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DIVERSITY OF INSECT FAUNA IN CROPLANDS OF DISTRICT FAISALABAD

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Insects are the largest and the most diverse group of organisms. Different crops showed varied responses towards insect populations. Present study was aimed at collection, identification and comparison of species richness, abundance and evenness of insect fauna from four major crops (sugarcane, fodder, wheat and brassica) in District Faisalabad. Sugarcane was the preferred crop by majority of faunal species followed by fodder, wheat and brassica. Maximum diversity of faunal species was found in sugarcane whereas; wheat crop was found to support maximum coleopteran predators and hemipteran pests. Wheat and brassica fauna showed maximum similarity. The insect data of the year 2007-8 was considerably more diverse and abundant than that of 2008-9. Trophic guild showed, phytophagous (175) followed by zoophagous (41), omnivore (27) and saprophagous (23) species. The present insect data base will be helpful in designing future integrated pest management studies.
Keywords: Insect, diversity, sugarcane, fodder, wheat, brassica

INTRODUCTION

Biodiversity is variation of life. In agroecosystems, biodiversity is generally a measure of the relative numbers of types of organisms present. When considering the effects of biodiversity on a system, two concepts are especially important to consider: stability and productivity (Schowalter, 2006). Most agro-ecosystems tend to be highly disturbed. Common practices like tillage, planting, application of fertilizers and pesticides, irrigation, and harvest can cause temporary or longer-lasting changes in average environmental conditions that change the functioning of the ecosystem (Altieri *et al*., 2005). Stability in ecosystems is a measure of resilience, or ability of the system to recover from a disturbance, and the resistance of the system to change (Schowalter, 2006).Agro-ecosystems rich in diversity gain greater resilience and are, therefore, able to recover more readily from stresses. When ecosystems are diverse, there is a range of pathways for primary production and ecological processes such as nutrient cycling, so that if one is damaged or destroyed, an alternative pathway may be used and the ecosystem can continue functioning at its normal level. The best evidence to date that species-rich ecosystems are more stable than species-poor ecosystems, is perhaps offered by Tillman and Downing (1994). If the relationship between biodiversity and stability holds, then it is in the interest of the long-term viability of a region to encourage diverse human and natural ecosystems (Minor, 2005). The objective of the present study was to analyze and evaluate the relative impact of human activities regarding chemical intensification on abundance, richness, and evenness of the insect fauna in the croplands of Faisalabad, since little attention has been paid to the response of insects to human activities in the region. This study will help in learning a great deal about the behaviour and relationships between insects and plants in the fields; it will also help in the management of agro-ecosystems.

MATERIALS AND METHODS

District Faisalabad covers an area of 5,856 sq. km of Central Punjab. Due to heterogeneity of crops and their importance as food crops, use of pesticides and synthetic fertilizers are less intensive in this zone. The district being located in the center was selected to represent agro-ecosystem in mixed crop zone. Fields of sugarcane, fodder, wheat and brassica were selected for study of faunal (predator and preys/pests) species; wheat fields are usually treated with herbicides whereas those of sugarcane occasionally with insecticides.

A survey was made to select the crop fields of sugarcane, fodder, wheat and brassica in Faisalabad (Mixed-crop zone) of Punjab. Study was conducted from June 2007 to May 2009, in the selected fields. For each crop sampling of insect fauna was done for two seasons i.e., for sugarcane and fodder crops from July to December (2007- 2008) whereas, for wheat and brassica from December to May (2008-2009). At each locality two blocks, each of more than five acres of different crops were taken. Then at each block, two acres were selected randomly for collection of fauna. Also, information on current and past management practices in these habitats with specific reference to the use of chemicals and mechanical operations at farms was obtained from the farmers of each locality.

