouse whitefly.	+	-
Solenopsis mandibularis	spotted Lady Beetle	Predator	Feed on aphids, thrips, fungal spores and pollens and greenhouse whitefly.	+	+
Eupeodes americanus	Fire ant	Predator	Feed on small insects, spiders, centipedes, millipedes.	-	+
Byturusunicolor	Paper wasp	Predator	Provision their larvae with immobilized prey.	+	-
Opomyza florum	House fly	predator	Feed on liquid, semi liquid substances beside solid material	+	+
Calliphora vomitera	Yellow Cereal Fly	predator	Larva feed on the stems of grasses and can be a pest of cereals	-	+
Cheilomenses sexmaculata	Three striped ladybeetle	Predator	feed on aphids/scale insects,	+	+
Camponotus pensylvanica	Six spotted zigzag beetle	Predator	Feed on aphids/scale insects,	+	-
Corizus hyoscyami	Spot-sided bug	Predator	Feeds on mallows and a wide variety of other hosts	+	+
Neottiglossa undata	red bugs	Predator	feeding on developing cranesbill seeds	-	+
Pentatomomorpha	stink- bugs	Predator	feeds on mites, mite eggs, aphids,	+	+
Geocoris punctipes	flat bugs	Predator	parasites of birds and mammals, feed on all parts of seed plants	+	+
Eristalinus megacephalus	Big eyed bug	Predator	Survive on nectar and honeydew when prey are scarce	+	+
Lucilia coeruleiviridis	Syrphid fly	Predator	Prey on aphids, thrips, and other plant-sucking insects.	+	+
chalybion japonicum	Blue mud dauber wasp	Predator	Preys primarily on black widow spiders.	+	+
Trupanea stellata	fruit flies	Predator	Aduls feed on pollen, nectar, leaves and fruits	+	-
Rhagoletismeigenii	fruit flies	Predator	Aduls feed on pollen, nectar, leaves and fruits	-	+
Total				25.91%(N=71)	25.22%(N= 83)
Eupeodes corelllae	American hoverfly	Pollinator	Feeds on a variety of aphids such as Acyrthosiphon pisum, A. spiraecola, A. craccivora,	-	+
eupeodes latifasciatus	hoverfly	Pollinator	Feeds on a variety of aphids such as Acyrthosiphon pisum, A. spiraecola, A. craccivora,	+	+
melanostomascalare	British hoverfly	Pollinator	. Adults feed on nectar; larvae feed on aphids and scale insects.	+	+
Melangyna arctica	Hover fly	Pollinator	adult female feeding on anemone flower in garden powys wales september	+	+
Syrphus vitripennis	Hover fly	Pollinator	adult female feeding on anemone flower in garden powys wales September	+	-
Calliphora vomitera	British hoverfly	Pollinator	. Adults feed on nectar; larvae feed on aphids and scale insects.	+	+
Bombus appositus	Bluebottle fly or bottlebee	Pollinator	Bluebottle fly adults feed on nectar, while the larvae feed on carcasses of dead animals.	+	+
Bombus terrestris	white-shouldered bumblebee	Pollinator	Adults feed on nectar;	-	+
rosalia alpina	buff-tailed bumblebee	Pollinator	Adults feed on nectar;	+	+
Episyrphus viridaureus	Rosalia longicorn	Pollinator	Beetles sit near flowers and feed on the pollen The larvae eat the bark and pupate	+	+
Episyrphus balteatus	Marmalade Hoverfly	Pollinator	Food source being nectar and pollen	-	+
Arocatus longiceps	marmalade hoverfly	Pollinator	Food source being nectar and pollen	+	+
Apis dorsata	social bees	Pollinator	feed on pollen and	+	+
Apis mellifera	Giant honey bee	Pollinator	Nectar feeder.	+	+
Polistes wattii	honey bee	Pollinator	Nectar feeder.	+	+
Total				18.61%(51)	22.79%(75)
Certoma trifurcata	Milkweed bug	pest	Feed on seeds of milkweed plants	+	+
*Piezodorusliturat*us	Bean LeafBeetle	pest	They feed heavily on the seedlings, The larvae feed on the roots	+	+
Gminatus australis	Gorse Shield Bug	pest	Adults and nymphs feed on the seed-pods.	+	-
Cletus sp	Assassin Bug	pest	sapsuckers that feed on plants	+	+

