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Naureen Rana
Department of Zoology, Wildlife & Fisheries, University of Agriculture, Faisalabad, Pakistan

Muhammad Imran
Department of Zoology, Wildlife & Fisheries, University of Agriculture, Faisalabad, Pakistan

Tahira Bakhat
Department of Zoology, Wildlife & Fisheries, University of Agriculture, Faisalabad, Pakistan

Ahmad Saeed Khan
Department of Continuing Education, University of Agriculture, Faisalabad, Pakistan

Komal Fatima
Department of Zoology, Wildlife & Fisheries, University of Agriculture, Faisalabad, Pakistan

Saira Javed
Department of Zoology, Wildlife & Fisheries, University of Agriculture, Faisalabad, Pakistan

Saira Fatima
Department of Zoology, Wildlife & Fisheries, University of Agriculture, Faisalabad, Pakistan

Sumia Bibi
Department of Zoology, Wildlife & Fisheries, University of Agriculture, Faisalabad, Pakistan

Muhammad Zafar Iqbal
Department of Zoology, Wildlife & Fisheries, University of Agriculture, Faisalabad, Pakistan

Correspondence
Naureen Rana
Department of Zoology, Wildlife & Fisheries, University of Agriculture, Faisalabad, Pakistan

Prevalence pattern and susceptible strains of order Diptera, Lepidoptera and Coleoptera among Sarson (*Brassica campestris*) fields under different ecological conditions

Naureen Rana, Muhammad Imran, Tahira Bakhat, Ahmad Saeed Khan, Komal Fatima, Saira Javed, Saira Fatima, Sumia Bibi and Muhammad Zafar Iqbal

Abstract
The present study was conducted at Ayub Agriculture Research Institute (AARI) and village Pansera, district Faisalabad from November, 2014 through March, 2015. Maximum population was recorded from AARI fields 51.89% (N=274) and least from Pansera fields i.e. 48.11% (N=254). Overall, significant results were recorded from AARI fields and among them, higher relative abundance (67.15%; N=184) was recorded for order Diptera. From Pensera Sarson fields, higher relative abundance (71.26%; N=181) was recorded again for order Diptera, followed by Lepidoptera (25.98%; N=66); however, least relative abundance (2.76%; N=7) was recorded for order Coleoptera. Diversity (H) was recorded maximum among AARI fields (0.0685) and least was recorded among Pansera fields (0.0635). Evenness ratio was also recorded in same context (0.0281 and 0.0264, respectively); and richness was a little bit recorded high among Pansera fields (17.7080) and least among AARI (15.1036).

Keywords: Prevalence, susceptible strains, Diptera, Lepidoptera, Coleoptera, *Brassica campestris*

Introduction
Pakistan is predominantly an agricultural country with two main cropping seasons, Rabi and Kharif; their duration range from April-October and November-March, respectively [1]. *Brassica* member of Brassicaceae (mustard family) comprises on many important crops which provide edible roots, leaves, stems, buds, flowers and seeds etc. especially for winter feeding of livestock and supplement pasture during other season of the year [15]. This crop provides high quality feed when the pasture growth and quality become poor during midsummer and winter [9]. This crop is also source of edible oil, nutritionally essential diets and its demand has been increased from 0.3 million tonnes to1.95 million tonnes [1]. It is grown on large area in the world and Pakistan is the seventh largest producer in the world. *Brassica compestris* (Sarson) plays a key role in maintaining human health by preventing liver, lungs and skin cancer, heart diseases, birth defects and contributes to a balance and healthy lifestyle. It is the best source of vitamin C, amino acids and other nutrients. Among various species and cultivars, Sarson has distinctive position for Pakistan. It accounts for about 55% of the world total production of mustard oil - Reticulata variety [5]. The eminent nuisances that cause economic losses to this crop throughout the world are *Brevicoryne brassica*, mustard aphid, Mustard leaf eater, *Spodaptera litura*, leaf miner, *Chromatomyia Horticola* (Thrips), *Thrip tabaci*, Whitefly and *Bemesia tabaci* [4]. They harm the nectar and pollen, and support large concentrations of honeybee colonies which produce good honey crops. *Aphis mellifera* visits to rapefruit flowers and represents the main pollinator of Sarson worldwide. Sarson is most attractive for various groups of insects; however number of these groups such as Hymenoptera, Diptera, Lepidoptera, Neuroptera and Coleoptera are eminent. Diversity of these and other invertebrate groups in the Sarson is significantly important to maintain the predator and prey/pests balance, in turn for better production of the oil seed [5, 14].
Biological control of insect pests being self-perpetuating and no more hazardous to environment; directly linked to diversity of invertebrates, various groups of invertebrates such as ladybeetles, mired bugs, and green lacewings are important biological control agents.