The samples were collected from soil, ground surface and air fortnightly. Sweep net was used to sweep all types of insect fauna present above the canopy. Heavy duty muslin nets (38 cm dimension) were used to sweep through the vegetation forming a figure of eight. Direct hand picking and automated sifters were also employed to collect the foliage fauna. Collection time was three hours. Ground fauna were captured by pitfall trapping method. Twenty-pitfall traps were placed in a field of one acre at regular intervals The pitfall traps used were 15 cm in diameter and 25 cm in depth having about 200 ml of aqueous solution of 10% formalin and were placed in the ground with their openings at the surface level. The openings of the traps were not covered. The traps were kept in the fields for 48 hours. On the prediction of rain, a rain cover was provided. The excavated soil was removed from the site to minimize hindrance. From the trap containing the sample, objects such as leaves, twigs, and vertebrates such as toads, frogs and rats and invertebrates other than insects, that had fallen into the traps were removed. Collection was also done by quadrat method (Bookhout, 1997). One meter square, metallic quadrate one foot deep in the soil was used to collect the subsoil crop fauna. All the insect specimens were washed in 70% alcohol to remove organic debris and were kept in glass bottles with 70% alcohol, with few drops of glycerin. The identification up to species level was done with the help of related taxonomic information in fauna of British India and online available keys on different websites.

Shannon's index of diversity (H′), given in Magurran (1988) was used to determine species diversity, species richness and species evenness. The Multiple linear regression (MLR) was applied to see the correlation of environmental factorX1 (light), X2 (Relative humidity), X3 (rainfall) and X4(wind velocity) and insect fauna. Cluster analysis using, chord distance (CRD) and flexible strategies, with, GWBASIC programs (Ludwig and James, 1988) were applied.

RESULTS

Species Composition and Diversity: The pooled up data of 2007-2009 showed a rich insect fauna comprising 265 (predator and preys/pests) species of insects belonging to 64 families and 7 Orders. Sugarcane had highest number of species followed by fodder, wheat and brassica. Abundance was maximum in wheat (Coleoptera 3274 and Hemiptera 3636 specimens), followed by sugarcane, fodder and brassica (Fig.1). It was also interesting that species richness of Hymenoptera was somewhat similar in four crops and abundance was more in fodder and sugarcane as compared to wheat and brassica. Orthoptera species richness and abundance was more in sugarcane (Table 1).

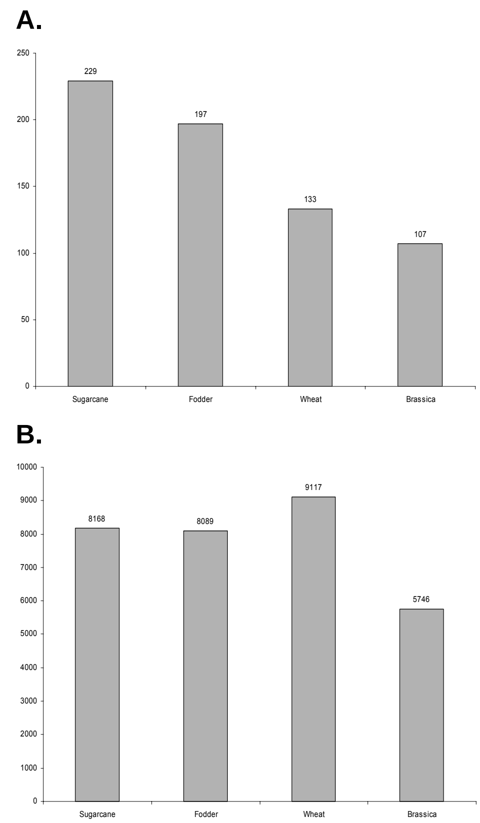

Fig.1. Comparison of species richness (A) and species abundance (B) of insect fauna in four crops MCZ (Faisalabad)

Insect fauna of the year 2007-2008 and 2008-2009 were also compared. Overall the insect fauna of the year 2007-2008 showed high diversity and abundance as compared to 2008-2009. Fauna varied significantly (p<0.001) in Dermoptera, Hemipter*a,* Coleoptera, Lepidoptera, Hymenoptera (Table2).

Effect of environmental factors on crop fauna was analyzed by applying Multiple Linear Regression (MLR). Rainfall effect was pronounced in all the orders except Orthoptera where relative humidity showed marked effect (Table 3).

