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DIVERSITY AND ABUNDANCE OF LEPIDOPTERAN POPULATIONS FROM SELECTED CROPS OF DISTRICT FAISALABAD, PAKISTAN

Sadia Maalik[1,*], Shahnaz Akhtar Rana[1], Hammad Ahmad Khan[1], and Muhammad Ashfaq,[2]

[1]Department of Zoology and Fisheries, University of Agriculture Faisalabad ;
[2]Department of Agri-entomology, University of Agriculture Faisalabad
[*]Corresponding author's email :Sadiacheema74@gmail.com

Lepidopterans are represented by one of the most diverse group of insects. They are phytophagous as well as pollinators at the same time. During present study four crops i.e Wheat, Fodder, Brassica and Vegetables were sampled to assess the diversity and abundance of Lepidopteran populations. A total of 2811 specimens belonging to 14 species and 6 families were recorded. *Pieris brassicae* (29.46%) was the dominant species followed by *Trichoplusia ni* (19.28%), *Helicoverpa Zea* (11.78%), *Helicoverpa armigera* (11.60%), *Spodoptera exigua* (6.65%), *Psedoplusia includes* (5.09%), *Spodoptera litura* (3.81%), *Agrotis ipsilon* (4.87%), *Plutella xylostella* (2.92%), *Lymatria dispar* (2.24%), *Pieris rapae* (0.92%), *Galleria mellonella* (0.71%), *Evergestris rimosalis* (0.53%) and *Menduca sexta* (0.14%). Significant differences were observed among different crops by applying Shannon Diversity Index and T- test. CA (Cluster analysis) represented the species association with different crops. Majority of the species showed association with Vegetables and Fodder and least association was observed with Wheat. Such types of studies are necessary to design integrated pest management programs to control these pests.

Keywords: Lepidoptera, cropland biodiversity, Faisalabad.

INTRODUCTION

Ecosystem stability appears as a result of interactions among groups of interdependent species which co-ordinate in many ways (Tilman, 2000). Biological diversity is represented at all levels it may include diversity within an ecosystem, species, population and by individuals. In an interconnected ecosystem there is division of labor as different species perform different functions such as, supply of food and recycling of nutrients, water and energy. In such type of interdependent systems, loss of even a single species can profoundly affect functioning of the whole system (Cardinale *et al.,* 2006).

Photosynthesis is directly related with the net primary production. The herbivores decrease photosynthesis and cause decrease in production. They may cause damage from 5-30% (Mattson and Addy, 1975) or it may range up to 70% in terrestrial ecosystems in case of insect outbreaks (Cry and Pace, 1993). Lepidopterans are main problem to gain crop production. The loss caused by these may range up to 5-73% under different environmental conditions (De Groote, 2002; De Groote *et al*., 2002). Diversified nature is being exhibited by Lepidopteran as they act both as pest and pollinators for crops (Zahoor *et al*., 2003). Activities of caterpillars became reason for their economic importance. They possess chewing type mouth parts and are among greatest pests of world (Price *et al*., 1996). These include a large number of most important pests of cultivated crop, fruit trees and agro-forests (Holloway *et al*., 1987). The larvae at early stage feed on leaves and at later stage bore into stem (Perez and Schulthess, 1998). Host plants are very important for increase and outbreaks of phytophagous insect pests (Umbanhowar and Hastings, 2002). Wheat is the main food crop of nation (Zulfiqar and Chishti, 2010) and vegetables are used as main supporting dish containing many micro nutrients, necessary for maintenance of health and prevention from diseases (Grivette and Ogle, 2000). While brassica is main source of edible oils (Ali and Rizvi, 2007) and along with other fodders act as food for livestock. Pest management of such important crops is certainly desirable to contribute to the economy. Lepidoptera is an order of pest of economic importance. To control such type of pests different method (Cultural, Chemical, biological) are being applied. These are being controlled by biological control agents who kill them ultimately (Greathead, 1986; LaSalle and Gauld, 1993; Godfray, 1994; Hawkins and Sheehan, 1994; Greenberg *et al*., 2001). Work has been carried out for its diversity and abundance from agro-forest area (Zahoor *et al*., 2003). Research has been carried out for Arthropod cropland biodiversity (Siddiqi, 2005; Rana *et al*., 2010; Ruby *et al*., 2011; Inayat *et al.*, 2012) from Punjab but no specific work has been carried out for assessing the diversity and abundance of these pests from cropland of Faisalabad. Without determining the diversity and abundance no methods to control these pests can be used effectively. Keeping in view the present study was conducted. .