Physiphora alceae	rice stink bugs	pest	feed on leaves and grass	+	+
Tentyria latreillei	Picture-winged fly	Pest	Larvae feed on decaying plant and animal material and excrements	+	+
myllocerus undatus	northafrica beetle	Pest	feeding on decaying vegetation, animal waste products, dung, seeds, cereals,	+	-
Musca domestica	Sri Lankan weevil	Pest	The adults feed on a wide range of host plants	+	+
Chrysomya rufifacies	House fly	Pest	Feed on liquid, semi liquid substances beside solid material.	+	+
Musca autumnalis	blow fly	Pest	feeding on feces as facultative feedr	+	+
Nomada fucata	Milk weed bug	pest	Feed on liquid, semi liquid substances beside solid material.	-	+
callipogon relictus	Aphid	pest	-	+	-
Aphthona euphorbiae -	flea beetle	pest	flea beetles can kill leafy spurge plants	+	+
Byturus ochraceus	Fruitworm Beetle	pest	beetle will feed on new leaves in an interveinal pattern.	-	+
Liriomyza huidobrensis	Raspberry beetle	pest	feed along the midribs of young leaves causing characteristic eliptical holes.	-	+
Formica rufa	serpentine leafminer	pest	larvae feed on the leaves	+	+
Trialeurodes vaporariorum	wood ants	pest	feed roots and leaves	+	+
Orchestes fagi	Greenhouse whitefly	pest	larvae feed on the leaves	+	+
hoplasoma unicolor	beech weevil	pest	Adults feed on hawthorn leaves	+	+
Chamaemyia aridella	[Leaf Beetle	pest	beetle is usually found feeding on the leaves of the Clerodendrum villosum	+	+
dermolepida albohirtum	small fly	pest	feeding on leaves.	+	+
Brumiodes suturalis	cane beetle,	Pest	feeding on the roots of plants	+	-
Tribe alysiini	jaw wasps	pest	arvae are parasitoids that feed on larvae of cyclorrhaphous Diptera	+	+
				39.41%(108)	32.52%(107)
Hermetia illucens	Black soldier fly	Scavenger	Consume decaying matter; reduce animal manure in commercial swine and poultry facilities.	-	+
Hypselonotus punctiventris	longhorn beetle	Scavanger	Larva feeds on rotten wood, and the adults drink juic	+	+
Cymindis axillaris	ground beetle	scavanger	feeding on soft-bodied insects,	+	+
Total				3.28%(9)	6.07%(20)
Musca levida	Green bottle fly	Parasite	Nectar or other suitable food, such as carrion	+	-
Disonycha caroliniana		parasites		+	+
Anthepiscopus sp	House fly	parasites	Feed on aphids/scale insects,	+	+
Fannia spathiophora	Fly	parasites	Adults also feed at flowers	+	+
fannia canicularis	Laterine fly	parasites	Eat solid foods	+	+
Mycodrosophila spp	Lesser house fly	parasites	Feed on decaying organic matter, including carrio	-	+
Total				6.56%(18)	8.20%(27)
Gonocephalum elderi	Vegetable beetle	Saprophagus	Decaying organic matter	+	+
Hilara interstincta	dance fly	Saprophagus	Decaying organic matter	-	+
clogmia albipunctata	Drain fly	Saprophagus	feed on decaying organic matter.	+	+
Trinolium castaneum	Red flour beetle	Saprophagus	Decaying organic matter	+	+
Onthophagus taurus	bull-headed dung beetle	Saprophagus	fed on the faeces of cattle	+	-
Total				6.20%(17)	5.16%(17)

Conclusions

As per finding of previous researchers and present study, it is quite obvious that insects inhabit the flowering plant variably. So, keeping in view their ecological role in agro-ecosystem and other areas of this biosphere following recommendations are made for future strategies:

1. Farming community should be aware about their ecological role in agro-ecosystem and other areas of the earth planet.
2. They also aware about their life histories so that they can play role to safeguard their population.
3. Systematic and taxonomic aspects should also be discussed with farming community to create knowledge among them regarding their life history stages for conservational strategies.
4. Fear and hunches about various poisonous species should also be share with them to decrease their obstacles regarding their conservation and to safeguard their life stages in in-situ conditions.

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