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Eco-diversity and Habitation Partiality of order Diptera and Coleoptera and Siphonaptera among okra (*Abelmoschus esculentus* L.) and cauliflower (*Brassica oleracea*L.) fields

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Abstract

The present study was conducted to accord “ecological diversity of order Diptera, Coleoptera and Siphonaptera among okra (*Abelmoschus esculentus* L.) and cauliflower (*Brassica oleracea* L.) fields” during the session 2014-15. The collection was made for ten days intervals from these vegetables fields with the help of sweep net, direct hand picking and with forceps over an area of 100m^{2}during morning hours (08:00 am to 10:00 am). Total eight (08) samplings were accomplished for okra and fourteen (14) for cauliflower fields. After completing the research trial, total 560 specimens were recorded from both fields pertaining to aforementioned orders. Among them, least population was recorded from okra fields 182 (32.5%) and higher population was from cauliflower fields 378 (67.5%) pertaining to order Diptera and Coleoptera. While, both fields were devoid off in case of order Siphonaptera population. Relative abundance was recorded maximum in okra fields for order Diptera (65.93%) and lowest for order Coleoptera (34.07%). However, in cauliflower fields, maximum relative abundance was recorded again for order Coleoptera (69.05%) and minimum for order Diptera (30.63%). In okra fields, diversity was recorded highest for the order Coleoptera (0.9596) and lowest for order Diptera (0.0682) and in cauliflower fields, diversity was recorded also in same context (2.2648 and 0.6731, respectively). According to Wilcoxon Rank Sum test, in okra fields population of both orders was differ significantly ($P \leq 0.001$) and in cauliflower fields, population of both orders were also differ significantly ($P \leq 0.001$).

Keywords: *Coleoptera, Diptera, Siphonaptera, okra and cauliflower*

1. Introduction

Vegetables are vital part of our everyday nutrition and used as mess as well as finger food. However, they contain different dietary contents e.g. protein, fat, vitamins (retinol, phylloquinone, pyridoxine, previtamin), minerals and sugar etc. They also hold natural oxidative compounds which act against microbes e.g. bacteria, virus and fungi; and they also act as carcino-preventive agent. Beside this, they also provide fiber, vital for metabolic activities for ideal fitness of the human body (Sharma and Rao, 2012).

Topography of Pakistan is supporting for agricultural activities and ecology of the region is favorable for cropping. According to previous estimates of last ten years, 3,460000ha area is under cultivation for overall 13.7 million tones edible crop cultivation (Akhtar et al., 2007), by providing earning over Rs. 600.000 billion in country income (Government of Pakistan, 2004).

Okra (Abelmoschus esculentus L.) is an important cash crop/ vegetable in Pakistan belongs to family Malvaeceae (Iqbal et al., 2011). In England, it is called ladyfinger, gumbo in southern USA, and bhindi in Pakistan (Uka et al., 2013). Its 1.7 million ton cultivation has been accomplished annually on this planet and preferred comparative to other vegetables as a garden-fresh pod; and it provides 4550Kcal/kg (Babatunde et al., 2007; Schippers, 2000), rich in Ca, Mg, P, K, protein, vitamin (B3, vitamin B2, vitamin B1, retinol, ascorbic acid, phylloquinone, pyridoxine) and micro-minerals like Fe, Mn, Zn, and Cu (Baidoo et al., 2011). Moreover, its paste increases the quantity of red body fluid (Onunkun, 2012), seeds as oil foundation and food (Ahmed et al., 2004).

Cauliflower (Brassica oleracea) is member of family Brassicaceae (Cruciferae) known as soft vegetable and called cauliflower in England, chou-fleur in French, couveflor in Poland. It originated in Roman times and spread over Italy to European countries. Now over the world, it is being cultivated on 8.12 million acres, with production of 15.3 million tons annually. China is at tope with 303,000 ha cultivation (Dawn, 2007). Being highly nutritive diet and fruit, this vegetable encompass 88.4g water, 3.6g protein, 3.0g sugar, vitamins (pantothenic acid, nicotinic acid, pyridoxine, vitamin B1, vitamin B2, vitamin B9 and vitamin C) along with many essential mineral e.g. Fe, Mg and P etc. but iron and zinc found in trace quantity (Rizvi et al., 2009). It also provides bioflavonoids and flucosinolates after catabolism and also provides glucoraphanin which act as carcinopreventive agent for humanity (Grubenn and Denton, 2004) and it is also appropriate diet for diabetics (Abbas, 2013).

