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Assessment of Possible Threats to Soil Macro-invertebrates Diversity in Wheat Fields from High Input Farming

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ABSTRACT

Soil macro-invertebrates are an integral part of all agro-ecosystems. But, modern/intensified agri-farming is deteriorating these key elements–resulting in negative impact on soil structure, hydrological processes, gas exchange, detoxification and recycling of organic matter. Present study was carried out to weigh up the deterioration of soil macro-invertebrates in wheat fields due to high inputs compared with low inputs of chemical fertilizers. Soil samples were taken by core sampler from three micro-habitats *viz*. open edge, sub-shadow and inside the field of each randomly selected field over two consecutive years. In total 1185, specimens belong to 16 orders, 57 families and 126 species (combined) were recorded from the both fields *viz.* 859 from low input and only 326 from high input. Species dynamics was also in same order. Out of 126, 102 were recorded in low input and 62 in high input fields. However, species diversity in micro-habitats was higher in low input among open edge, sub-shadow places (under trees), while inside the field was dominant in high input field. Order Pulmonata, Hymenoptera, Coleoptera, Isopoda and Dermaptera were the most abundant. The t-test analysis between low input and high input was remarkable ($t = 3.369$; $p < 0.01$). Diversity's Index was 3.848 in low input and 3.611 in high input fields, whilst evenness were 0.452 and 0.706, in low input and high input, respectively. It is concluded that deterioration of macro-invertebrates was less pronounced in organically managed fields (low input) as compared to high input farming.

Key Words: Extensive farming; Macro-fauna; Diversity; High input farming

INTRODUCTION

Soil macro-fauna is imperative to sustain the soil components. They decompose and redistribute the organic matter in soil, play superficial role for re-cycling of nutrients, contribute to soil turnover/structure as well as to sustain ecological niches/pyramids. Moreover, they manage the interactions between above-and below-ground fauna and play vital role to uphold the biogeochemical cycling of biotic and abiotic factors (Chaudhry *et al.,* 1999; Rana *et al.,* 2006; Kapagianni *et al.,* 2010). Liiri *et al*. (2002) studied the ecological co-relation of species diversity for primary production among agro-ecosystems and have reported optimistic possessions for ecosystem functioning. In many of the earlier experiments, positive association between biodiversity and ecosystem functioning has been observed because they uphold the ecological niches for sustainable ecosystem functioning, indicating the importance of species number for affecting system functioning. With an increase in species richness, decline in system functioning has been observed. In spite of this, some species and their activities were redundant (Schläpfer & Schmid, 1999; Schwartz *et al*., 2000). However, population structure of macro-fauna is more pronounced with broad spectrum in sustainable soil/organic farming as comparing to high input farming (Bullock *et al*., 2001; Stromberger *et al.,* 2005) because deterioration of their population has been recorded significantly higher among high input crop fields (Desaeger *et al.,* 2004). High input farming distresses all the soil demographical and topographical properties (Ibekwe *et al.,* 2001; Stromberger *et al.,* 2005; Klose *et al.,* 2006) along with process of soil turnover and mineralization of nutrients (Akhtar & Mahmood, 1994; Collins *et al*., 2006).

To fill the gap between supply and demand and to achieve the ideology of 'green revolution', the establishment of ideal agro-ecosystem and sustainability of soil is obligatory (Government of Pakistan, 2009; FAO, 2010). It has been observed that use of chemical (high input farming) is disrupting all soil processes by degradation of biomass (micro-, meso- & macro-fauna), which is important for its integrity. Any alteration in their community/trophic structure or maturity index can induce profound losses to natural and induced vegetation as well as human health (Bongers, 1990; Coleman *et al*., 1992).