Wherein biodiversity in agricultural landscape is affected by many factors other than the farming system. Non-cropped areas, such as fields' margins, edge zones, habitat islands, hedgerows, natural pastures, wetlands, ditches, ponds and other small habitats are important refuges and source area for many organisms. Maintenance of biodiversity in agricultural landscape depends upon the preservation, restoration and managment of such habitats [11-14].

Order Coleoptera have more than three million known species over the world and exist in all types of ecosystem excluding marine water and the freezing point regions of central Antarctica. They occupy on foliage, in cavities, and above the sea-level height in the Himalaya Mountain. As per report of many researches, they can respond quickly to minor fluctuation in their habitat and show signs for these fluctuations. Member of family Coccinellidae, control many prey communites, manage the equilibrium of environment and reduces the demand of insecticides [8].

Order Lepidoptera is probably one of the most suitable groups for most quantitative comparisons between insect faunas to be valid, for the many reasons elaborated by, especially their abundance, species richness, response to vegetation and climate, their ease of sampling using light traps and relatively advanced taxonomy [14].

Natural habitats surrounding agricultural fields provide a source of biota to assist in pest control, but the boundaries are filter, which result in diverse communities within the agro-ecosystems. The diversity and abundance of ground and rove beetles in crops is positively correlated with the presence of forest fragments and similar natural habitats, contributing to the sustainability of the agriculture. Order Lepidoptera larvae feed on the leaves which heavly defoliate the stems. This group of insects is responds quickly to large-scale variation in the temperate climate [6, 7, 16]. The diversity of invertebrates plays a key role for controlling the pest's problems in sarson fields. Therefore, the present study was designed to evaluate the prevalence pattern and susceptible strains of order Diptera, Lepidoptera and Coleoptera among Sarson (*Brassica campestris*) fields under different ecological conditions.

Materials and Methods

The present study was conducted at Ayub Agriculture Research Institute (AARI) and village Pansera, from November, 2014 through March, 2015 under ecological conditions of Faisalabad (district Faisalabad) Punjab, Pakistan. District Faisalabad 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 district Faisalabad is joined on the eastern side with the tehsil Jumhra and in the west with the district Jhang. Its north boundary is joined with the district Chiniot and in the south with tehsil gojra.

Study area at first glimpse: First trail was conducted at "New 2 plots, located in the center of Faisalabad city, Ayub Agricultural Research Institute (AARI), Faisalaabad "a restricted territory with high input farming" and 2nd trail was conducted at 25km away from main city, village Pansera, and cultivations made here with least use of fertilizers as well as pesticides were selected to conduct the research trails for sarson fields. The selected site is also called as "Pendori".

Vegetation: Overall, *Populas ciliate* and *Euclyptus* spp. were abundant in Faisalabad district. In many areas other crops e.g. cotton (*Gossypium hirsutum*), sugarcane (*Saccharum officinarum*), green chili (*Capsicum annum*), sweet corn (*Saccharata rugosa*) and sarson (*Brassica campestris*) are cultivated. In sarson fields, neem (*Azadirachta indica*) trees were also present.

Collection and Identification

Collection of data: The fields of sarson were sampled after seven days intervals right from the pre-harvest stage to post-harvest stage. The specimens were collected by selecting an area of 100 m^2 of field by following methods: i) Direct hand picking method, ii) By using Sweep Net, iii) By using Forceps. Moreover, temperature and humidity of area were also recorded as per objectives and collection was made from these sarson fields during 08:00 am to 10:00 am. Collected specimens were stored in jars containing, 70:30% alcohol and glycerin solution and shifted to Biodiversity Laboratory, Department of Zoology, Wildlife and Fisheries, University of Agriculture, Faisalabad for further systematic studies. Here, the specimens were preserved in separate glass vials, containing 70:30% alcohol and glycerin solution for further identification. The collected specimens were identified and sorted with the aid of: i) Naked eye, ii) Magnifying glass, iii) Microscope. All the specimens were identified up to species level according to the taxonomic/ reference material [3] and internet.

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:

Diversity (H'): $H' = -\sum pi \ln pi$

Where p_i is the proportion of individuals found in the ith species. The value of p_i is estimated as n_i / N.

Evenness "Hill's Modified Ratio (E)".

$$E = \frac{(1/\lambda)}{e^{H-1}} = \frac{N2-1}{N1-1}$$

Where, E is the index of evenness, λ is the Simpson's index of diversity and N1 and N2 are the number of abundant and very abundant species respectively in the sample. The richness, diversity and evenness indices were computed by using the Programme SPDIVERS. BAS.

Richness

$$S = n + \left(\frac{n-1}{n}\right)^k$$

Where,

- S = species richness
- n = total number of species present in sample population
- k = number of "unique" species (of which only one organism was found in sample population)

Dominance

D= 1-E

Where, "E" is evenness.