Member of phylum Arthropoda is comprise of 75% insects and they make 66% of 1.5 million known living organisms (Chapman, 2013). They can spent their lives under range of ecological circumstances e.g. peak, plus or negative temperature, humidity and desiccation etc. They show diversity in relation to environment and are prominent part of food web. Though! they may be unsocial, unreserved and communal; while their limited life span, extraordinary fertility and comfort of rising in test center promote their use in biological exploration (Gullan and Cranston, 2010).

Order Diptera is consists of flies representing 128 families with regard to 1,24,000 individuals over the world (Brown, 2001); and word diptera is originated from Greek word "di" denoted as "two" while "ptera" as "wings" so called as two wings or true flies with one purposeful annex (Mayer, 2009a). They are helpful in agro-ecosystem as pollinators and are essential for reconditioning of decay material (Chapman, 2013), but they also act as nuisance, spread dengue and some other infections. Some of them are eminent as plant eater; though! many are dependent on animals for nourishment as their mouth is designed to puncture the cell and get liquid or sap (Mayer, 2009a).

Order Coleoptera is an eminent order and makes 1/3rd of all the identified insects and have more than three million known species over the world (Majumder et al., 2013; Chapman, 2013). Being a leading group of insects, they accorded as environment friendly by virtue of nuisance managing agent (Mayer, 2009b). Mostly, they concentrate on foliage fauna for nourishment because they are easy to access and fruit producing plant support such activities (Chapman, 2013). They get access to their targeted prey by simulating the smell (Mayer, 2009b).

Fleas are the members of order Siphonaptera having 2,000 known species on this planet (Chapman, 2013). "Siphon" and "aptera" are two parts of word Siphonaptera denoted as "tube" and "wingless" respectively (Meyer, 2009c) and only few are found in warm regions of earth because of environmental conditions. They live according to proper host density and more than 90% are external parasites and get nourishment from the blood of animals and birds. Their metamorphic stages rely on the waste and desiccated body fluid host burrow (Anonymous, 2014).

Keeping in view the findings of the previous studies, it is obvious that fauna and flora of an area depend on each other for many aspect of their life. So, the present study was designed to underline the eco-diversity of under reference insect orders on okra and cauliflower vegetables with respect to ecological aspects for managing IPM strategies among these vegetables crop fields in future.

2. Materials and Methods

Study area:

Present research was done to find the "Eco-diversity and Habitation Partiality of order Diptera, Coleoptera and Siphonaptera among okra (*Abelmoschus esculentus* L.) and cauliflower (*Brassica oleracea* L.) fields" under ecological conditions of Gojra (district Toba Tek Singh), Punjab, Pakistan during the session 2014 - 2015. Overall research trails for both vegetables was done from "New 98 plot" located in the north of Gojra city. The selected site is also called as "Ngaa-wala-muraba" owing to the reason that few years ago snakes were common at this place.

Collection and Identification:

The fields of okra and cauliflower were sampled right from the pre-harvest stage to post-harvest stage and invading insects pertaining to selected orders were collected by selecting an area of 100 m^2 of each field by following methods:

• Direct hand picking method
• By using Sweep Net
• By using Forceps

Sampling Techniques

Sampling was done fortnightly from three different sugarcane cultivars selected collection of foliage insect fauna associated with them from an area of 100m^2. Temperature and humidity were also being checked and noted carefully as per objective with the help of digital thermometer and hygrometer respectively. Sampling was done by using sweep net/forceps/direct hand picking technique:

Sweep Netting

Sweep nets were used to capture flying insects (order Diptera) present above the canopy crop. For this purpose the sweep net was stroked and swing through the insect population rapidly to force the insect into the very bottom of net. After completing strokes net was twisted to hang the bottom of net over the rim so that the specimens could not escape. Soft bodied insects were gently removed from the bottom of the net bag.

With the help of forceps and direct hand picking

Small insects were collected by direct hand picking and with the help of forceps. The forceps was used carefully to avoid insect damage.

Moreover, temperature and humidity of area were also recorded to weigh up the ecological relations and collection was made after ten days intervals from these vegetables 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 vial, containing 70:30% alcohol and glycerin solution for further identification.

Identification:

The collected specimens were identified and sorted with the aid of:
 Naked eye
 Magnifying glass
 Microscope

All the specimens were identified up to species level according to the taxonomic/ reference material (Borror and DeLong, 2005, 1992; Pocock, 1990; Holloway *et al*., 1991; Triplehorn and Johnson, 2005; Rafi *et al*., 2005) and available keys on internet.