Soil communities are assembled in complex and varied numbers of diversified living organisms; those uphold the ecological niches for sustainable ecosystem functioning. Their structure and number vary soil to soil and patch to patch. Their population also alters with change of land use, which is under cultivation through high input

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farming to fill gap between supply and demand for an increase in food production. There is upward consents that more sustainable agriculture is needed to ensure long-term productivity and stability of ecosystems (Tilman *et al*., 2002; Petersen, 1995; Scheu & Schulz, 1996). However, agricultural management at the confined range can affect the soil macro-fauna (Doring & Kromp, 2003; Purtauf *et al*., 2005; Birkhofer *et al*., 2008a, b). In addition to this, Bengtsson *et al*. (2005) have reported optimistic possession of organic farming on the abundance and richness of soil organisms. They also emphasized that landscape management interaction can significantly influence the density of macro-fauna decomposers and the species richness. Moreover, these communities are most striking feature of soil with massive variation for capitalization of output (Tilman, 2000; Gaston, 2000). They are imperative to fragmentize and re-distribute the organic matter as well as soil turnover along with strengthening ecological niches and pyramids, primary resources for food security, pharmaceutical and cosmetic products (Lovejoy, 1994; Chaudhry *et al.,* 1999; Rana *et al.,* 2006; Kapagianni *et al.,* 2010).

Considering aforementioned threats owing to high input farming, researchers are taking eager curiosity in low input farming, which is less detrimental to agro-ecosystems and soil macro-fauna (Akhtar & Mahmood, 1994) and can play important role in improving the soil structure and topographical properties (FAO, 2010). Therefore, the quantitative estimate of the deterioration of soil macro-fauna in high input farming is important (Hanneman & Riddle, 2005).

Keeping in view all these facts, the present study was carried out to weigh up the probable interactions of soil macro-fauna among soil community owing to high input farming (cultivation with intensive farming using pesticides and synthetic fertilizers) and low input farming (cultivation using relatively low doses of agrochemicals and use of organic manure replacing most of the synthetic fertilizers). Quantitative estimation of deterioration of soil-macro-fauna in wheat crops owing to high input (chemically intensive farming) vs. low input farming has been made for comprehensive analysis and along the micro-habitats *viz.* Open edge, Sub-shadow and Inside the field.

MATERIALS AND METHODS

Study area: To fulfill the objectives of the study, a preliminary survey was made to select the wheat fields under chemically low input (cultivation using relatively low doses of agrochemicals & use of organic manure replacing most of the synthetic fertilizers) from Gatti–situated in north-east about 24 km away from the main city, in district Faisalabad and chemically high input farming systems (cultivation with intensive farming using pesticides & synthetic fertilizers) from Ayub Agriculture Research Institute, Faisalabad, Pakistan. Faisalabad lies from 30^{o}-$40'$ to 31^{o}-$47'$N latitudes and 72^{o}-$42'$ to 73^{o}-$40'$E longitudes. At least four blocks of wheat from each locality given above, were randomly selected. Each block was covered an area of ten acres. Low input farming system was taken as control whereas, those of high input farming system was taken as treated.

High input/low input: The assessment of low input and high input was made on the basis of the prescribed standards for cultivation of wheat by the Government of Punjab (2008), Pakistan to get 2400-2600 kg/acre yield. Following doses (kg/acre) of various fertilizers were used to obtained this yield: nitrogen 70, phosphorus 50, potassium 70-80, calcium 7, sulfur and magnesium 12 each (Government of Punjab, 2008). The pesticide use was variable in both the fields. Cultivation using non-recommended/easily available natural and artificial resources in contrast to high input was low input. But, chemical and physical parameters were with fewer differences as they are recorded in present study and earlier reported by Mader *et al.* (2002) and Schinner *et al*. (1993) (Fig. 1).

Soil sampling: Sampling was done from wheat fields from January to June for six months over two consecutive wheat growing seasons (2008 & 2009). Each month the samples were taken from a new location in selected 10 acre block. For the extraction of invertebrates, soil's samples were taken from randomly selected one acre field from each 10 acre block in each month. Three microhabitats were sampled from selected field for the extraction of macro-fauna from the soil. These microhabitats are defined as follows:

Open edge: It is an elevated ridge along the crop fields, making the boundary of the field of wheat crops. Samples were taken from any place on this ridge without any shade of shrub/scrub/tree plant on it.

Sub-shadow: Samples were taken from the above said boundary ridge under the shade of a shrub/scrub/tree plant.