Results and Discussion

Agro-ecosystems are unfavorable environments for the insects due to high levels of disturbance in habitat management – that is an ecological to enhance agricultural production. The goal

of habitat management is to create a suitable ecological infrastructure within the agricultural landscape to provide resources such as food for adult natural enemies, alternative prey/hosts, and shelter from adverse conditions. These resources must be integrated in to the landscape in a way that is spatially/temporally favorable to natural enemies and practical for producers to implement. While, in connection to plants life histories, insects are key motor of an ecosystem function and they can live in various ecological circumstances e.g. peak/ negative temperature, humidity, and desiccation. Ecological co-relation toward their diversity and density for primary production and ideal ecosystem functioning have been acknowledged by many researchers [19, 6, 13, 14]. Keeping in view all these facts, the present study was conducted to record "Prevalence pattern and susceptible strains of order Diptera, Lepidoptera and Coleoptera among Sarson (*Brassica campestris*) fields under different ecological conditions of district Faisalabad (Punjab), Pakistan". After completing the whole research trials, taxa composition was recorded as follow: among Ayub Agriculture Research Institute (AARI) sarson fields, total 49 species were recorded belonging to 3 orders, 24 families and 37 genera; whereas among Pansera fields, total 58 species were counted pertaining to 3 orders, 25 families and 52 genera. Among both fields, total 528 specimens were collected during entire sampling (10 sampling from each category) and maximum population was recorded from Ayub Agriculture Research Institute (AARI) sarson fields 51.89% (N = 274) and least population was recorded from Pansera sarson fields i.e. 48.11% (N=254). Wherein in case of Ayub Agriculture Research Institute (AARI) sarson fields (Table 1), maximum population was recorded during 1st sampling (36±6.08), followed by 33±3.96 (3rd sampling), 31±2.55 (4th sampling) and so on – while, least values were recorded during 3rd sampling (20±5.23). Whereas, species abundance was recorded utmost during 2nd sampling (26 species) at temperature and humidity of 27 ºC and 28%, respectively. However, least species abundance was recorded during 8th sampling i.e. 14 species at 23 ºC (temperature) and 39% (humidity). In case of Pansera sarson fields, maximum population was recorded during 4th sampling (37±8.20), followed by 36±7.50 (1st sampling), 30±3.25 (5th sampling), 30±3.25 and so on. While, least value was recorded during 9th sampling (14±8.06) whereas species abundance was recorded utmost in 4th sampling (31 species) at temperature and humidity 30 ºC, 34%, respectively. However, least species abundance was recorded during 9th sampling i.e. 10 species at 20 ºC temperature and 35% humidity. Previously, it was reported that sarson is a host for many insect pests recorded over more than 450 species and mites have been recorded associated with it; whereas, these insects usually belong to order Diptera, Lepidoptera and Coleoptera [12]. Furthermore, fruit fly diversity and abundance has been reported from many sarson producing areas and causes huge economic losses in Nigeria [17]. *Bactrocera invadens* Drew Tsuruta and White, *Bactrocera cucurbitae* (Coquillett), *Ceratitis ditissima* (Munro), *Ceratitis capitata* (Wiedemann) and *Dacus bivittatus* (Bigot) were contributors. But, major highlighted fly pest on sarson fieldss was only the medfly, *C. capitata*. Brassica fly pest in Asia, especially in China is *Bactrocera dorsalis* (Hendel) (Yang *et al*. 2011) and *Bactrocera zonata* in India [2]. Keeping in view their findings, results of present study was quite analogous with them.

Table 1: Population Mean ± SD and Species Composition of recorded Taxa from AARI and Pansera

Sampling No.	AARI (sarson)	Species	Pansera(sarson)	Species
	N ± SD		**N** ± SD	
1	36±6.08	23	36±7.50	27
2	33±3.96	26	27±1.13	24
3	20±5.23	16	26±0.42	21
4	31±2.55	21	37±8.20	31
5	28±0.42	21	30±3.25	20
6	23±3.11	16	17±5.94	13
7	26±0.99	20	16±6.65	12
8	22±3.82	14	21±3.11	16
9	25±1.70	17	14±8.06	10
10	30±1.84	18	30±3.25	21