3. Results and Discussion:

Presently, after completing the entire research trial, total 560 specimens were recorded and identified up to species level from these vegetable fields. Among them, pertaining to order Diptera and Coleoptera, 182 (32.5%) were recorded from Okra and 378 (67.5%) from Cauliflower fields. However, none of the specimen was recorded for order Siphonaptera from both vegetable fields as already endorsed by Chapman (2013), Meyer (2009c), Petrie (2009), Gage (1998), Komar (2003). Wherein significant results were recorded in case of order Coleoptera among these vegetable fields over the entire study period (Fig. 1-2). Furthermore, diversity of any ecosystem depends upon the relative abundance and density of inhabiting taxa in that ecosystem. Presently, relative abundance was recorded maximum in Okra fields for order Diptera (65.93%) and lowest for order Coleoptera (34.07%); whereas in cauliflower fields, maximum relative abundance was recorded for order Coleoptera (69.05%) and minimum for order Diptera (30.63%). Moreover, it was assessed that population of order Coleoptera was recorded high among winter vegetables (Cauliflower) and least population from summer vegetable fields (Okra). Wherein, Dipteran 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 vegetable fields. These observations were quite in-line with the observations endorsed by Gullan and Cranston (2010); Chen and Shelton (2007); Lepage *et al.* (2012).

Comparative relative abundance of each species from each vegetable was recorded heterogeneously (Table 1-2). For example, from Okra fields, maximum relative abundance 69.17% was recorded for *Physiphora alceae* and *P. smaragdina* (Ulidiidae); whereas, least relative abundance (n ≤ 05) was recorded for *Fannia* spp. (Fanniidae), *Musca domestica*, *Hydrotaea dentipes* (Muscidae), *Physiphora* spp. (Ulidiidae) *Chrysomya bezziana* (Calliphoridae), *Dolichopus comatus*, *Drosophila funebris* (Drosophilidae), *Sarcophaga aurifrons* (Sarcophagidae), *Anthrax trifasciatus* (Bembionidae), *Sturmia bella* (Tachinidae). Because, living entities manipulate in turn with contribution of ecosystem variances (Nasir *et al.*, 2011) and abundance of class Insecta among cultivation sites fluctuate in accordance to cultivation system, crop thickness, level of pesticides used, controlling methods, and intensity of biotic and abiotic factors (Forster, 1991; Kremen *et al.*, 1993; Nasir *et al.*, 2011). Whilst, in Cauliflower fields, maximum relative abundance 25.64% was recorded for *Eristalinus aeneus* (Syrphidae), followed by *Liriomyza huidobrensis* (Calliphoridae) 13.68%; however, least relative abundance (n ≤ 05) was recorded for *Calliphora vicina* (Calliphoridae), *Fannia* spp. (Fanniidae), *Dolichopus comatus, Condylostylus* spp. (Dolichopodidae), *Mycodrosophila* spp. (Drosophilidae), *Rhamphomyia albohirta* (Empididae), *Sarcophaga carnaria* and *Sarcophaga* spp. (Sarcophagidae). While, with regard to overall species composition and ecological scenario of cultivation, (35) species were not recorded from Cauliflower field which proves findings of previous studies e.g. Hallet (2007) acknowledged that *Brassica oleracea* was less damaged by Diptera nuisance comparative to other cole vegetables.

Coleopteran was recorded in similar context among Okra and Cauliflower field; because mostly this order proves helpful for crops as acknowledged by Majumder *et al.* (2013) that predatory beetles (Coccinellids) act as biological tool to control plant eating nuisance insects. From Okra fields, their maximum relative abundance 50.00% (n ≥ 31) was recorded for *Myllocerus undatus* (Curculionidae), followed by 14.52% (n ≥ 09) *Brumoides suturalis* (Coccinellidae) and least relative abundance was recorded for *Alcides karelini, Sitona lineatus, Sitona humeralis, Cleonus piger* (Curculionidae), *Cymindis axillar is* (Carabidae), *Cheilomenes sexmaculata, Coccinella septempunctata, Dinocampus coccinellae* (Coccinellidae), *Paederus fuscipes* (Staphylinidae), *Gonocephalum elderi* (Tenebrionidae), *Onthophagus taurus* (Family Scarabaeidae), *Hoplasoma unicolor* (Chrysomelidae) (n ≤ 05). While, rest of the (39) species were not recorded for Okra fields. These results showed similarity to somewhat with Christopher *et al.* (2007) who investigated the coleopteran diversity from shrub forest, pine forest, mixed woodland and post-harvested vegetables, and reported that all sites and post-harvested site showed less species abundance comparative to all woodlands. It was also possible that the population of Coleoptera in these field was disturbed by any of the following factor as mentioned by the Holland and Luff (2000); they endorsed that coleopteran control the number of plants' nuisance insects in all agricultural regions of moderate climate, but a number of physical factor like loam type and its wetness and crop farming influence in determining the population of beetle in field. Furthermore they endorsed, that plowing effects on its population in relation to environmental conditions.