MATERIALS AND METHODS

Faisalabad is geographically located in central Punjab, Pakistan. Maximum of more than 50°C temperature during summer and minimum of -1°C. Average rainfall recorded during 2010-11 was 400 mm that was found maximum during the months of July and August. Due to climatic conditions soil is suitable for cultivation of Rabi and Kharif crops. To assess the diversity and relative abundance of lepidopterans sampling was carried out from June, 2010 to May, 2011 from four crops viz., Fodder, Brassica, Vegetables and Wheat from different localities of district Faisalabad ranging 15-20 Km from University campus**.** A preliminary survey was conducted throughout the sampling area to assess the availability of crops. From selected area fortnightly sampling site was selected randomly.. During each sampling two fields of each crop were selected randomly from an area of 2.5 hectare. At least 4 quadrates comprising an area of 1m sq. were selected from each of crop field, randomly two from edge and two from the center. All plants of crop and weeds were counted and related fauna was captured from prescribed quadrate. Different collection methods were used such as hand picking, with the help of forceps and with the use of hand nets to collect samples from selected quadrates (Inayat *et al*., 2012). Samples collected during each sampling were shifted into vials having 70% alcohol as preservative. Each vial was labeled with Date, locality, no. of specimens, Macro-habitat and Micro-habitat. After shifting data into lab the samples were washed with tap water and again preserved into 70% alcohol with few drops of glycerin to avoid brittleness. Data was identified up to species level by using available taxonomic information from Fauna of British India Talbot (1978), Borror and Delong (2005), further confirmed by electronic keys available at different web sites. Museum of the Department of Agri. Entomology, University of Agriculture Faisalabad and Ayube Agriculture Research Institute Jhang road Faisalabad were also consulted for this purpose.

Statistical Analysis**:** Shannon's Diversity Index (Magurran, 1988) was applied to calculate diversity (H'), richness (D) and evenness (E). While differences in diversity among selected crops was compared by t-test. CCA was applied to check the effect of different environmental factors on distribution of lepidopterans (Rana *et al*., 2010). Cluster analysis was applied by using Statistica version 9 to investigate the habitat preference of lepidopteran populations (Ruby *et al*., 2011).

Per Quadrate Number **:** Per quadrate numbers were calculated by dividing number of specimen/specimens belonging to Lepidoptera with total number of quadrates per sampling from selected crops.

RESUTS AND DISCUSSION

Crop Wise Distribution: A total of 2811 specimens belonging to six genera and 14 species were recorded from all the four crops throughout the sampling duration. Fig.1 shows relative abundance of all the lepidopteran species recorded during study. *P. brassicae* was dominant species with 29 % specimens from all crops with 63% share in Brassica, 27% in Vegetables, 13% Fodder and 3% Wheat. Pajmon (1999) listed a total of 38 insect crop pest and rendered *P. brassicae* as one of the most damaging pest causing damage to all parts of crop plants (Schan and Gangwar, 1980; Lal and Ram, 2004; Younas *et al.,* 2004). *T. ni* (19%) was second abundant species with 28% contribution in Fodder, 17% in Brassica, 13% in Vegetables and 5% contribution in Wheat. *H. armigera* and *H. zea* (12 %) each were recorded 21% and 17% from Vegetables, 16%, 11% from fodder respectively. *H. armigera* a pest of economic importance and is being reported from Okra, Tomato and Cotton from Pakistan (Ahmad *et al*., 1998). *S. exigua* with 7% specimens in all data were recorded from fodder vegetable, brassica and Wheat. These results also coincide with the report which indicated that *S. exigua* as a pest of more than 120 plant species. *A. ipsilon* was abundant from wheat 54% followed by fodder (8%) while it showed 5%age as a whole, *S. litura* (4 %), *L. dispar* and *P. xylostela* (2%) each, *E. rimosalis* and *P. rapae* (1%) each (Figure, 1).