However, from the overall findings, significant results were recorded in case of order Diptera from both fields 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. Overall from Ayub Agriculture Research Institute (AARI) sarson fields higher relative abundance (67.15%; N=184) was recorded for order Diptera, followed by Lepidoptera (26.28%; N=72), However, least relative abundance (6.57%; N=18), was recorded for order Coleoptera. From Pansera sarson fields higher relative abundance (71.26%; N=181) was recorded for order Diptera, followed by Lepidoptera (25.98%; N=66), However, least relative abundance (2.76%; N=7) was recorded for order Coleoptera. However, impacts of climatic changes (temperature and humidity) were not significant over the occurrence of both orders in two sarson fields. Whereas, comparative relative abundance of each species from each fieldwas recorded heterogeneously (Table 2 & 3), because overall relative abundance of each species was vary 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 fields instead of overall representation. For example, from sarson fields, *Coccinella septempunctata* (Coccinellidae) was recorded as an extraordinary contributing species with relative abundance of 5.47% (N=15). Thereafter, *Musca domestica* (Muscidae), *Danaus archippus* (Nymphalidae) wererecorded with utmost relative abundance 4.74% (N=13), followed by *Eristalinus megacephalus*, *Episyrphus balteatus* (Syrphidae), *Chrysomya megacephalae* (Caliphoridae), *Coccinella sanguinea* (Coccinellidae) 3.28% (N=09), *Episyrphus viridauerus* (Syrphidae), *Coccinella magnifica* (Coccinellidae) 2.92% (N=08), *Musca autumnalis* (Muscidae), *Helophilus pendulus* (Syrphidae), *Dioctria oelandica* (Asilidae), *Pontia protodice* (Pieridae) 2.55% (N=07), and *Melanostoma scalare*, *Eristalis tenax* (Syrphidae), *Dioctria rufipes* (Asilidae), *Crysomya rufifacies* (Caliphoridae), *Danaus genutia* (Nymphalidae),

Coccinella novemnotata (Coccinellidae), *Calosoma semilaeve* (Carabidae), 2.19% (N=06). However, least relative abundance (N≤05) was recorded for *Bactreocera zonata* (Tephritidae), *Ichneumon sarcitorius* (Ichneumonidae), *Lucilia* spp. (Caliphoridae), *Cacoxenus indigator* (Drosophillidae), *Hybomitra mican* (Tabanidae), *Nephrotoma appendiculata* (Tipulidae), *Danaus archippus*, *Melitaea deserticola* (Nymphalidae), *Colias philodice*, *Calias eurytheme*, *Elondina slundica* (Pieridae), *Tineola bisselliela* (Tineidae), *Papilio demodocus* (Papilionidae), *Cabera erythemaria* (Lymantriidae), *Lambdinapellucidaria* (Geometridae), *Amata fortcinei* (Arctidae), *Coccinella undecimpunctata*, *Adalia decempunctata* (Coccinellidae), *Rosalia alpine*, *Callipogon relicatus* (Crambycidae), *Tentyria latreillei* (Tenebrionidae), *Brumoides suturadis* (Crysomelidae), *Eusphalerum leuteum*, *Paederus fuscipes* (Staphylinidae), *Dermestes hovorei* (Dermestidae), and *Orchestes fagi* (Tenebrionidae). It has been already reported 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 [14, 19].

From Pansera sarson fields, *Musca domestica* (Muscidae) was recorded most abundantly with relative abundance of 6.30% (N=16). Thereafter, *Danaus plexippus* (Nymphalidae) was recorded with maximum relative abundance 5.91% (N=15), followed by *Coccinella septempunctata* (Coccinellidae) 5.51% (N=14), *Zosteria* spp. 4.72% (N=12), *Danaus archippus* (Nymphalidae) 3.54% (N=09), *Melanostoma scalare* (Syrphidae), *Atherigona oryzae* (Muscidae), *Hybomitra mican* (Drosophillidae) 3.15% (N=08), *Eristalinus megacephalus* (Syrphidae), *Pieris rapae* (Pieridae) 2.76% (N=07), *Helophilus pendulus* (Syrphidae), *Chrysomya megacephalae*, *Lucilia* spp. (Caliphoridae), *Phytomyza ilicis* (Agromyzidae), and *Coccinella sanguinea* (Coccinellidae) 2.36% (N=06). However, least relative abundance (N≤05) was recorded for *Xanthogramma pedissequm*, *Meloyyana labiotrum*, *Cheilosia albitarsis*, *Eupeodes americanus*, *Eupheodes latifastadatus* (Syrphidae), *Eudasphora eyanella* (Muscidae), *Bactreocera zonata* (Tephritidae), *Calliphora latifrons*, *Protophormia tenaenoval* (Caliphoridae), *Photica variegate* (Drosophillidae), *Physilphora alceae* (Ulididae), *Mydas tibialis* (Mydidae), *Culex pipines* (Culicidae), *Odonmyia* spp. (Stratiomyidae), *Thaumatomyia notate* (Chloropidae), *Limenitis archippus*, *Caligo illioneous* (Nymphalidae), *Pontia protodice*, *Colias philodice*, *Calias eurytheme*, *Elondina slundica* (Pieridae), *Lambdina pellucidaria* (Geometridae), *Amata fortcinei* (Arctidae), *Spodoptera exigua*, *Sesamia inferems*, *Plutella xylostella*, *Spodoptera litura*, *Helicoverpa armigera*, *Mythim separate* (Noctuidae), *Tryporyza incerrtulas*, *Tryporyza innotata*, *Chiol supperessalis* (Crambidae), and *Cheilomenes sexmaculata*, *Dinocampus coccinellae* (Coccinellidae).

