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DIVERSITY AND ABUNDANCE OF SOIL MACROFAUNA IN WHEAT FIELDS WITH LOW AND HIGH INPUT OF FERTILIZERS

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ABSTRACT

The diversity and abundance of soil macrofauna under different plant covers can indicate the health and fertility of the soil because they are considered a rich source for improving the nutritive status of the soil through decomposition and scavenging of the organic material in the soil. The study was conducted to deal with the exploration of soil macrofauna for a period of six months extending from January through June 2022 in Faisalabad. Two locations of choice were selected where high- and low-input crop fields were present. One was from Ayub Research Institute, Faisalabad, high-input (HIP) crop fields (cultivated with intensive farming using pesticides and synthetic fertilizer), and the other from Gatti near Faisalabad, low-input (LIP) crop fields (cultivated with relatively low doses of synthetic fertilizers and mostly using organic manures) to study the diversity and abundance of soil macrofauna in wheat fields. A total of 81 specimens were picked up and identified as belonging to 12 orders, 23 families, and 41 species. Orders were Collembola (01 specimen), Diplura (01), Orthoptera (01), Dermaptera (02), Isoptera (04), Coleoptera (03), Diptera (05), Lepidoptera (03), Hymenoptera (30), Pulmonata (17), Oligochaeta (04) and Isopoda (11). Low-input crop fields showed 25 different species with 35 specimens, while high-input crop fields also showed 25 different species with 46 specimens. The Shannon-Weiner index indicated higher diversity in LIP crop fields (H= 3.04) than in HIP crop fields ((H' = 2. while higher abundance was found in HIP crop fields. In conclusion, research on the variety and quantity of soil macrofauna in wheat fields with different fertilizer inputs is important from a socioeconomic standpoint because it has the potential to improve agricultural production, sustainability, and the general well-being of communities that depend on agriculture.

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INTRODUCTION

Wheat amongst crops is a well-recognized staple food, providing a remarkable portion of the world's caloric intake and playing a vital role in global food security, especially in regions like North America, Europe, the Middle East, and South Asia. It serves as the primary ingredient in various staple foods, including bread, pasta, and noodles (FAO, 2019). It is a cereal grain that belongs to the grass family and is cultivated for its edible seeds. It is the most notable carbohydrate in a majority of countries, and, globally, it is the leading source of vegetal protein in human food, with a protein content of about 13%, relatively high as compared to other major cereals. Wheat, as a whole grain, is also considered an origin of micronutrients and dietary fiber, most minerals, vitamins, and fats (lipids), and a small amount of animal or legume protein to make it highly nutritious (Sarwar *et al*., 2013; Lafiandra *et al*., 2014; Shewry & Hey, 2015).

Increasing crop production requires a comprehensive understanding of the soil, its associated environment, including floral and faunal balance, and other physical factors involved in boosting yield. The soil invertebrate fauna is known to play a significant role and occurs in three different forms, i.e., micro (nematodes and protozoans), meso (mites and springtails), and macro (earthworms, beetles, and termites). All these organisms contribute directly to the soil through the release of mineralized nutrients in their excreta. Soil invertebrate macrofauna has both beneficial (saprophagus, necrophagus, or predators) as well as harmful (phytophagus) forms (George *et al*., 2001). They play an integral role in the cycling of organic matter and associated nutrients that physically alter soil structure through movement (Belnap and Susan, 2001; Wolfe, 2005; Jouquet *et al.,* 2014). Thus, maximum retention of invertebrate biodiversity in different covers of soil is beneficial to biotic communities.There is no doubt about the importance of biodiversity for organic agriculture system stability; the strategy of plant protection is exemplary. Adoption of control measures has a direct and indirect influence on organic pest and disease management. Wyss *et al.* (2005) lodged a visionary model for arthropod pest management for organic crop production. Indirect methods are to be considered early in the adoption process, followed by more direct and curative measures as needed. Application of manure and crop rotations within organic farmland accelerates greater species diversity and abundance for insects, plants, and soil macrofauna, although some taxa will not be significantly affected (Fuller *et al.,* 2005; Gabriel *et al.,* 2007). A prevailing situation in biodiversity may be habitat diversity in contrast to management practices (Weibull *et al.,* 2003). The diverse range of organisms and their functions in the soil combine to produce diversity in biogenic soil structures to regulate soil physical properties and nutrient cycles, further anchoring ecosystem services that help to increase heterogeneity in soils and the soil ecosystem's resilience and resistance to ecological disequilibria (e.g., pest outbreaks, degradation). Moreover, various representatives of the soil macrofauna have also come up as bio-indicators of healthy soil sustainability (Pankhurst *et al.,* 1997; Paoletti, 1999; Bardget and Putten, 2014; Mueller *et al*., 2016).