Table 1. Abundance and Richness of Insect Orders in MCZ (Faisalabad

Orders	Sugarcane	Fodder	Wheat	Brassica	Total
Orthoptera	2592(72)	1705(48)	808(19)	114(6)	5239(76)
Dermoptera	366(13)	212(10)	80(3)	25(3)	683(13)
Hemiptera	1033(18)	1828(18)	3636(15)	2093(14)	4082(27)
Coleoptera	1712(70)	2214(67)	3274(53)	2189(47)	9389(73)
Lepidoptera	496(17)	368(15)	331(12)	308(13)	1386(30)
Diptera	483(12)	250(12)	139(5)	66(4)	938(16)
Hymenoptera	1466(27)	1512(27)	849(26)	951(20)	4778(30)
Total	8186(229)	8089(197)	9117(133)	5746(107)	31083(265)

Species abundance is given in open and species number in parentheses.

Table 2. Comparison of Shannon diversity indices of 2007-2008 and 2008-2009

Order	Faisalabad (2007-2008)						Faisalabad (2008-2009)						*t*-test	*df*	*P-value*
	No.	H'	N1	N2	R	E5	No.	H'	N1	N2	R	E5			
Orthoptera	72.0	3.7	39.4	25.6	8.9	0.6	61.0	3.6	37.4	23.9	7.7	0.6	1.3	>120	0.200
Dermoptera	12.0	2.1	8.6	7.3	1.9	0.8	11.0	1.9	7.0	5.0	1.6	0.7	5.0	>120	0.000***
Hemiptera	25.0	2.4	11.4	7.2	2.8	0.6	25.0	2.4	10.7	6.6	2.9	0.6	7.9	>120	0.000***
Coleoptera	69.0	3.5	32.1	19.5	8.0	0.6	64.0	3.6	38.3	28.3	7.5	7.5	3.3	>120	0.001***
Lepidoptera	29.0	3.0	21.0	17.4	4.1	0.8	23.0	2.8	16.7	13.4	3.5	0.8	6.2	>120	0.000***
Diptera	14.0	2.3	9.9	8.6	2.1	0.8	14.0	2.3	10.0	8.7	2.2	0.9	1.5	>120	0.160
Hymenoptera	28.0	2.6	13.9	9.0	3.4	0.6	28.0	2.7	15.3	10.6	3.5	0.7	3.1	>120	0.002**

P-value for the factors are given ***(****ns:* $p>0.05$,*: $p<0.05$, **: $p<0.01$, ***: $p<0.001$).

Table 3. Multiple linear regression of insect (orders) with environmental factors

Order	Environmental factor				F Ratio	R. Value
	Temp	R, Humid	Rainfall	W. Velocity		
Orthoptera	1.4	43.9	40.7	14.0	14.20	0.983
Hemiptera	28.1	9.8	49.4	12.6	12.88	0.978
Coleoptera	33.5	9.4	50.0	7.1	13.43	0.947
Lepidoptera	25.4	9.7	52.0	12.8	7.44	0.908
Diptera	24.3	8.6	35.1	31.9	2.82	0.790
Hymenoptera	4.6	27.0	59.7	8.7	20.81	0.965
Dermaptera	8.5	10.2	72.8	8.6	27.67	0.974

Grouping of insect fauna (orders) on the basis of similarity in species richness and abundance is depicted in the form of dandrograms in Fig.2. Wheat and brassica were closely clustered for Hemiptera, Coleoptera, Lepidoptera, Diptera and Hymenoptera indicating maximum faunal similarity. Entirely different trend was observed for Dermoptera where sugarcane was closely grouped with fodder.