From Cauliflower fields, utmost for order Coleoptera relative abundance 30.27% (n ≥ 79) was recorded for *Psammodes sulcicollis* (Tenebrionidae), followed by 13.79% (n ≥ 36) for *Paederus fuscipes* (Staphylinidae) and least relative abundance (n ≤ 05) was recorded for *Sitona lineatus* (Curculionidae), *Bembidion maritimum, Bembidion petrosum* (Carabidae), *Micraspis discolor Dinocampus coccinellae* (Coccinellidae), *Philonthus rubripennis* (Tenebrionidae), *Cryptophagus pallidus* (Cryptophagidae) and *Maladera castanea* (Scarabaeidae). While, rest of the (24) species were not recorded for Cauliflower field. Among these, family Coccinellidae proved to be helpful for any crop as acknowledged by Majumder *et al.* (2013) that predatory Coccinellids act as biological tool to control plant eating nuisance insects.

Genera level grouping was made to weigh up the overhead protocol and form Okra fields, overall genera abundance of order Diptera was recorded maximum 77.50% (n ≥ 93) for genus *Physiphora* (Ulidiidae); whereas, in Cauliflower fields peak relative abundance 25.64% (n ≥ 30) was recorded pertaining to genus *Eristalinus* (Syrphidae). However, overall genus abundance was moderate in these fields. For order Coleoptera, in Okra field up to genus level abundance was not much convincing due to homogeneity at low level; however maximum relative abundance was recorded for genus *Myllocerus* (Curculionidae) 50.00% (n ≥ 31); whereas, in Cauliflower fields, maximum relative abundance at genus level was recorded for *Sitona* (Curculionidae) 45.52% (n ≥ 183). Satti (2012) acknowledged that beetles act to boost natural means of nuisance management, and to reduce the requirement for pesticides use on ladyfinger and other plant; but many ecological factors also effects occurrences of order Coleoptera. Because, Holland and Luff (2000) have endorsed that physical factor e.g. loam type and its wetness, and crop farming affect the population of beetle in crop fields.

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 field provide a realistic approach (Tillman *et al.*, 2002). Hence, the fundamental issue, relative abundance was again accessed at family level to overcome these aspects. Among total of 21 families recorded pertaining to order Diptera, 12 families were

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recorded among Okra fields. Here, maximum relative abundance was presented for family Ulidiidae 77.50% (n ≥ 93) and thereafter family Muscidae was only recorded with high relative abundance 10.00 (n ≥ 12). While, in Cauliflower fields, overall 15 families were recorded and among them peak relative abundance 29.06 % (n= 34) was observed for family Syrphidae and thereafter family Ulidiidae was only recorded with maximum relative abundance 15.38% (n ≥ 18). Among total of 11 families recoded pertaining to order Coleoptera, 07 families were recorded among Okra fields, 09 in Potato and 10 among Cauliflower fields; while, peak relative abundance 70.97% (n ≥ 44) was recorded for family Curculionidae and 31.42% (n ≥ 82) for family Tenebrionidae from two vegetable fields, respectively.

During present study, the entire diversity indices were documented pertaining to both insects' orders and three vegetable fields. In Okra fields, diversity was recorded highest for the order Coleoptera (0.9596) and lowest for order Diptera (0.0682) and in Cauliflower fields, diversity was recorded in similar context 2.2648 and 0.6731, respectively. Diversity $_{maximum}$ (H_{max}) was recorded highest for order Diptera (2.0792) and minimum for Coleoptera (1.7924) in Okra fields and in Cauliflower fields was also recorded in similar context 2.4216 and 2.0682, respectively. Evenness (E) was recorded maximum for order Coleoptera (0.5353) and minimum for order Diptera (0.0328) in Okra fields; while, in Cauliflower fields it was recorded as (0.9353) order Coleoptera and (0.3254) was recorded for order Diptera. Dominance (D) was recorded maximum for order Diptera (0.9672) and minimum for order Coleoptera (0.4647) in Okra fields; index for Cauliflower fields was as (0.0647) for order Coleoptera and (0.6746) was recorded for order Diptera. Richness (R) was recorded maximum for order Diptera (7.0177) and minimum for order Coleoptera (5.8385) in Okra fields; while, in Cauliflower fields order Coleoptera was recorded as (12.0939) and (10.0989) order Diptera. These findings were again similar as per acknowledgments of Alyokhin *et al*. (2008); Koss *et al*. (2005); Scott *et al*. (2003); Sexson and Wyman (2005).