Pesticides can cause detrimental effects on non-target organisms before converting into harmless compounds, so their persistence in the soil is a key factor in influencing soil inhabitants. The movement of pesticides through soil was reviewed by Flury (1996). Effects of pesticides have been observed and analyzed as various responses by soil biota, such as 1) soil macrofauna, either an explicit direct response or an indirect secondary response to pesticides. 2) Pesticides may have detrimental effects only on certain organisms. 3) Some pesticide residues apparently do not show ill effects even though they accumulate in the tissues of some soil organisms; and 4) certain sensitive species are killed when exposed to acute or chronic application of biocides. It is obvious from all cases that the use of pesticides can modify the structure and function of soil communities (Dindal, 1980; Uwizeyimana *et al*., 2017).

Macrofauna includes the following orders: Gastropodes, Lumbricidae, Arachnids, Isopodes, Myriapodes, Dipterans, Lepidopterans, Coleoptera, etc. They feed on the soil organic matter, surface microflora, and macrofauna. They have the ability to move through the porous soil and therefore affect soil porosity, water, and air flow. The present study was aimed at confirming and adding some new information with respect to the soil macro-faunal diversity and abundance in the two contrasting wheat fields with respect to fertilizers. Thus, the objective of the present study was authenticity, showing that there was diversity and abundance in the macrofauna collected from the two wheat fields of different chemical inputs.

MATERIAL AND METHODS

To study the diversity and abundance of soil macrofauna in wheat fields, high input (HIP) crop fields, cultivated with intensive farming using pesticides and synthetic fertilizers, located at Ayub Research Institute, Faisalabad, and low input (LIP) crop fields, cultivated with relatively low doses of synthetic fertilizers and mostly using organic manures, located at Gatti near Faisalabad, were selected at random. Soil macrofauna was collected from these areas by extracting soil samples from three different locations within the wheat fields: the middle of the field using core samplers, underneath trees at the edge of the fields, and the open edge of the fields using an iron rectangle of one square foot up to one foot deep in the soil. Sampling commenced at the start of wheat growth and continued until harvest, spanning six months from January to June. Soil samples, taken one inch deep, were packed in plastic bags, labeled with the location, date, and whether they were from LIP or HIP fields, and analyzed for moisture content. The soil was then sorted to extract

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the invertebrate macrofauna. Collected specimens were preserved in bottles containing a 70% alcoholic solution in distilled water, labeled with the date and location of the sample. These specimens were then separated into individual bottles with their respective labels for identification.

Identification of the sorted specimens was conducted under suitable magnification using a microscope and various identification keys:

- "Fauna of British India" by Blanford and Godwin (1908)
- Borer Identification keys, Borer (1954), Distant (1918)
- Google images and Google web

The record of plants other than wheat occurring on the sampling sites was also taken into account. The collected specimens were subjected to microscopic identification using keys. To study of different attributes of species, simple statistics and Shannon-Weiner Index of biodiversity was applied to analyze the data by using Magurran (1988) as follows:

Shannon-Weiner Diversity Index

Data collected was statistically analyzed to discover species diversity, richness and evenness using Shannon-Weiner Diversity Index (H'), Shannon (1948).

$$H' = N \ln N - \Sigma n \ln n / N$$

Here N is the number of categories and n being the sample size and the magnitude of H' is affected by distribution of the data and the number of categories.