Trophic Guilds: Insect fauna recorded were assigned to guilds based on food habits. Accordingly, five arthropod guilds were identified (Table 4). 175 species of phytophagous insects were recorded. The phytophagous guild was dominated by Orthoptera (70 spp.) followed by Coleoptera (31 spp.), Lepidoptera (30 spp.), Hemiptera (22 spp.), Diptera (9 spp.) and Hymenoptera with 8 species. Maximum abundance of phytophagous insects was in wheat (5276 specimens). Predators were represented by 33 species where Coleoptera were the dominant predatory group with 24 species followed by Hemiptera with 5 species and Dermoptera with 4 species. Predators were abundant in wheat (2276 specimens). The Omnivore guild contained 26 species, dominated with Hemiptera with 18 species and Orthoptera and Dermoptera with 4 species each. The scavenger/decomposer guild contained (23 spp.), dominated by Order Coleoptera, with 18 species, followed by Orthoptera and Diptera with 2 species each and Dermoptera with one species. The parasitoid guild contained 4 species each of Diptera and Hymenoptera. The overall species composition reflects a high richness of insect

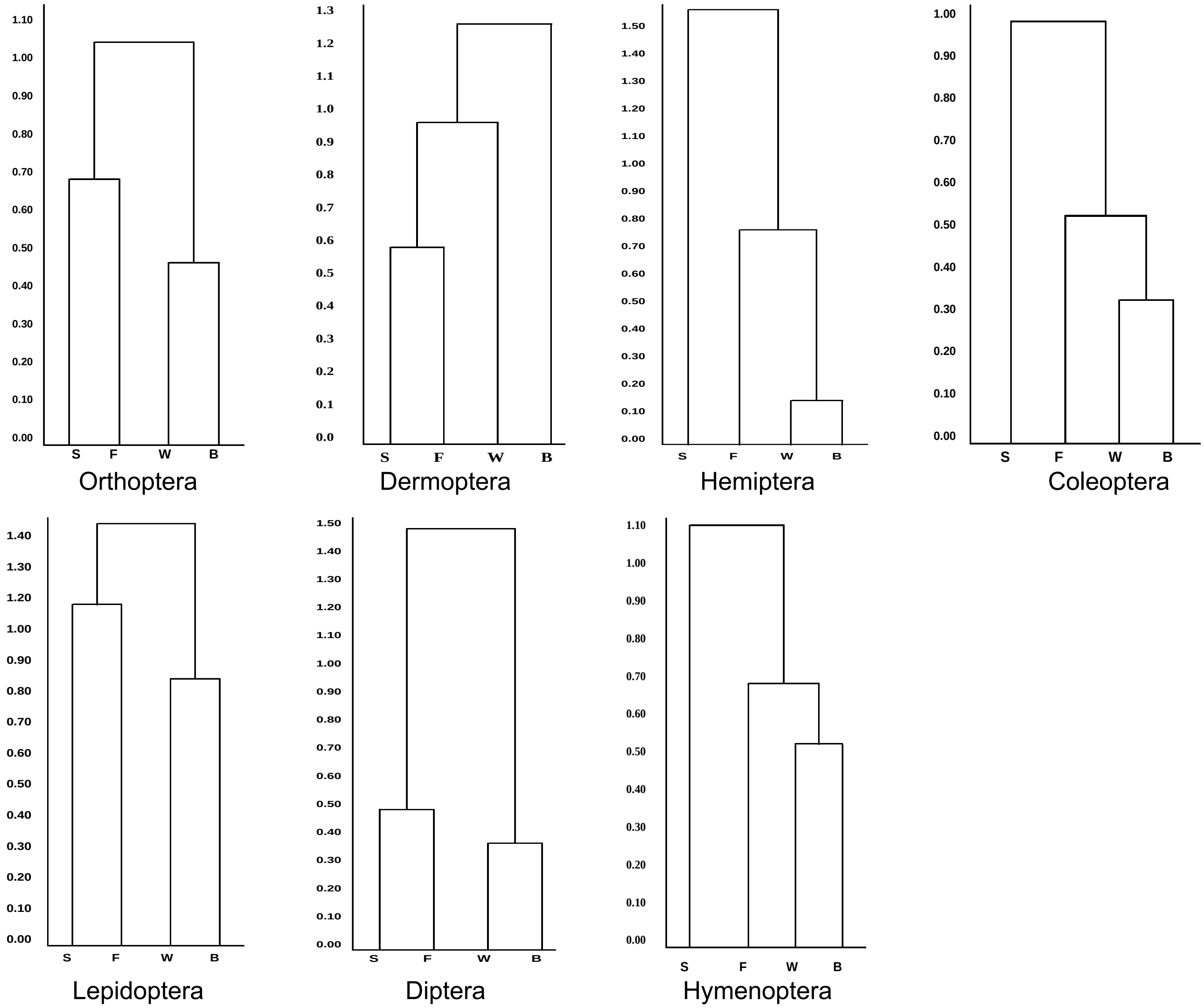

Fig.2. Dendrogram for cluster analysis of fauna in Insect orders of four croplands using Chord and flexible strategy (S- Sugarcane, F- Fodder, W- Wheat, B- Brassica)

Table 4. Abundance and Richness of Trophic guilds (Insects) in four Crops of MCZ (Faisalabad)

Trophic Structure	Sugarcane	Fodder	Wheat	Brassica	Total
Phytophagous	5086(144)	4614(121)	5276(75)	2844(56)	17820(175)
Predator	780(31)	1344(27)	2276(24)	1654(22)	6054(33)
Parasite	252(6)	151(7)	100(5)	61(3)	564(8)
Omnivore	1457(26)	1336(21)	648(17)	761(11)	4165(27)
Phytozoosaprophagous	482(18)	372(17)	745(8)	311(9)	1873(19)
Zoosaprophagous	6(1)	8(1)	3(1)	6(1)	23(1)
Phytosaprophagous	35(3)	30(3)	6(2)	5(1)	3(1)

Species abundance is given in open and species number in parentheses.

pests\prey species in comparison with natural enemies (predators and parasitoids). Sugarcane's trophic structure was most complex followed by fodder wheat and brassica.

DISCUSSION

This study highlights the richness of the insect fauna comprising 31083 specimens belonging to 256 species associated with cropland agro-ecosystem in Central Punjab (Faisalabad) representing mixed crop zone. Diversity indices for sugarcane fauna was highest followed by fodder, wheat and brassica, respectively. The probable reason is that sugarcane crop is available round the year in the field and the phytomorphic heterogenicity in this crop due to lesser use of chemicals especially weedicides. However, excessive use of insecticides was recorded on other crops.