Shanon Diversity Index: Data was subjected to statistical analysis by applying Shanon diversity index (Magurran, 1988). Table 1 represents diversity index. Significant results were there for diversity, evenness and dominance (at $p<0.001$) it was further confirmed by applying t-test. Results were found t highly significant among crops. Hooks *et al*. (2006) also reported significant differences in diversity and abundance of larvae of Lepidoptera between inter-planting systems.

Cluster Analysis**:** Habitat preference was investigated by applying Cluster analysis with the software Statistica using version 9. Interestingly many different clustering patterns were observed as majority of the species showed association with Vegetables and fodder and least association was observed with Wheat (Figure, 2).

Per Quadrate Number: Table 2 shows per quadrate number of different species of Lepidoptera from district Faisalabad. A total of eight quadrates of each crop were sampled during a sampling and sixteen quadrates in a month. Total of 192 quadrates were sampled from each of vegetable and Fodder crops. Overall per quadrate number remained 5.31 for vegetable crops with maximum per sweep number for *P. brassicae* (1.45) followed by *H. armigera* (1.09), while least for *E. rimosalis* (0.01).

Table 1. Shannon diversity indices of four crops. P value for test of factor are given. (ns: p>0.05, *: p< 0.05, **: p< 0.01, ***: p< 0.001,)

Type	N1	H/1	E1	N2	H/2	E2	*t-test*	Df	P-value
Fodder vs Brassica	1048	2.115	0.882	649	1.223	0.6285	18.763	>120	<0.0001***
Fodder vs Wheat	1048	2.115	0.882	44	1.55	0.8651	5.266	<120	<0.0001***
Fodder vs Vegetables	1048	2.115	0.882	1018	1.913	0.8308	6.554	>120	<0.0001***
Brassica vs Wheat	649	1.223	0.6285	44	1.55	0.8651	2.885	>120	<0.001**
Brassica vs Vegetables	649	1.223	0.6285	1018	1.913	0.8308	14.419	>120	<0.0001***
Wheat vs Vegetables	44	1.55	0.8651	1018	1.913	0.8308	3.379	>120	<0.001**

Table 2. Per quadrate number of different species of Lepidoptera from selected crops

Species	Wheat	Fodder	Vegetables	Brassica
Spodoptetra exigua	0.053571	0.395833	0.33333333	0.320313
Spodoptera litura		0.276042	0.10416667	0.265625
Trichoplusia ni	0.044643	1.494792	0.71875000	0.875000
Pseudoplusia includes	-	0.182292	0.44791667	0.171875
Evergestis rimosalis	-	0.072917	0.00520833	-
Helicoverpa zea	-	0.843750	0.88020833	-
Helicoverpa armigera	-	0.604167	1.09375000	-
Pieris brassicae	0.026786	0.729167	1.44791667	3.179688
Pieris rapae	-	-	0.13541667	-
Lymantria dispar	0.053571	0.130208	0.10937500	0.085938
Plutella xylostella	-	0.281250	0.03125000	0.171875
Gleria melonella	0.178571	-	-	-
Menduca sexata	0.035714	-	-	-
Agrotis ipsilon	0.455357	0.447917	-	-
Total	**0.848214**	**5.458333**	**5.30729167**	**5.070313**

Table 3. Temporal distribution of different families of Lepidoptera from crops

Lepidopteran **(Families)**	**%Relative Abundance**				
	Summer	**Autumn**	**Winter**	**Spring**	**Total**
Noctuidae	50 (26)	84.56 (241)	62.78 (415)	60.18 (1091)	63.07(1773)
Pieridae	5.77(3)	4.21(12)	28.59 (189)	35.85(650)	30.38 (854)
Pyralidae		2.11 (6)	0.61 (4)	0.50 (9)	0.68 (19)
Lymantridae	42.31 (22)	5.97 (17)	2.42 (16)	0.44 (8)	2.24 (63)
Plutellidae	1.92(1)	3.16(9)	4.84 (32)	2.21 (40)	2.92 (82)
Sphingidae	-	-	0.76 (5)	0.83(15)	0.71 (20)
Total	**1.85 (52)**	**10.14(285)**	**23.52 (661)**	**64.50 (1813)**	**100 (2811)**