Evenness is calculated as:

$$E = H / \ln N$$

The quantity E depicted the homogeneity or relative diversity. The measure I-E is measure of heterogeneity of dominance. So,

$$D = I - E$$

RESULTS

Significant disparities in the variety and population of soil macrofauna between low input (LIP) and high input (HIP) wheat farms were recorded. A total of 35 specimens were gathered from the LIP fields, encompassing a diverse range of 25 distinct species. The specimens comprised a diverse range of taxa, including Hymenoptera, Dermaptera, Collembola, Orthoptera, Coleoptera, Diptera, Lepidoptera, Isoptera, Diplura, Oligochaeta, Pulmonata, and Isopoda. The LIP fields were also found to contain Formica spp., Solenopsis japonica, Camponotus spp., Forficula auricularia, Isotomurus palustris, and others. Notably, these species were observed in higher numbers under trees and along the open edge of the fields. On the other hand, HIP fields had a greater overall number of specimens, totaling 46 and including 25 different species. This entailed a heightened occurrence of species such as Formica sanguinea, Syrphus torvus, and Oniscus asellus, among other species. The HIP fields had a greater abundance of specimens, particularly in areas located beneath trees and inside the confines of the fields. The diversity index (Shannon-Weiner) was stronger in LIP fields (H'=3.04) than in HIP fields (H'=2.91), suggesting that LIP fields had a higher species variety despite the higher overall abundance in HIP fields (Table 1). These findings highlight the influence of fertiliser input levels on soil macrofauna communities. LIP fields show a greater variety of macrofauna species, while HIP fields have a higher number of individual specimens. This variation emphasises the ecological consequences of farming methods on soil health and the possible advantages of lower input systems in preserving biodiversity.

Table 2 indicates the monthly variation in the diversity and abundance of soil macrofauna in low input (LIP) crop fields over a six-month period from January to June. In January, six specimens were collected across six species, including Camponotus pennsylvanicus, Planispira nagporensis, and Monacha cartusiana. In February, seven specimens from five different species were collected, with noteworthy findings of Camponotus pennsylvanicus and Monacha cartusiana. In March, six specimens representing three different species were observed: Formica spp., Solenopsis invicta, and Camponotus spp. In April, no specimens were collected. A notable rise was observed in May, with 14 specimens across 14 different species, including Solenopsis japonica, Dolichoderus spp., Forficula auricularia, Isotomurus palustris, and Acanthoscelides obtectus. In June, there was a decrease in the number of specimens, with only two individuals from two different species, namely Camponotus spp. and Xerocrassa mesosterna. The highest diversity and abundance were observed in May, while no specimens were collected in April.

The data showcase the fluctuation in macrofauna activity throughout the seasons, with a notable peak in late spring. A total of 35 specimens were collected from the LIP fields over a period of six months, encompassing a diverse range of 25 different species.

Table1. Diversity and abundance of soil macrofauna in LIP and HIP crop fields.