Diversity indices recorded during the year 2007-2008 were higher, for almost all orders of insects (251 species), as compared to the year 2008-2009 (226 species). It might be attributed to rainfall which was low during 2008-2009, thus effecting temperature, residual effect of fertilizers, insecticides, weedicides and other environmental factors. Cartea *et al.* (2009) studied Lepidopteran pests of brassica in Spain for six years and reported change in pest populations with change in environmental conditions.

Multiple Linear Regression (MLR) analyses showed the effect of environmental factors on different orders of insect fauna. Rainfall effect was pronounced in all the orders except Orthoptera where relative humidity showed marked effect This finding coincides with that of Siddiqi (2005) who related higher relative humidity effect to the emergence of oligochaetes.

Cluster analysis indicated maximum faunal similarity in wheat and brassica and also in sugarcane and fodder was probably because both grew in the same season and were subjected to similar environmental conditions and resulted in similar faunal distribution.

The guild structure of the insect fauna further emphasize the importance of the phytophagous (175 spp., 66%) that outnumbered the predators (33 spp., 12.45%) and parasitoids (8 spp., 3%) Thus, the natural enemies accounted for nearly 15.47% of the insect taxa collected. The composition of the cropland insect fauna while highlighting the high biodiversity in a polyculture crops, indicated instability of the cropland agroecosystem of MCZ in the coming years with respect to pests and natural enemies.

The effect of pesticide use on insect pest populations and their natural enemies were clearly evident from this study. Phytomorphic heterogeneity in the crops results in increase in faunal diversity. Wheat has less insect diversity due to regular use of weedicdes, which results in reduction of weeds in the crop, whereas in sugarcane use of insecticides is very less has greater phytomorphic heterogeneity and more diversity of insects. Compared to the predators, the faster recovery of insect pest populations after a pesticide induced reduction suggests that pesticides cause substantially higher mortality to predators than to pests. The reduction of arthropod natural enemies and the resurgence of pest insects due to indiscriminate pesticide use have been emphasized by many researchers (Kiritani, 1979; Pingali and Roger, 1995; Pingali and and Gerpacio, 1997; Chelliah and Bharathi, 1994).