No. in brackets shows original no and outside shows %age relative abundance of different families of Lepidoptera

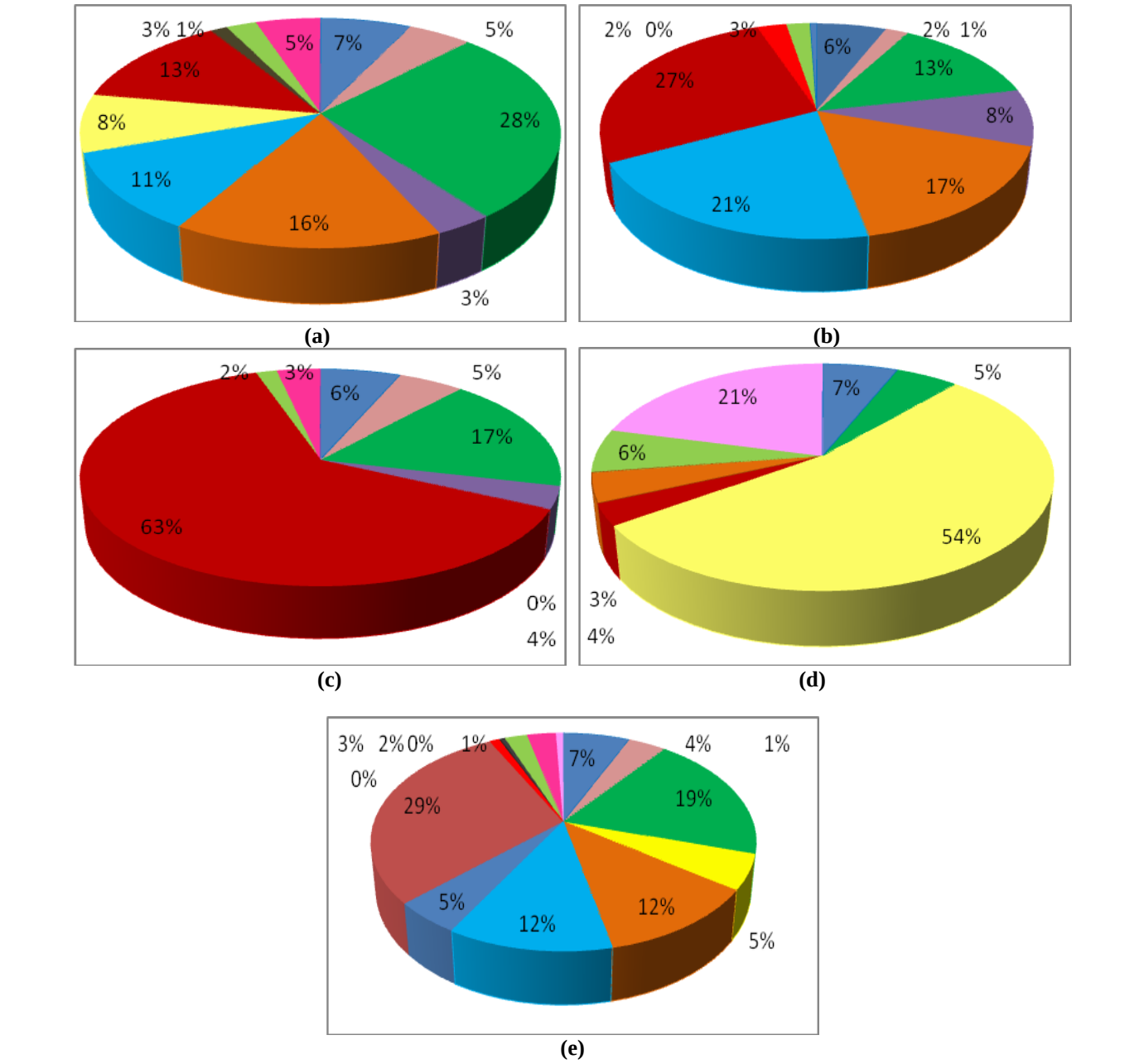

Figure 1. Graphs showing the percentage relative abundance of Lepidopterans in (a) Fodder, (b) Vegetable, (c) Brassica, (d) Wheat and (e) Overall of all crops