Texa			LIP				HIP			
ORDER	FAMILY	SPECIES	Open edge	Under tree	Inside field	Total	Open edge	Under tree	Inside field	Total
HYMNOPTERA	Formicidae	*Formica spp.*	-	1	-	1	3	-	2	5
		Solenopsis japonica	-	1	-	1	1	3	-	4
		Solenopsisinvicta	1	-	-	1	-	-	-	-
		Pheiddehyaiti	-	-	-	-	-	1	-	1
		Camponotus spp.	2	3	-	5	-	1	1	2
		Camponotuspennsylvanicus	-	2	-	2	-	-	-	-
		Formica sanguinea	-	-	-	-	-	6	-	6
	Typhiidae	*Neozeleboria*	-	-	-	-	-	1	-	1
	Dolichondrinae	*Dolichonderus spp.*	-	1	-	1	-	-	-	-
DERMETERA	Forficulidae	*Forficulaauricularia*	-	-	-	1	1	-	-	1
COLLEMBOLA	Entomobryidae	*Isotomorus palustris*		-	1	1	-	-	-	-
ORTHOPTERA	Gryllotalpidae	*Gryllotalpa altricans*	-	-	-	-	-	1	-	1
COLEOPTERA	Mylabridae	*Acanthoscelides obtectus*	-	1	-	1	-	-	-	-
	Meloidae	*Macrobasis unicolor*	-	-	-	-	1	-	-	1
		Tetanopsaldrichs	1	-	-	1	-	-	-	-
DIPTERA	Syrphidae	*Syrphustorvus*	-	-	-	-	-	-	2	2
	Asilidae	*Leptogasterannulates*	-	-	-	-	-	1	-	1
	Ceratopogonidae	*Forcipomyia spp.*	-	-	-	-	1	-	-	1
	Trypetidae	*Euxestastigmatias*	-	-	-	-	-	-	1	1
LEPIDOPTERA	Phalaenidae	*Alomoginaeumata*	-	-	-	-	1	-	-	1
		Laphygmafrugiperde	1	-	-	1	-	1	-	1
ISOPTERA	Rhinotermitidae	*Prototermesadamsoni*	-	-	-	-	-	1	-	1
	Termitidaess	*Microtermesobesi*	-	-	-	-	-	2	-	2
		Odontotermisobesus	-	-	-	-	-	1	-	1
DIPLURA	Japygidae	*Japyx spp.*	-	-	-	-	1	-	-	1
OLIGOCHAETA	Megasolicidae	*Pheretimaposthuma*	1	-	-	1	1	-	-	1
		Pheretimaelongata	1	-	-	1	1	-	-	1
PULMONATA	Helicidae	*Planispiranagporensis*	-	2	-	2	-	-	-	-
		Monachacartusiana	-	4	-	4	-	-	1	1
	Hygromidae	*Cernuellajonica*	-	1	-	1	-	-	-	-
		Xerocrassamesosterna	-	1	-	1	-	-	-	-

		Hygromiacinctella	-	1	-	1	-	-	-	-
		Xerosectacespitum	-	2	-	2	-	-	-	-
		Metafruticicolanicosiana	-	1	-	1	-	-	-	-
		Euomphaliastrigella	-	1	-	1	-	-	-	-
		Trichia hispida	-	1	-	1	-	-	-	-
	Subulinidae	*Obeliscussallei*	-	-	-	-	1	-	-	1
ISOPODA	Oniscidae	*Oniscus asellus*	1	-	-	1	2	4	1	7
		Platyarthrushoffmannsaggii	-	-	-	-	-	-	1	1
	Trichoniscidae	*Trichoniscus spp.*	1	-	-	1	-	-	-	-
	Armadillidae	*Armadillidum vulgare*	-	1	-	1	-	-	-	-
Number of specimen			9	24	2	35	14	23	9	46
Number of species			8	16	1	25	11	12	7	25

Table 2. Monthly variation in diversity and abundance of soil macrofauna in LIP crop fields

Texa			Low Input						
ORDER	FAMILY	SPECIES	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
HYMNOPTERA	Formicidae	*Formica spp.*	-	-	1	-	-	-	1
		Solenopsis japonica	-	-	-	-	1	-	1
		Solenopsisinvicta	-	-	1	-	-	-	1
		Pheiddehyaiti	-	-	-	-	-	-	-
		Camponotus spp.	-	-	4	-	-	1	5
		Camponotuspennsylvanicus	1	1	-	-	-	-	2
		Formica sanguinea	-	-	-	-	-	-	-
	Typhiidae	*Neozeleboria*	-	-	-	-	-	-	-
	Dolichondrinae	*Dolichonderus spp.*	-	-	-	-	1	-	1
DERMETERA	Forficulidae	*Forficulaauricularia*	-	-	-	-	1	-	1
COLLEMBOLA	Entomobryidae	*Isotomorus palustris*	-	-	-	-	1	-	1
ORTHOPTERA	Gryllotalpidae	*Gryllotalpa altricans*	-	-	-	-	-	-	-
COLEOPTERA	Mylabridae	*Acanthoscelides obtectus*	-	-	-	-	1	-	1
	Meloidae	*Macrobasis unicolor*	-	-	-	-	-	-	-
		Tetanopsaldrichs	-	-	-	-	1	-	1
DIPTERA	Syrphidae	*Syrphustorvus*	-	-	-	-	-	-	-
	Asilidae	*Leptogasterannulates*	-	-	-	-	-	-	-
	Ceratopogonidae	*Forcipomyia spp.*	-	-	-	-	-	-	-
	Trypetidae	*Euxestastigmatias*	-	-	-	-	-	-	-