Heong *et al*. (1991) stated that besides the immediate environment, cropping patterns and cultivation practices, arthropod communities may vary with the crop varieties planted. However, during the present study, the influence of different crop varieties on the diversity of insect during two consecutive crop cultivation seasons of each crop was evident. The changes in the arthropod community in croplands appear to be largely governed by ecological changes that thrusted upon the agro- ecosystem by the agronomic practices essential to cultivation.

In conclusion, the study highlights the fact that the composition and structure of the insect communities in a croplands are characterized by a high turn over of species, rapid waves of colonization, presence of species well adapted to specific niches, presence of species tolerant to short lived, but drastic physical changes in the fields The findings also highlight the existence of unstable relationships between the insect pests and their insect natural enemies, under moderate biocide application. The populations of insect natural enemies in croplands could be conserved and enhanced through the maintenance of a rich weed flora during the fallow period, management of weed communities through partial slashing, and by minimal use of biocides when needed, to avoid economic damage by specific insect pests. Natural biological control which maintains the diversity and integrity of this man-made agro-ecosystem should be given prime importance in deciding environmentally safe and effective integrated pest management strategies. The role of biodiversity in the dynamics and management of insect pests of croplands highlighted by Way and Heong (1994) is further substantiated by the present study.

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REFERENCES

Altie Altieri, M., Nichols, C.I., Fritz, M.A. 2005. Manage insects on your farm: A guide to ecological strategies. Sustainable Agriculture Network Hanbook Series Book 7.

Bookhout, T.A. 1996. Research and Management Techniques for Wildlife and Habitats. Maryland: The Wildlife Society. pp740

Cartea, M.E., G. Padilla, M. Vilar amd P. Valesco. 2009. Incidence of the major Brassica Pests in Northwestern Spain. J. Econom. Entomol. 102:767-773.

Chelliah, S. and M. Bharathi. 1994. Insecticides management in rice. In: E.A. Heinrichs (Ed.) Biology and management of rice insects. Wiley Eastern Ltd., India and IRRI, Manila Philippines. pp.657-680.

Heong, K.L., G.B. Aquino and A.T. Barrion. 1991. Arthropod community structure of rice ecosystems in the Philippines. Bull. Ento. Res. 81:407-416.

Kiritani, K. 1979. Pest management in rice. Annual Review of Entomology 24:279-312.

Ludwig, L.A. and F.R. James. 1988. Statistical Ecolog: A Primer on Methods and Computing. A Wiley-International Publication, New York.

Magurran, A.E. 1988. Ecological Diversity and its Measurements. Princeton University Press, New Jersey. pp.34-37.

Minor, M. 2005. Soil biodiversity under different land uses in New York State. The SUNY College of Environmental Sciences and Forestery in Syracuse, Moscow State University.

Pingali, P.L. and P.A. Roger. 1995. Impact of pesticides on farmer health and rice environment. Kluwer academic publishers & IRRI, Philippines.

Pingali, P.L. and R.V. Gerpacio. 1997. Living with reduced insecticides use for tropical rice in Asia. Food Policy 22:107-118.

Tillman, D. and J. Downing. 1994. Biodiversity and stability in grasslands. Nature 367:363-365.

SchS Schoowalter, T.D. 2006. Insect ecology: An ecosystem approach. 2nd edition. Academic Press. Burlington, MA.

Siddiqi, M.J.I. 2005. Studies on the biodiversity of invertebrates in the wheat (*Triticum aestivum*) farm agroecosystems of Punjab (Pakistan). Ph.D. Theses, University of Agriculture, Faisalabad pp.108.

Way, M.J. and K.L. Heong. 1994. The role of biodiversity in the dynamics and management of insect pests on tropical irrigated rice. Rev. Bull. Ento. Res. 84: 567-587.