Inside field: Samples were taken from inside positions in the crop field.

The micro-habitats mentioned above were different from each other owing to impacts of ecological successions and intensity of chemicals, being limiting factors, which affect their superficial roles.

Experimental procedure: An iron square quadrangle measuring 30 cm^3 was used to collect the samples of soil from two micro habitats in each crop field. Three samples from each micro habitat were taken. Core sampler measuring 7.6 cm diameter was used to collect the samples of soil from third micro habitat *i.e.,* inside the crop field. Three core samples were taken as the triplets of three, at a depth of 30 cm inside the fields (Magurran, 1988; Dangerfield, 1990). Samples of the soil were brought to the laboratory for sorting invertebrate fauna. They were sorted through (i) hand sorting and (ii) burlese funnel.

Identification: Identification of the specimens was done with the help of reference material (Triplehorn & Johnson, 2005) in the Biodiversity Laboratory, Department of Zoology and Fisheries, University of Agriculture, Faisalabad. Analyses of soil samples for nutrients were made at Ayub Agriculture Research Institute, Faisalabad, Pakistan (Fig. 1), according to the methods described by Tendon (1993).

Statistical analysis: Statistical analysis was made to calculate the Shahnon's Diversity Index, (Magurran, 1988; Ludwig & James, 1988) through GW-BASIC Microsoft (www.daniweb.com-online). The richness, diversity and evenness indices were computed by using the Programme SPDIVERS.BAS. Data were analyzed statistically to determine species diversity, species richness and species evenness with Shannon diversity index (H′) (Magurran, 1988) as:

$$H' = - \sum pi \ln pi$$

The variance of H′ was calculated as:

$$\text{Var } H' = \frac{\sum pi (\ln pi)^2 - (\sum pi \ln pi)^2}{N} + \frac{S-1}{2N^2}$$

't-test' analysis was made to weigh up the significance differences between samples as (Hutcheson, 1970):

$$t = \frac{H'_1 - H'_2}{(\text{Var } H'_1 + \text{Var } H'_2)^{1/2}}$$

Evenness was calculated according to the Hill's Modified Ratio (E) (Ludwig and James, 1988):

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

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 program SPDIVERS.BAS.

Richness was calculated (Ludwig & James, 1988):

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

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).

RESULTS AND DISCUSSION

In total, 1185 specimens belonging to 16 orders, 57 families and 126 species were recorded and identified up to species level from the both low-and high-input fields (Table I). *Monadenia fidelis* (147), *Formica spp.* (78) and *Componotus spp.* (78), *Solenopsis invicta* (55), *Oxychillus alliarius* (39), *Armadillidium vulgare* (38), *Harpalus spp.* (35), *Megomphix hemphilli* (29), *Formi spp.* (26), *Armadillidium nasatum* (25), *Oxychillus cellarium* (22), *Haplotrema vancouverense* (20), *Forficula auricularia* (18), *Oxychillus draparnaudi* (17), *Dolichoderus taschenbegi* (15), *Componotus pennsylvanicus* (14), *Ischyropalpus fuscus* (14), *Hippasa partita* (12) and *Microtermes obesi* (12) were the most prominent species from the entire collection among low input and high input fields. However, low input farming was recorded with higher abundance (859) as compared to high input, where only (326) specimens were recorded (Table I & II). From the entire population dynamic structure, order Pulmonata, Hymenoptera, Coleoptera, Isopoda and Dermaptera were the most abundant. It has been observed from the entire investigations that high input farming is significantly influencing the population of soil macro-fauna and their ecological role, consequently, disruption of the ecological conditions of soil; and has confirmed our expectation about the study and also have supported the views of many researchers (Scheu & Schulz, 1996; Tilman *et al*., 2002; Doring and Kromp (2003); Purtauf *et al*. (2005); Birkhofer *et al*. (2008a, b); Bengtsson *et al*. (2005). It has been realized that more sustainable agriculture is needed to ensure long-term productivity and stability of ecosystems.