The results of ANOVA between depending variables (Okra and Cauliflower) and independent variables (Coleoptera and Diptera) were not convincing the imperative status of significance (F= 1.53; P= 0.2175): it was happened owing to large variations pertaining to population density of each taxa. In order to underline the natural, comparative and verified credibility of all these vegetables (Okra and Cauliflower) toward these orders (Okra and Coleoptera), Kruskal-Wallis test was used to further confirm the ANOVA predictions. The results of Kruskal-Wallis test pertaining to rank order of taxa composition and population density were much convincing and significant (F = 4.53; P= 0.0115). These were due to shuffle the orders by their density and population ranks for Kruskal-Wallis Test to attain the most convincing results.

Wilcoxon Rank Sum Test was used to compare the occurrence regarding population dynamics of both orders viz. Diptera and Coleoptera among two vegetables to weigh up the population mean difference; either they are distributed normally or not, as for requirement of Null hypothesis (Richerd, 2011; Frank, 1945; Kerby, 2014). After completing the analysis with regard to both orders, it was observed that in Okra and Cauliflower fields population of both orders was differ significantly (P-value = 0.0007) and (P-value = 0.0014), respectively.

From the overall data presentation and discussion, it is confirmed that findings of present study was analogous as per findings of previous researchers in different areas over the world and sometime diverge situation was faced owing to ecological conditions and skill power of researcher during handling and documenting the data (Gullan and Cranston, 2010; Rana, *et al*., 2006, 2010b; Liiri *et al*., 2002; Schwartz *et al.*, 2000; Tilman *et al*., 1996, 2000, 2002; Chen and Shelton, 2007; Lepage *et al.*, 2012. Nasir *et al.*, 2011; Forster, 1991; Kremen *et al.*, 1993; Majumder *et al.*, 2013; Christopher *et al.*, 2007).

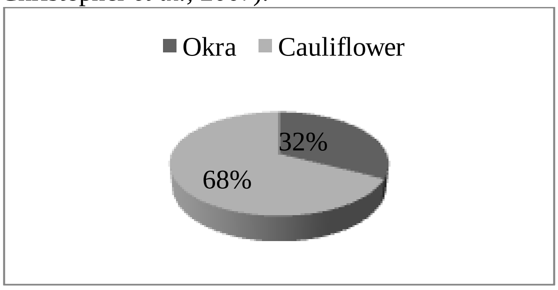

Fig. 1: Overall Relative Abundance of both Orders among two Vegetable Fields

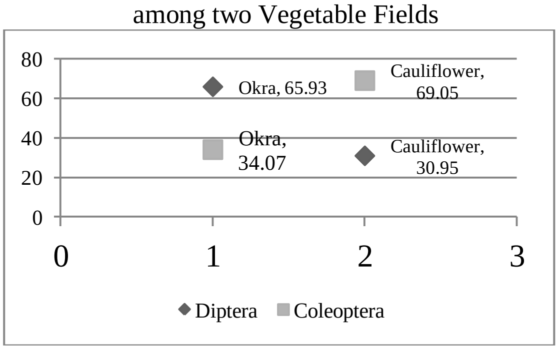

Fig. 2: Comparative Relative Abundance of both Orders among two Vegetable Fields

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Table 1: Comparative Relative Abundance of order Coleoptera in Okra and Cauliflower fields