From AARI fields, overall genera abundance for genus *Coccinlla* 15.69% (N=43). Then, *Danaus* was recorded with utmost relative abundance 13.50% (N=37), followed by *Crysomya* (5.47%; N=15), *Dictoria* (4.74%; N=13), *Eristalinus* (3.28%; N=9), *Colias* (2.92%; N=8), *Helophilus* (2.55%; N=7), *Eristalis*, *Calosoma* (2.19%; N=6). From Pansera fields, *Danaus* was recorded as an extraordinary contributing genus with relative abundance of (9.45%; N=24). Thereafter, genus *Coccinella* recorded with utmost relative abundance 7.87% (N=20), followed by *Musca* (6.30%; N=16), *Crysomya* (5.51%; N=14), *Zosteria* (4.72%; N=12), H*ybomitra* (3.15%; N=8), *Pieris* (2.76%; N=7) *Helophilus*, *Lucilia*, *Phytomyza* and *Spodoptera* (2.36%; N=6).

To launch the IPM strategies in a best fitted manner, use of community representative for population suppression or to motivate the beneficial organisms is considered a cornerstone factor. For this purpose, highlighting a diversity and density of various existing families in under reference fields provide a realistic approach [18]. Hence, the fundamental issue, relative abundance was again accessed at family level to overcome these aspects. As far as relative abundance upto family for Ayub Agriculture Research Institute (AARI) sarson and Pansera fields was concerned, in case of Ayub Agriculture Research Institute (AARI) sarson from total of (49) recorded families, 24 were recorded from AARI fields and among them, extra ordinary relative abundance was recorded for Coccinellidae family (18.25%; N=50) and then maximum relative abundance was recorded for family, followed by Coccinellidae family (16.42%; N=45), Nymphalidae (14.60%; N = 40), Pieridae (8.03%; N=22), Muscidae (7.30%; N=20), and Asilidae (4.74%; N=13). However, least relative abundance (N≤10) was recorded for family Tephritidae, Ichneumonidae, Drosophillidae, Tipulidae, Tineidae, Papilionidae, Lymantriidae, Geometridae, Arctidae, Cerambycidae, Tenebrionidae, Crysomelidae, Carabidae, Staphylinidae, Dermestidae and Curculionidae.Wherein from total of the 24 recorded families, 09 families were not recorded from AARI sarson fields. However, from total of 49 recorded families, 25 were recorded from Pansera fields and among them, relatively higher abundance (12.60%; N=32) was recorded for Syrphidae and Nymphalidae family. Thereafter, relative abundance was recorded for Muscidae (11.42%; N= 29), Caliphoridae (10.63%; N=27), Coccinellidae (10.24%; N = 26), Noctuidae (6.30%; N=16), Pieridae (5.91%; N = 15), Asilidae (4.72%; N=12), and Drosophillidae (4.33%; N=11), However, least relative abundance (N≤10) was recorded for family Tephritidae, Ulididae, Mydidae, Culicidae, Stratiomyidae, Agromyzidae, Lymantriidae, Geometridae, Byturidae, Tenebrionidae, Chloropidae, Crambidae, Crysomelidae, Carabidae, and Staphylinidae. Whilst, from total of the 25 recorded families; 07 families were not recorded Pansera sarson fields.

Table 2: Relative Abundance recorded upto Order level from AARI and Pansera fields

Orders	Relative Abundance (%)		Significance	P-value
	AARI (Sarson)	Pansera(Sarson)		
Diptera	67.15(184)	71.26(181)	NS	≥ 0.005
Lepidoptera	26.28(72)	25.98(66)	NS	≥ 0.005
Coleoptera	6.57(18)	2.76(7)	**	≤ 0.005
r^2	0.9797	0.9828		