As far as species richness is concerned, it was highly interesting during present investigation, depicting a soaring abundance in low input fields as compared to high input. Higher richness was recorded in low input (102) field as compared to high input (62). Similarly, among the micro-habitats, low input fields was with high species richness under tree (74), followed by open edge (57) and inside field (21), while among high input fields, species richness was slightly higher at open edge (34) other than under tree (29) and inside fields (29) (Table II). The diversity index was high in low input (3.848) as compared to high input fields (3.611), highlighting bare differences of disturbance. However, species diversity in microhabitats was higher in low input among open edge, sub-shadow (3.458), (3.566), while inside the field, high input field was dominant (3.194). Evenness was (0.452) in low input and (0.706) in high input fields. These estimates supported the previous findings of Schinner *et al*. (1993) and Mader *et al.* (2002) who opined that organically managed soils exhibit greater biological activity than the conventionally managed soils.

In contrast, soil chemical and physical parameters displayed fewer differences (Fig. 1), which exhibited higher soil aggregate stability in the organic plots than in the conventional plots and also characterized the healthy ecosystems owing to high species diversity. Terry and Linda (1986) said that many farmers are turning towards organic or 'low input' farming as a strategy for economic survival.

Table I: Population dynamics of macro-fauna in low input and high input farming

Order	Family	Species	Jan		Feb		Mar		Apr		May		Jun	
			LIP	HIP	LIP	HIP	LIP	HIP	LIP	HIP	LIP	HIP	LIP	HIP
Haplotaxida	Megascholoida	*Pheretima elongate*	-	-	-	-	-	+	-	-	+	+	-	-
		Pheretima heterochaeta	+	-	-	-	-	+	-	-	-	-	-	-
		Pheretima posthuma	-	-	-	-	-	-	-	-	-	+	+	-
Diplura	Japygidae	*Japyx spp.*	-	-	-	-	-	-	-	-	-	+	-	-
Collembolla	Entomobryidae	*Isotomorus palustris*	-	-	-	-	-	-	-	-	+	-	-	-
Orthoptera	Gryllotalpidae	*Gryllotalpa altricans*	-	-	-	-	-	+	-	-	-	-	-	-
Isoptera	Rhinotermitidae	*Prototermes adamsoni*	-	-	-	+	-	-	-	-	-	-	-	-
		*Rhino. spp.**	-	-	-	+	-	-	-	-	-	-	-	-
	Termitidae	*Microtermes obesi*	-	-	-	+	-	-	-	-	-	-	-	-
		Odontotermis obesus	-	-	-	+	-	-	-	-	-	-	-	-
Dermaptera	Labiduridae	*Labidura riparia*	-	-	-	-	+	-	-	-	-	-	-	-
		Anisolabis martima	-	-	-	-	+	-	-	-	-	-	-	-
	Labiidae	*Labia minor*	+	-	-	-	-	-	-	+	-	-	-	-
	Forficulidae	*Forficula auricularia*	+	+	-	+	+	+	+	+	+	+	+	+