LEPIDOPTERA	Phalaenidae	*Alomoginaeumata*	-	-	-	-	-	-	-
		Laphygmafrugiperde	-	-	-	-	1	-	1
ISOPTERA	Rhinotermitidae	*Prototermesadamsoni*	-	-	-	-	-	-	-
	Termitidaess	*Microtermesobesi*	-	-	-	-	-	-	-
		Odontotermisobesus	-	-	-	-	-	-	-
DIPLURA	Japygidae	*Japyx spp.*	-	-	-	-	-	-	-
OLIGOCHAETA	Megasolicidae	*Pheretimaposthuma*	-	-	-	-	1	-	1
		Pheretimaelongata	-	-	-	-	1	-	1
PULMONATA	Helicidae	*Planispiranagporensis*	1	1	-	-	-	-	2
		Monachacartusiana	1	3	-	-	-	-	4
	Hygromidae	*Cernuellajonica*	-	1	-	-	-	-	1
		Xerocrassamesosterna	-	-	-	-	-	1	1
		Hygromiacinctella	-	1	-	-	-	-	1
		Xerosectacespitum	1	-	-	-	1	-	2
		Metafruticicolanicosiana	-	-	-	-	1	-	1
		Euomphaliastrigella	-	-	-	-	1	-	1
		Trichia hispida	1						1
	Subulinidae	*Obeliscussallei*							
ISOPODA	Oniscidae	*Oniscus asellus*	-	-	-	-	1	-	1
		Platyarthrushoffmannsaggii	-	-	-	-	-	-	-
	Trichoniscidae	*Trichoniscus spp.*	-	-	-	-	1	-	1
	Armadillidae	*Armadillidum vulgare*	1	-	-	-	-	-	1
Number of specimen			6	7	6	0	14	2	35
Number of species			6	5	3	0	14	2	25

Table 3. Monthly variation in diversity and abundance of soil macrofauna in HIP crop fields.

Texa			High Input						
ORDER	FAMILY	SPECIES	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
HYMNOPTERA	Formicidae	*Formica spp.*	-	-	2	-	3	-	5
		Solenopsis japonica	-	3	-	-	1	-	4
		Solenopsisinvicta	-	-	-	-	-	-	-
		Pheiddehyaiti	-	1	-	-	-	-	1
		Camponotus spp.	-	1	-	-	1	-	2
		Camponotuspennsylvanicus	-	-	-	-	-	-	-
		Formica sanguinea	-	4	-	1	-	1	6