Family	Species	Relative Abundance (%)	
		Okra	Cauliflower
Curculionidae	*Alcides karelini*	1.61	0.00
	Sitona waterhousei	0.00	0.00
	Sitona cylindricolis	14.52	8.05
	Sitona lineatus	1.61	0.38
	Sitona humeralis	1.61	0.77
	Myllocerus undatus	50.00	3.83
	Cleonus piger	1.61	0.77
	Cleonus exotiques	0.00	0.77
Carabidae	*Bembidion quadrimaculatum*	0.00	1.92
	Bembidion lunatum	0.00	0.77
	Bembidion maritimum	0.00	0.38
	Bembidion guttula	0.00	1.15
	Bembidion petrosum	0.00	0.38
	Calosoma denticolle	0.00	1.53
	Cymindis axillaris	1.61	0.00
	Harpalus pensylvanicus	0.00	8.81
	Ophonus puncticeps	0.00	1.15
Coccinellidae	*Cheilomenes sexmaculata*	1.61	3.83
	Brumoides suturalis	14.52	1.53
	Coccinella septempunctata	1.61	2.68
	Micraspis discolor	0.00	0.38
	Dinocampus coccinellae	1.61	0.38
Leiodidae	*Colenis immunda*	0.00	4.21
Staphylinidae	*Paederus fuscipes*	3.23	13.79
	Megalinus flavocinctus	0.00	5.75
	Philonthus rubripennis	0.00	0.38
Tenebrionidae	*Psammodes sulcicollis*	0.00	30.27
	Gonocephalum elderi	1.61	1.15
Scarabaeidae	*Onthophagus Taurus*	1.61	0.00
	Maladera castanea	0.00	0.38
Chrysomelidae	*Hoplasoma unicolor*	1.61	1.15
	Monomacra violacea	0.00	1.15
Cryptophagidae	*Cryptophagus pallidus*	0.00	0.38
Anobiidae	*Byrrhodes intermedius*	0.00	1.92
Total		**62**	**261**

Table 2: Comparative Relative Abundance of order Diptera in Okra and Cauliflower fields

Family	Species	Relative Abundance (%)	
		Okra	Cauliflower
Piophilidae	*Mycetaulus nigritellus*	1.67	1.71
Syrphidae	*Eristalinus aeneus*	0.00	25.64
	Eristalis tenax	0.00	1.71
	Episyrphus balteatus	0.00	1.71
Fanniidae	*Fannia spathiophora*	2.50	3.42
	Fannia spp.	0.00	0.85
Muscidae	*Musca domestica*	5.83	3.42
	Muscina levida	1.67	0.00
	Hydrotaea dentipes	2.50	0.00
	Hydrotaea irritans	0.00	5.13
	Phaonia subventa	0.00	1.71
	Stomoxys calcitrans	0.00	1.71
Ulidiidae	*Physiphora alceae*	77.50	7.69
	Physiphora aenea	0.00	2.56
	Physiphora smaragdina	0.00	5.13
Calliphoridae	*Chrysomya megacephala*	0.83	4.27
	Calliphora vicina	0.00	0.85
	Chrysomya bezziana	0.00	1.71
Agromyzidae	*Liriomyza huidobrensis*	0.00	13.68
Dolichopodidae	*Dolichopus comatus*	0.83	0.85
	Condylostylus spp.	0.00	0.85
Heleomyzidae	*Amoebaleria spp.*	0.00	1.71
Curtonotidae	*Curtonotum helva*	1.67	1.71
Drosophilidae	*Mycodrosophila spp.*	0.00	0.85
	Drosophila melanogaster	0.83	0.00
Empididae	*Anthepiscopus spp.*	0.00	2.56
	Hilara cornicula	0.00	1.71
	Rhamphomyia albohirta	0.00	0.85
Culicidae	*Culex pipiens*	0.00	2.56
Sarcophagidae	*Sarcophaga carnaria*	0.83	0.85
	Sarcophaga aurifrons	0.00	0.00
	Sarcophaga spp.	0.00	0.85
Asilidae	*Dicolonus spp.*	0.00	1.71
Bembionidae	*Anthrax trifasciatus*	0.83	0.00
Tachinidae	*Sturmia bella*	0.83	0.00
Scathophagidae	*Scathophaga spp.*	0.67	0.00
Total		**120**	**117**

4. Conclusion

It is concluded from the above all discussion that: Ecological conditions i.e. range of temperature and humidity, nature of crop and canopy, agronomic and horticultural practices, very damp and desiccated soil acts as a shield against the occurrence of order Diptera and Coleoptera. However, impacts of climatic changes (temperature and humidity) were not significant over the occurrence of both orders in these vegetable fields.

5. Recommendations

Currently, vegetable sector is facing tremendous challenges by virtue of losses towards production and yield owing to damage induced by insect pests and governing methods and techniques right from pre-harvest stage to post-harvest stage. Therefore, it is recommended that:

- Farming community will be aware regarding the biological, ecological and recreational values of the insect community.
- They must be educated with in-site information about the beneficial and harmful insects of various vegetables and they should be free to adopt the possible strategies regarding the conservation of beneficial insects.

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