		*Forfi. spp1.**	-	-	+	-	+	-	-	-	+	-	-	-
Hemiptera	Cydnidae	*Pangaeus bilineatus*	+	-	+	+	+	+	-	+	+	+	-	+
Coleoptera	Cicindelidae	*Cicindela scutellaris*	-	-	-	+	-	-	-	-	-	-	-	-
	Carabidae	*Scaphinotus angulatus*	-	-	-	-	-	+	-	-	-	-	-	-
		Calosoma maderae	-	-	+	-	-	+	-	-	-	-	-	-
		Calosoma scurutator	-	-	-	-	-	-	+	-	-	-	-	-
		Harpalus spp.	-	+	+	+	+	-	-	+	-	+	+	+
		*Carab. spp.**	+	-	-	-	+	-	-	+	-	-	-	-
	Anthicidae	*Ischyropalpus fuscus*	+	-	-	-	-	-	-	-	-	-	-	-
	Meloidae	*Macrobasis unicolor*	-	-	-	-	-	-	-	-	-	+	-	-
		Tetanops aldrichs	-	-	-	-	-	-	-	-	+	-	-	-
	Tenebrionidae	*Merinus leavis*	+	-	-	-	-	-	-	-	-	-	-	-
		Geotrupes spp.	+	-	-	-	-	-	-	-	-	-	-	-
		Promethis valgipes	+	-	-	-	-	-	-	-	-	-	-	-
		Strongylium saracenum	-	-	-	-	+	-	-	-	-	-	-	-
		Gymnopleurus mospsus	-	-	-	-	-	-	-	-	-	+	-	-
		Tenebrio obscurus	-	-	+	-	-	-	-	-	-	-	-	-
		Tribolium castaneum	-	-	-	-	-	-	-	-	-	+	-	-
		Gonocephalum elderi	-	-	-	-	+	-	-	-	-	-	-	-
		Adelina plana	+	-	-	-	-	-	-	-	-	-	-	-
		Platydema spp.	+	+	-	-	-	-	-	-	-	-	-	-
		Neomida bicornis	+	-	-	-	-	-	-	-	-	-	-	-
		Gonocephalum depressum	+	-	-	-	-	-	-	-	-	+	-	-
		Tenebrio molitor	+	-	-	-	+	-	-	-	-	-	-	+
		Eleodes spp.	-	-	-	-	+	-	+	-	-	-	-	-
		Tribolium confusum	-	-	+	-	-	-	-	-	-	+	-	-
		*Teneb. spp.**	-	-	-	-	+	-	-	-	-	-	-	+
	Mylabridae	*Acanthoscelides obtectus*	-	-	-	-	-	-	-	-	+	-	-	-
	Scarabaeidae	*Oryctes nasicornis*	+	-	-	-	-	-	-	-	+	-	-	-
		Osmoderma eremite	-	-	-	-	+	-	-	-	-	-	-	-
		Pentodon idiota	-	-	+	-	-	-	-	+	-	-	-	+
		Phyllophaga protoricensis	-	-	-	-	+	-	-	-	-	-	-	-
	Curculionidae	*Nyctoporis carinatus*	-	-	-	-	-	-	-	-	-	+	-	-
Lepidoptera	Noctuidae	*Noctu. spp.**	-	-	-	-	+	+	-		-	-	-	-
	Phalaenidae	*Alomogina eumata*	-	-	-	-	-	+	-	-	-	-	-	-
		Laphygma frugiperde	-	-	-	-	-	-	-	-	+	+	-	-
Diptera	Asilidae	*Leptogaster annulates*	-	-	-	+	-	-	-	-	-	-	-	-
	Syrphidae	*Syrphus torvus*	-	-	-	-	-	+	-	-	-	-	-	-
	Ceratopogonidae	*Forcipomyia spp.*	-	-	-	-	-	+	-	-	-	-	-	-
	Trypetidae	*Euxesta stigmatias*	-	-	-	-	-	+	-	-	-	-	-	-
Hymenoptera	Tiphiidae	*Neozeleboria spp.*	-	-	-	-	-	+	-	-	-	-	-	-
	Formicidae	*Formica spp.*	+	+	+	+	+	+	+	+	+	+	+	+
		Componotus spp.	+	+	+	+	+	+	+	+	+	+	+	+
		Solenopsis japonica	-	-	+	+	-	-	-	-	-	+	-	-
		Solenopsis invicta	+	+	+	+	+	+	+	+	+	+	+	+
		Pheidde hyaiti	-	-	-	+	-	-	-	-	-	-	-	-
		Dolichoderus taschenbergi	+	-	+	+	+	+	+	+	+	+	+	-
		Camponotus pennsylvanicus	+	-	+	-	-	-	-	-	-	-	-	-
		Formica sanguinea	-	-	-	+	-	-	-	+	-	-	-	+
		*Formi. spp.1**	+	+	+	+	+	+	+	-	+	-	-	-
		*Formi. spp.2**	-	-	-	+	-		+	-	+	-	-	-
	Dolichoderinae	*Dolichoderus spp.*	-	-	-		-		-	-	+	-	-	-