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	Typhiidae	*Neozeleboria*	-	-	1	-	-	-	1
	Dolichondrinae	*Dolichonderus spp.*	-	-	-	-	-	-	-
DERMETERA	Forficulidae	*Forficulaauricularia*	-	-	1	-	-	-	1
COLLEMBOLA	Entomobryidae	*Isotomorus palustris*	-	-	-	-	-	-	-
ORTHOPTERA	Gryllotalpidae	*Gryllotalpa altricans*	-	-	1	-	-	-	1
COLEOPTERA	Mylabridae	*Acanthoscelides obtectus*	-	-	-	-	-	-	-
	Meloidae	*Macrobasis unicolor*	-	-	-	-	1	-	1
		Tetanopsaldrichs	-	-	-	-	-	-	-
DIPTERA	Syrphidae	*Syrphustorvus*	-	-	2	-	-	-	2
	Asilidae	*Leptogasterannulates*	-	1	-	-	-	-	1
	Ceratopogonidae	*Forcipomyia spp.*	-	-	1	-	-	-	1
	Trypetidae	*Euxestastigmatias*	-	-	1	-	-	-	1
LEPIDOPTERA	Phalaenidae	*Alomoginaeumata*	-	-	1	-	-	-	1
		Laphygmafrugiperde	-	-	-	-	1	-	1
ISOPTERA	Rhinotermitidae	*Prototermesadamsoni*	-	1	-	-	-	-	1
	Termitidaess	*Microtermesobesi*	-	2	-	-	-	-	2
		Odontotermisobesus	-	1	-	-	-	-	1
DIPLURA	Japygidae	*Japyx spp.*	-	-	-	-	1	-	1
OLIGOCHAETA	Megasolicidae	*Pheretimaposthuma*	-	-	-	-	-	1	1
		Pheretimaelongata	-	-	-	-	1	-	1
PULMONATA	Helicidae	*Planispiranagporensis*	-	-	-	-	-	-	-
		Monachacartusiana	-	1	-	-	-	-	1
	Hygromidae	*Cernuellajonica*	-	-	-	-	-	-	-
		Xerocrassamesosterna	-	-	-	-	-	-	-
		Hygromiacinctella	-	-	-	-	-	-	-
		Xerosectacespitum	-	-	-	-	-	-	-
		Metafruticicolanicosiana	-	-	-	-	-	-	-
		Euomphaliastrigella	-	-	-	-	-	-	-
		Trichia hispida	-	-	-	-	-	-	-
	Subulinidae	*Obeliscussallei*	-	-	1	-	-	-	1
ISOPODA	Oniscidae	*Oniscus asellus*	-	-	3	-	3	1	7
		Platyarthrushoffmannsaggii	-	1	-	-	-	-	1
	Trichoniscidae	*Trichoniscus spp.*	-	-	-	-	-	-	-
	Armadillidae	*Armadillidum vulgare*	-	-	-	-	-	-	-
Number of specimens			0	16	14	1	12	3	46
Number of species			0	10	10	1	8	3	32

Similarly, the monthly variation in the diversity and abundance of soil macrofauna in high input (HIP) crop fields was recorded over a six-month period from January to June (table 3). In January, no specimens were collected. In February, 16 specimens across 10 species, including Solenopsis japonica, Formica sanguinea, and Microtermes obesi, were collected. March yielded 14 specimens from 10 species, such as Formica spp., Syrphus torvus, and Oniscus asellus. A significant drop was noted in April, with only one specimen of Formica sanguinea collected. In May, 12 specimens from eight species, including Formica spp., Camponotus spp., and Laphygma frugiperda, were observed. June saw a further decrease, with only three specimens from three species, namely Formica sanguinea, Oniscus asellus, and Pheretima posthuma. A total of 46 specimens representing 32 species were collected from HIP fields over the six months. The highest diversity and abundance were noted in February and March, with no specimens collected in January. This data highlights the seasonal variation and peak macrofauna activity during late winter and early spring.

Table 4 presents the monthly variation in the Shannon-Weiner diversity index for soil macrofauna in low input (LIP) and high input (HIP) wheat fields. The species richness (S) was observed to be 35 in LIP fields and 46 in HIP fields, with a combined total of 57 species. The diversity (H') index was higher in LIP fields (3.04) compared to HIP fields (2.91), with an overall diversity index of 3.09. Evenness (E) was recorded at 0.93 for LIP fields and 0.89 for HIP fields, resulting in an overall evenness of 0.76. The dominance (D) was lower in LIP fields (0.07) compared to HIP fields (0.11), with a total dominance value of 0.24. These metrics indicate higher diversity and more evenly distributed species in LIP fields, while HIP fields showed higher species richness but greater dominance of certain species.