Table 3: Overall Relative Abundance of recorded Taxa from AARI and Pansera

Order	Family	Species	Relative Attendance (%)		Significance/ Probabiulity	P-value
			AARI	Pansera		
Diptera	Syrphidae	*Eristalis tenax*	2.19(6)	0.00(0)	***	≤ 0.001
		Melanostoma scalare	2.19(6)	3.15(8)	NS	≥ 0.005
		Helophilus pendulus	2.55(7)	2.36(6)	NS	≥ 0.005
		Episyrphus viridauerus	2.92(8)	0.00(0)	***	≤ 0.001
		Episyrphus balteatus	3.28(9)	0.00(0)	***	≤ 0.001
		Eristalinus megacephalus	3.28(9)	2.76(7)	*	≤ 0.005
	Muscidae	*Musca domestica*	4.74(13)	6.30(16)	*	≤ 0.005
		Musca autumnalis	2.55(7)	0.00(0)	***	≤ 0.001
		Eudasphora eyanella	0.00(0)	1.97(5)	***	≤ 0.001
		Atherigona oryzae	0.00(0)	3.15(8)	***	≤ 0.001
	Tephritidae	*Bactreocera zonata*	1.82(5)	0.79(2)	**	≤ 0.005
	Ichneumonidae	*Ichneumon sarcitorius*	1.82(5)	0.00(0)	***	≤ 0.001
	Asilidae	*Dioctria oelandica*	2.55(7)	0.00(0)	***	≤ 0.001
		Dioctria rufipes	2.19(6)	0.00(0)	***	≤ 0.001
		Zosteria spp.	0.00(0)	4.72(12)	***	≤ 0.001
	Caliphoridae	*Crysomya rufifacies*	2.19(6)	3.15(8)	***	≤ 0.001
		Chrysomya megacephalae	3.28(9)	2.36(6)	NS	≥ 0.005
		Lucilia spp.	1.82(5)	0.00(0)	***	≤ 0.005
		Lucilia caesar	0.00(0)	2.36(6)	***	≤ 0.001
	Drosophillidae	*Hybomitra mican*	1.09(3)	3.15(8)	**	≤ 0.005
	Agromyzidae	*Phytomyza ilicis*	0.00(0)	2.36(6)	***	≤ 0.001
	Chloropidae	*Thaumatomyia notata*	0.00(0)	1.97(5)	***	≤ 0.001
Lepidoptera	Nymphalidae	*Danaus genutia*	2.19(6)	0.00(0)	***	≤ 0.001
		Danaus plexippus	4.74(13)	5.91(15)	NS	≥ 0.005
		Danaus archippus	4.74(13)	3.54(9)	**	≤ 0.005
		Danaus chryppus	1.82(5)	0.00(0)	***	≤ 0.001
		Caligo illioneous	0.00(0)	1.97(5)	***	≤ 0.001
	Pieridae	*Pontia protodice*	2.55(7)	0.79(2)	**	≤ 0.005
		Pieris rapae	1.82(5)	2.76(7)	NS	≥ 0.005
Coleoptera	Coccinellidae	*Coccinella septempunctata*	5.47(15)	5.51(14)	NS	≥ 0.005
		Coccinella sanguinea	3.28(9)	2.36(6)	**	≤ 0.005
		Coccinella novemnotata	2.19(6)	0.00(0)	***	≤ 0.001
		Coccinella undecimpunctata	1.82(5)	0.00(0)	***	≤ 0.001
		Coccinella magnifica	2.92(8)	0.00(0)	***	≤ 0.001
	Cerambycidae	*Rosalia alpina*	1.09(3)	1.97(5)	*	≤ 0.005
	Carabidae	*Calosoma semilaeve*	2.19(6)	0.79(2)	**	≤ 0.005

Susceptible strains among Sarson fields under different Ecological Condition

During the present research work, susceptible strains of recoded taxa were also determined according to their occurring frequency and following species of order Diptera were found to be more susceptible from sarson fields at Ayub Agriculture Research Institute (AARI), Faisalabad viz. *Eristalis tenax*, *Melanostoma scalare*, *Helophilus pendulus*, *Episyrphus viridauerus*, *Eristalinus balteatus*, *E. megacephalus* (Syrphidae); *Musca domestica*, *M. autumnalis* (Muscidae); *Bactreocera zonata* (Tephritidae); *Ichneumon sarcitorius* (Ichneumonidae); *Dioctria oelandica*, *D. rufipes* (Asilidae); *Crysomya rufifacies*, *Chrysomya megacephalae*, *Lucilia* spp. (Caliphoridae); *Cacoxenus indigator*, *Hybomitra mican* (Drosophillidae) and *Nephrotoma appendiculata* (Tipulidae). While, these sarson fields were proved Non- susceptible for all other recorded species in case of Panseera Agriculture fields.