Table I: Continued

Table I: Continued

Arachnida	Lycosidae	*Hippasa madhuae*	-	-	+		-		-	-	-	-	-	-
		Hippasa partita	-	-	+		-	+	-	-	-	-	-	-
	Clubionidae	*Clubiona obesa*	-	-	-	+	+		+	+	+		-	+
		Clubi. spp..*	-	-	-	-	-	-	-	-	+	-	-	-
Julida	Julidae	*Cylindroiulus boleti*	+	-	-	-	+	-	-	-	+	-	+	-
Geophilomorpha	Schendylidae	*Schendyla nemorensis*	+	-	-	-	-	-	+	-	-	-	-	-
	Geophilidae	*Necrophleophagus longicornis*	-	-	-	-	+	-	-	-	-	-	-	-
		Geophilus carpophagus	+	-	-	-	-	-	-	-	-	-	-	-
Isopoda	Oniscidae	*Oniscus asellus*	-	-	-	-	+	+	-	+	-	+	-	+
		Platyarthrus hoffmannseggi	-	-	-	+	-	-	-	-	-	-	-	-
	Trichoniscidae	*Trichoniscus spp.*	-	-	-	-	-	-	-	-	+	-	-	-
	Armadillidiidae	*Armadillidium vulgare*	+	+	+	+	+	+	+	+	+	+	+	+
		Armadillidium nasatum	+	-	+	+	+	+	+	+	+	+	-	+
		*Armad. spp.1**	-	+	-	-	-	+		+		+	-	
		*Armad. spp.2**	+	-	-	-	-	-	+	-	+	-	-	-
	Trachelipusidae	*Trachelipus rathke*	-	-	-	-	-	+	-	-	-	-	-	-
Pulmonata	Lancidae	*Lanci. Spp.*	-	-	+	-	-	-	-	-	-	-	-	-
	Lymnaeidae	*Galba truncatula*	+	-	+	-	-	-	-	-	+	-	-	-
		Lymnaea cubensis	+	-	+	-	-	-	-	-	-	-	-	-
	Aciculidae	*Acicula lineata*	-	-	+	-	-	-	-	-	+	-	-	-
		Platyla polita	-	-	+	-	-	-	-	-	-	-	-	-
	Physidae	*Physella acuta*	+	-	-	-	-	-	-	-	-	-	-	-
		Physa acuta	-	-	-	-	-	-	-	-	+	-	-	-
	Planorbidae	*Anisus leucostoma*	+	-	-	-	-	-	+	-	-	-	-	-
		Planorbis planorbis	-	-	+	-	-	+	-	-	-	+	-	-
		Biomphalaria peregrina	-	-	+	-	-	-	-	-	-	-	-	-
	Bradybaenidae	*Monadenia fidelis*	+	-	+	-	+	-	+	-	+	-	-	-
	Discidae	*Discus rotundatus*	-	-	+	-	-	-	-	-	-	-	-	-
	Haplotrematidae	*Haplotrema vancouverense*	+	-	+	-	-	-	-	-	-	-	-	-
	Helicidae	*Planispira nagporensis*	+	-	+	-	-	-	-	-	-	-	-	-
		Monacha cartusiana	-	+	+	-	-	-	-	-	-	-	-	-
		*Helic. spp.**	+		-		-		-		-	+	-	
	Hygromiidae	*Cernuella jonica*	-	-	+	-	-	-	-	-	-	-	-	-
		Xerocrassa mesosterna	-	-	-	-	-	-	-	-	-	-	+	-
		Hygromia cinctella	-	-	+	-	-	-	-	-	-	-	-	-
		Helicella profuga	+		-		-		-	+	-		-	
		Xerosecta cespitum	+		-		-	+	-		+		-	
		Metafruticicola nicosiana	-	-	-	-	-	-	-	-	+	-	-	-
		Euomphalia strigella	-	-	-	-	-	-	-	-	+	-	-	-
		Trichia hispida	+	-	-	-	-	-	-	-	-	-	-	-
		*Hygro. Spp.**	-	+	-	+	-	+	+		-	+	-	+
	Megomphicidae	*Megomphix hemphilli*	+	-	+	-	+	-	-	-	+	-	+	-
	Clausiliidae	*Balea perversa*	-	-	+	-	+	-	+	-	-	-	-	-
		Cochlodina laminata	-	-	+	-	+	-	-	-	+	-	-	-
		Cochlostoma septemspirale	-	-	+	-	+	-	+	-	+	-	-	-
	Achatinellidae	*Achatinella bulimoides*	+	-	-	-	-	-	-	-	-	-	-	-
	Enidae	*Jaminia quadridens*	-	+	+	-	+	-	-	+	-	+	-	-
		Mastus olivaceus	-	+	-	-	+	-	-	-	-	+	-	-
		Paramastus episomus	-	+	+	-	+	-	-	-	+	-	-	+
	Punctidae	*Punctum pygmaeum*	-	-	-	-	+	-	-	-	-	-	-	-
	Pristilomatidae	*Oxychillus alliarius*	+	-	+	-	+	-	+	-	+	-	-	-
		Microphysula cookie	-	-	-	-	+	-	+	-	+	-	-	-
	Achatinidae	*Achatina fulica*	-	-	+	-	-	-		-	-	-	-	-
	Subulinidae	*Obeliscus sallei*	-	-	-	-	-	+	-	-	-	-	-	-
	Valloniidae	*Planogyra clappi*	-	-	+	-	-	-	-	-	+	-	-	-
	Helixarionidae	*Euconulus fulvus*	-	-	-	-	+	-	-	-	-	-	-	-
	Zonitidae	*Oxychillus cellarium*	-	-	+	-	+	-	+	-	+	-	+	-
		Oxychillus draparnaudi	+	-	+	-	-	-	+	-	+	-	-	-
		*Zonit. spp.**	+	-	-	-	-	-	-	-	-	-	-	-
		Aegopinella nitidula	-	-	+	-	-	-	-	-	-	-	-	-