Table 4. Monthly variation in Shannon-Weiner diversity index for LIP & HIP macro fauna of wheat field.

	LIP	HIP	Total
Species richness (S)	35	46	57
Diversity (H')	3.04	2.91	3.09
Evenness (E)	0.93	0.89	0.76
Dominance (D)	0.07	0.11	0.24

DISCUSSION

Organic compounds bind colloidal clay minerals together, ensuring the cohesion of soil structure. Microorganisms and various small organisms continually utilize these organic compounds, requiring a constant input of biomass through root decay and above-ground remnants to sustain soil organic matter (Jenny, 1980). According to Bardgett (2005), the extensive diversity of microorganisms and creatures inhabiting soil, which make up the decomposer food web, plays a critical role in ecosystems by facilitating the recycling of organic materials originating from both the aboveground and underground plant-based food chains. Kevan (1968) defined soil macrofauna as those invertebrates visible without the need for magnification. It was shown by Bonick and Lal (2005) and Fox *et al*. (2006) that soil macrofauna can change the structure of the soil (Snyder and Hendrix, 2008; Bottinelli *et al*., 2015). Lavelle *et al*. (2006) added to this by showing that soil invertebrates are actively involved in shaping the soil, keeping its physical structure, controlling prey and pests, and facilitating nutrient cycling through decomposition, which helps primary production. This function holds particular significance in soils with limited fertility.

The present study was performed to show a relationship between soil and soil organisms, as well as their abundance and diversity. Wheat fields were selected at random, and soil macrofauna were collected from high-input wheat fields (HIP), located at Ayub Research Institute, Faisalabad, and low-input wheat fields (LIP), located at Gatti near Nishatabad, Faisalabad. Table 1 provides a list of invertebrates found in soil samples taken from LIP and HIP wheat fields. Accordingly, out of a total of 81 specimens, 35 were extracted from LIP and 46 were extracted from HIP wheat fields. A diverse range of soil macrofauna was found. Pankhurst *et al*. (1997) and Paoletti (1999) discussed the role of various soil macrofauna in serving as bio-indicators for soil health and sustainability, with Diptera order members being recognized as part of this group.

Earthworms, termites, and ants have been identified as the primary soil engineers among soil-dwelling inhabitants (Jeffery *et al*., 2010). In this study, ants (Formicidae) were more abundant than termites and earthworms, with the remaining macro-faunal species. The lower earthworm population during the months of May and June could be attributed to the high population of predatory ants.

Soil structure and fertility are determined by soil invertebrates and microorganisms. Soil organisms such as earthworms, slugs, land snails, ants, and other insects frequently alter and improve the soil structure through their activities. Earthworms were present in both LIP and HIP wheat crops, which indicated that they are important for soil. It is in line with the result given by Arden-Clarke and Hodges (1987), who described that lumbricoides, through their sub-soil penetration and binding capacity, bring about alterations in the physical structure of soil. This activity reduces soil erosion and transport while encouraging organic matter mixing within the soil. Bishop (2003) concluded that earthworms' direct impact on organic matter decomposition in soil is relatively minor compared to their role in integrating and facilitating communication among litter, which in turn regulates microbial decomposition.

10 genera of pulmonates were found; almost all were present in low-input fields, showing their sensitivity towards agro-chemicals. Farhat (2006), in a previous study, also demonstrated the same effects of agrochemicals on the snail species.

Only three species of Coleoptera were found, which acted as pests and caused damage to crops. Kendall *et al.*, in 1995; Purvis and Fadl, 1996; Anderson, 1999; and Holland and Reynolds, 2003, reported that the soil holds diverse predators, including Coleortera and Arachnida, because they eat saprophytic and detritus-feeding species. They spend some or all of their lives in fields and become sensitive to crops. The Shannon-Weiner index showed higher diversity (H = 3.04) in LIP wheat fields than in HIP (H = 2.91). The study concludes that soil macrofauna exposed to LIP and HIP fertilizers varied in terms of diversity and abundance.

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