While, under natural condition, agricultural fields near Panseera (district Faisalabad), from sarson fields; following species of order Diptera were more susceptible: *Musca domestica*, *Atherigona oryzae*, *Eudasphora eyanella* (Muscidae); *Culex pipines* (Culicidae); *Phytomyza ilicis* (Agromyzidae); *Odonmyia* spp. (Stratiomyidae); *Zosteria* spp. (Asilidae); *Thaumatomyia notate* (Chloropidae); *Bactreocera zonata* (Tephritidae); Chrysomya megacephalae, *Crysomya rufifacies*, *Calliphora latifrons*, *Stomorhina lunata*, *Lucilia caesar*, *Protophormia tenaenoval* (Caliphoridae); *Hybomitra mican*, *Phortica variegate* (Drosophillidae); *Melanostoma scalare*, *Meloyyana labiotrum*, *Helophilus pendulus*, *Eristalinus megacephalus*, *Xanthogramma pedissequum*, *Cheilosia albitarsis*, *Eupeodes americanus*, *E. latifastadatus* (Syrphidae); *Physilphora alceae* (Ulididae); *Mydas tibialis* (Mydidae); *Culex pipines* (Culicidae); *Odonmyia* spp. (Stratiomyidae); *Phytomyza ilicis* (Agromyzidae); *Thaumatomyia notata* (Chloropidae). While, these sarson fields were proved non- susceptible for all other recorded species in case of AARI (Table - 4).

Table 4: Susceptibility of recorded Taxa regarding order Diptera in Sarson (AARI) and Sarson (Pansera) fields

Family	Species	Sarson (AARI)	Sarson (Pansera)
Syrphidae	*Eristalis tenax*	+	–
	Melanostoma scalare	+	+
	Helophilus pendulus	+	+
	Episyrphus viridauerus	+	–
	Episyrphus balteatus	+	–
	Eristalinus megacephalus	+	+
	Meloyyana labiotrum	–	+
	Xanthogramma pedissequum	–	+
	Cheilosia albitarsis	–	+
	Eupeodes americanus	–	+
	Eupheodes latifastadatus	–	+
Muscidae	*Musca domestica*	+	+
	Musca autumnalis	+	–
	Eudasphora eyanella	–	+
	Atherigona oryzae	–	+
Tephritidae	*Bactreocera zonata*	+	+
Ichneumonidae	*Ichneumon sarcitorius*	+	–
Asilidae	*Dioctria oelandica*	+	–
	Dioctria rufipes	+	–
	Zosteria spp.	–	+
Caliphoridae	*Crysomya rufifacies*	+	+
	Chrysomya megacephalae	+	+
	lucilia spp.	+	–
	Calliphora latifrons	–	+
	Stomorhina lunata	–	+
	Lucilia caesar	–	+
	Protophormia tenaenoval	–	+
Drosophillidae	*Cacoxenus indigator*	+	–
	Hybomitra mican	+	+
	Phortica variegata	–	+
Tipulidae	*Nephrotoma appendiculata*	+	–
Ulididae	*Physilphora alceae*	–	+
Mydidae	*Mydas tibialis*	–	+
Culicidae	*Culex pipines*	–	+
Stratiomyidae	*Odonmyia* spp.	–	+
Agromyzidae	*Phytomyza ilicis*	–	+
Chloropidae	*Thaumatomyia notata*	–	+

Susceptibility of order Coleoptera from sarson (AARI**)** fields were recorded as follows species **:** *Coccinella septempunctata, C. sanguine, C. novemnotata, C. undecimpunctata, C. magnifica, Adalia decempunctata, Harmonia* spp. (Coccinellidae); *Rosalia alpina, Callipogon relicatus* (Cerambycidae); *Tentyria latreillei* (Tenebrionidae); *Brumoides suturadis* (Crysomelidae); *Calosoma semilaeve* (Carabidae); *Eusphalerum leuteum, Paederus fuscipes* (Staphylinidae); *Dermestes hovorei* (Dermestidae); *Orchestes fagi* (Curculionidae). While, all other recorded species were found non succeptible for this sarson crop.

From Pansera sarson fields susceptibility was recorded as follow: *Coccinella septempunctata, C. sanguinea, Cheilomenes sexmaculata, Dinocampus coccinellae* (Coccinellidae); *Rosalia alpina, Callipogon relicatus, Byturus unicolor* (Cerambycidae); *Gonocephalum elderi* (Tenebrionidae); *Ceotoma trifurcate,* (Crysomelidae); *Calosoma semilaeve* (Carabidae); *Eusphalerum leuteum,* (Staphylinidae); While, all other recorded species were found non-susceptible for this sarson crop (Table 5).