In previous study, Siddiqui *et al.* (2005) and Rana *et al.* (2006) reported negative association between low and high input farming on foliage and soil macro-fauna in wheat and sugarcane crops, respectively with regard to micro-habitats. According to them, high input farming was attributable to sever deterioration (Kapagianni *et al.,* 2010). However, in present study considerations were on below ground-soil fauna in wheat fields, to explore the impacts of low input and high input in general and among three micro-habitats.

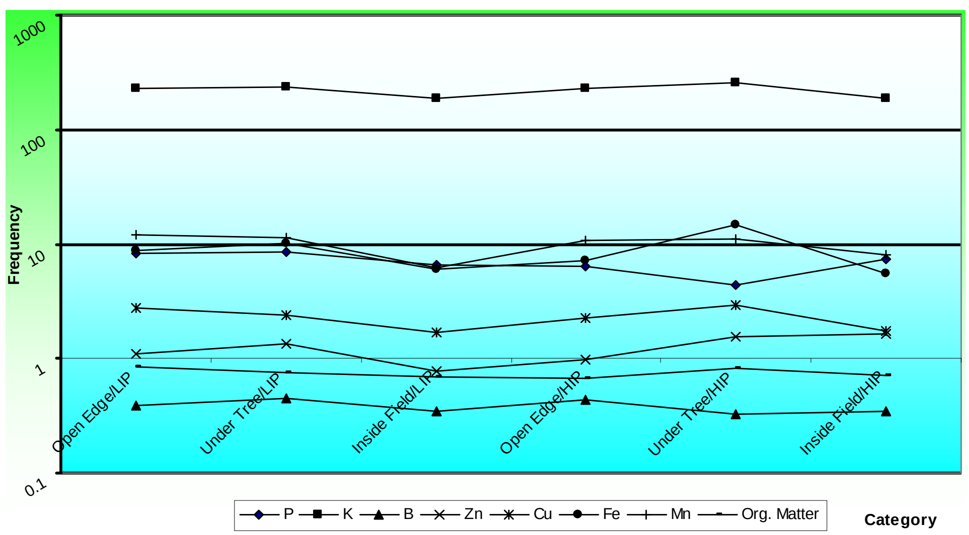
As far as evenness for micro-habitats is concerned,

Table II: Shannon diversity indices among low input and high input in wheat fields