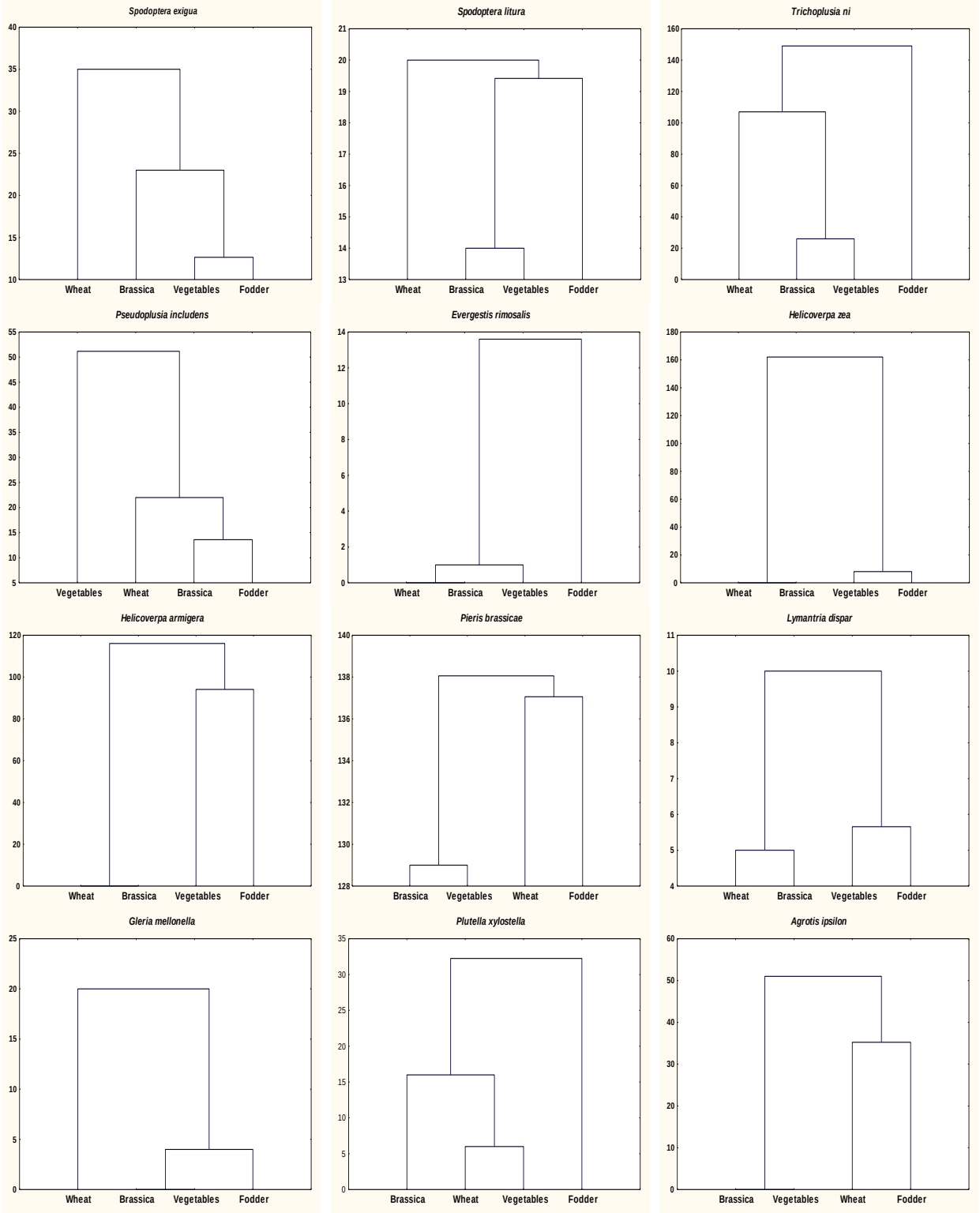

Figure 2. Cluster analysis based on Euclidean distance showing habitat preferences by Lepidopteran populations.