Table 5: Susceptibility of recorded Taxa regarding order Coleoptera in sarson (AARI) and sarson (Pansera) fields

Family	Species	Serssu (AARI)	Serssu (Pansera)
Coccinellidae	*Coccinella septempunctata*	+	+
	Coccinella sanguinea	+	+
	Coccinella novemnotata	+	–
	Coccinella undecimpunctata	+	–
	Adalia decempunctata	+	–
	Coccinella magnifica	+	–
	Harmonia spp.	+	–
	Cheilomenes sexmaculata	–	+
	Dinocampus coccinellae	–	+
Cerambycidae	*Rosalia alpine*	+	+
	Callipogon relicatus	+	+
Byturidae	*Byturus unicolor*	–	+
Tenebrionidae	*Tentyria latreillei*	+	–
	Gonocephalum elderi	–	+
Crysomelidae	*Brumoides suturadis*	+	–

	Ceotoma trifurcata	-	+
Carabidae	*Calosoma semilaeve*	+	+
staphylinidae	*Eusphalerum leuteum*	+	+
	Paederus fuscipes	+	-
dermestidae	*Dermestes hovorei*	+	-
Curculionidae	*Orchestes fagi*	+	-

Susceptibility of order Lepidoptera in sarson (AARI**)** fields were accessed and following species were recorded: *Danaus genutia, D. plexippus, D. archippus, D. chryppus, Melitaea deserticola* (Nymphalidae); Pontia protodice, *Pieris rapae, Colias philodice, Calias eurytheme, Elondina slundica* (Pieridae); *Papilio demodocus* (Papilionidae); *Cabera erythemaria* (Lymantriidae); *Lambdina pellucidaria* (Geometridae); *Amata fortcinei* (Arctidae). While, all other recorded specimens were found non- susceptible for this sarson fields.

Susceptibility of order Lepidoptera in sarson (Pansera) fields were accessed as follow: *Limenitis archippus, Danaus archippus, D. plexippus, Caligo illioneous* (Nymphalidae); *Elodina slandica, Pontia protodice, Pieris rapae, Colias philodice, Calias eurytheme* (Pieridae); *Tryporyza incerrtulas, Tryporyza innotata, Chiol supperessalis* (Crambidae); *Spodoptera exigua, Sesamia inferems, Plutella xylostella, Spodoptera litura, Helicoverpa armigera, Mythim separata* (Noctuidae); *Lambdina pellucidaria* (Geometridae); *Amata fortcinei* (Arctidae). While, all other recorded species were found non-susceptible for this sarson fields (Table 6).

Table 6: Susceptibility of recorded Taxa regarding order Lepidoptera in sarson (AARI) and sarson (Pansera) fields

Family	Species	Serssu(AARI)	Serssu (Pansera)
Nymphalide	*Danaus genutia*	+	-
	Danaus plexippus	+	+
	Danaus archippus	+	+
	Danaus chryppus	+	-
	Melitaea deserticola	+	-
	Limenitis archippus	-	+
	Caligo illioneous	-	+
Pieridae	*Pontia protodice*	+	+
	Pieris rapae	+	+
	Colias philodice	+	+
	Calias eurytheme	+	+
	Elondina slundica	+	+
Tineidae	*Tineda bisselliela*	+	-
papilionidae	*Papilio demodocus*	+	-
lymantriide	*Cabera erythemaria*	+	-
geometridae	*Lambdina pellucidia*	+	+
Arctidae	*Amata fortcinei*	+	+
Noctuidae	*Spodoptera exigua*	-	+
	Sesamia inferems	-	+
	Plutella xylostella	-	+
	Spodoptera litura	-	+
	Helicoverpa armigera	-	+
	Mythim separate	-	+
Crambidae	*Tryporyza incerrtulas*	-	+
	Tryporyza innotata	-	+
	Chiol supperessalis	-	+

Diversity was recorded maximum among Ayub Agriculture Research Institute (AARI) sarson fields (0.0685) and least was recorded among Pansera fields (0.0635). Diversity maximum was also higher among Ayub Agriculture Research Institute (AARI) sarson fields (2.4378) and least was recorded again in Pansera fields (2.4048). Evenness ratio was also recorded in same context (0.0281 and 0.0264, respectively). Dominance was recorded maximum from Ayub Agriculture Research Institute (AARI) sarson fields (1.0281) and least from Pansera fields (1.0264). However, richness was a little bit recorded high among Pansera fields (17.7080) and least among Ayub Agriculture Research Institute (AARI) sarson fields (15.1036). While, to compare the overall occurrence, density and diversity of insects in Ayub Agriculture Research Institute (AARI) sarson and Pansera fields, Analysis of Variance (ANOVA) was made. After completing the analysis and it was observed that population mean of recorded taxa among both fields (AARI sarson and Pansera sarson) showed non-significant results (F=0.01; P=0.9152). Similar findings were acknowledged previously [14, 6].

Conclusions

As per finding of previous researchers and present study, it is quite obvious that insects inhabit the flowering plant variably. So, farming community should be aware about their ecological role in agro-ecosystem and other areas of the earth planet as well as about their life histories so that they may plan their control measures as per their existing stauts. 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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