Wheat Years (1, 2)	N_0	$H^{/}$	N1	N2	E5	N_0	$H^{/}$	N1	N2	E5	t-test	df	p - value
			Open Edge					Under Tree					
LIP	57	3.458	31.77	20.54	0.635	74	3.566	35.37	15.93	0.434	-1.264	>120	0.207ns
			Open Edge					Inside Field					
LIP	57	3.458	31.77	20.54	0.635	21	2.741	15.50	14.53	0.934	7.805	>120	0.000***
			Under Tree					Inside Field					
LIP	74	3.566	35.37	15.93	0.434	21	2.741	15.50	14.53	0.934	8.855	>120	0.000***
			Open Edge					Under Tree					
HIP	34	3.237	25.46	21.60	0.842	29	2.949	19.09	16.41	0.852	2.836	>120	0.005ns
			Open Edge					Inside Field					
HIP	34	3.237	25.46	21.60	0.842	29	3.194	24.38	27.93	1.152	0.484	>120	0.629ns
			Under Tree					Inside Field					
HIP	29	2.949	19.09	16.41	0.852	29	3.194	24.38	27.93	1.152	-2.868	>120	0.004**
			LIP					HIP					
Open Edge	57	3.458	31.77	20.54	0.635	34	3.237	25.46	21.60	0.842	2.259	>120	0.02*
Under Tree	74	3.566	35.37	15.93	0.434	29	2.949	19.09	16.41	0.852	6.881	>120	0.000***
Inside Field	21	2.741	15.50	14.53	0.934	29	3.194	24.38	27.93	1.152	-5.084	>120	0.000***
Total	102	3.848	46.67	21.66	0.452	62	3.611	37.01	26.42	0.706	3.369	>120	0.000***

*P-value for the factor are given (ns: p>0.05, *: p<0.05, * *: p<0.01, * * *: p<0.001), N0 = Total No. of Species, H/ = Diversity and E = Evenness

Fig. 1: Comparison of soil nutrients between LIP and HIP wheat fields



open edge, under tree, inside field evenness was 0.635, 0.434, 0.934 in low input fields and 0.842, 0.852, 1.152 in high input, showing significant differences ($p < 0.05$), ($p < 0.01$), ($p < 0.01$), respectively. The t-test analysis was significant ($t = 3.369$; $p < 0.01$) among three micro-habitats. In relation to this, it has been observed that use of pesticides can reduce the numbers of non-target soil arthropods either directly or indirectly through alterations of the microhabitat (Pfiffner & Niggli, 1996). Reduction in use of pesticides can enhance soil biological and chemical properties (Scow *et al*., 1994), enhance nutrient cycling and reduce nutrient losses from soils (Arden-Clarke & Hodges, 1988) and reduce contamination of ground and water supplies. For future strategies, their numbers, biomass, activity and community structure is important to perform critical processes and functions of soil to establish ideal agro-climatic ecosystem because they are responsible for nutrient retention in soil. If, nutrients are not retained contained by any soil, further output will not be superlative (Huston, 1997; Symstad *et al.*, 1998; Hector *et al.*, 1999; Schwartz *et al.*, 2000; Tilman, 2000; Siddiqui *et al.*, 2005; Rana *et al.,* 2006). Scientific research has demonstrated that organic agriculture significantly increases the density and species of soils' life. Suitable conditions for soil fauna and flora as well as soil forming, conditioning and nutrient cycling can be encouraged by organic practices such as; manipulation of crop rotations and strip cropping green manuring and organic fertilization (animal manure, compost, crop residues); minimum tillage; and of course, avoidance of pesticides and herbicides use (Scialabba, 2000).

CONCLUSION

Deterioration of soil-macro-fauna is much higher in high- than in low-input farming. If this deterioration continues, the malfunctioning and eco-efficiency of agroeco-system will not prolong. This deterioration at all scales provokes to beware about the importance of this diversity because these outstanding can introduce massive extinctions among soil communities, to avoid their stern decline; and insurance against possible disturbances of ecosystem functions is dire. For future sustainability, strategies to manage of biogeochemical and hydrological cycling of soil, capitalization of biotic components, use of organic matter/low input farming is imperative.

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