From fodder crops overall per quadrate number was calculated as 5.46 with Maximum 1.49 for *T. ni* and minimum 0.07 for *P. xylostella*. From Brassica crop a total of 128 quadrates were sampled. Overall per quadrate ratio was calculated as 5.07. Maximum per quadrate ratio was calculated 3.18 for *P. brassicae* followed by 0.88 for *T. ni*. From 112 quadrates of Wheat crop overall 0.84 per sweep ratio was calculated.

Temporal Distribution of Lepidopterans: Lepidopteran populations were recorded minimum during summer 1.85 % of the total data from which 50 % were members of Noctuidae, 43.31 % of Lymantridae, 5.77 % of Pieridae, and 1.92% of members of Plutellidae. In autumn 10.14 % of the total Lepidopteran data was recorded and among them 84.56 % were of Noctuidae followed by 5.96 % Lymantridae, 4.21% of Pieridae, 3.15 % of Plutellidae, and 2.11 % of Pyralidae. Similar kinds of results were reported by Tayyib *et al.* (2005) while working on agro forest area of Faisalabad. During winter 23.51 % of total Lepidopteran data was sampled while spring was most abundant season for Lepidopteran populations as 64.50% of lepidopteran fauna was sampled. It may be due to temperature suitability of spring season for these pests as Mbapila *et al*. (2002) also considered temperature a primary factor for development and mortality of Lepidopterans.

***Canonical Correspondence Analysis*:** CCA was performed on Lepidopterans collected from four crops to check the effect of environmental factors like temperature, Humidity, Rainfall and Wind speed by using MVSP software (version 3.13 f). Most of the species showed strong association with Temperature, Relative humidity and wind speed (Fig.3). Temperature significantly effects Lepidopteran development time and mortality (Berg, 1989; Mbapila *et al*., 2002).

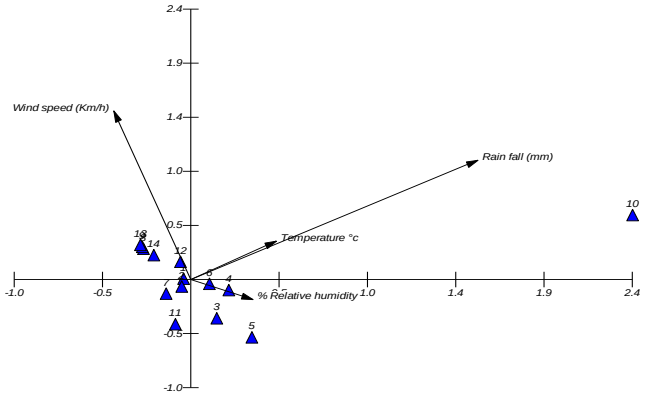

Figure 3. Canonical corresponding analysis showing effect of meteriological factors on species distribution of Lepidoptera in Faisalabad (1. *S. exigua*, 2. *S. litura*, 3. *T. ni*, 4. *P. includes*, 5. *E. rimosalis*, 6. *H. zea*, 7. *H. armigera*, 8. *P. brassicae*, 9. *P. rapae*, 10. *L.dispar*, 11. *P. xylostella*, 12. *G. mellonella*, 13. *M. sexta*

Conclusions: Maximum relative abundance of lepidopteran fauna was recorded from Fodder crops followed by Vegetables and Brassica while Wheat was least effected crop by these pests. The most abundant species of this pest group was *P. brassicae*. Temperature was the main factor which supports their growth and development such types of studies are very necessary for designing control programs for crop pests.

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