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ROLE OF WEEDS IN CREATING AGRO-ECOLOGICAL STABILITY

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We devised a study to ascertain the role of weeds in agro-ecosystem. Therefore, we made seasonal cataloguing of the line data on multiple crops i.e., sugarcane, fodder, wheat and mustard to see crops' viability and role of weeds' diversity in preventing insect outbreaks by reducing crop productivity losses. We found that out of fifteen weed species, 11 weed species were of broad-leaved category while four were of pointed-leaves. The arthropod-fauna included insect pest-species from Orthoptera, Hemiptera and Lepidoptera that used weeds as priority food. Besides that, some specific zoophagous insect-predators belonging to orders Odonata, Coleoptera, Hymenoptera and Araneae were documented on similar weeds, for food, shelter and egg-laying. In the light of our observations, we concluded that there is a significant role of weeds in a crop-system that may support other essential life forms in creating ecological balance.
Keywords: Weeds, arthropods, cropland, Southern Punjab

INTRODUCTION

Agriculture in Punjab is mainly dependent on major cultivations of sugarcane, wheat, rice, cotton, and mustard. Weed populations continually persist in the crop fields and are considered as a threat to productivity but actually they have a functional role within the agro-ecosystems (Munyuli *et al.,* 2011). Such non-crop plants, being cohort of crop plants, enhance the floral diversity of a cropping system (primary producers) and act as a key component of agro-ecosystem, providing environmental heterogeneity. The ground parts provide food while aerial parts like pollen and nectar are a resource for pollinating insects, supply of cover and reproduction sites (Marshall *et al.,* 2003).

Weeds retort to landscape attributes, also have numerous interactions with other organisms and, in turn, some of these interactions can have direct, either negative or positive effects on the agro-ecosystem functioning (Hogg *et al.*, 2011). Mostly the interactions are species specific, and therefore, by assessing the role of weed communities in the agro-ecosystem would be benefited for further development in the functional grouping of weeds species. Weeds also provide alternate resources for phytophagous insects and indirectly serve zoophagous beneficial arthropod species when their preferred crop plants are absent (Norris and Kogan, 2005). A variety of insect species are dependent on specific weed for their survival. These non-crop plants support various types of invertebrates, also important for farmland birds (Williams and Kremen, 2007). Changes in agricultural practices like crop intensification is one of the major causes of floral decline, which effects the other aspects of the agro-ecosystem as well. Careful observations regarding organisms associated with these floral species provide information about the sustainability of the cropping system (Hyvonen and Huusela-Veistola, 2008).

Traditionally maintained vegetation patches support higher weed populations where such patches are present, they are occupied by many arthropods. The response of arthropod groups to vegetation cover (bare ground, litter, crop cover, broadleaf weed cover and grass cover) is very important in studying a sustainable crop system and its faunal community composition. Even where weed cover was relatively low, some relationships between arthropods and vegetation were seen (Johnson *et al.,* 1996). Addressing few of the above roles of weeds in different crops following objectives were in view, i.e., identification of major weed species associated with major crops of the area, and the faunal species associated with them, and the role of these faunal species in the crop.

MATERIALS AND METHODS

Based on different cropping pattern and agro climatic conditions, cultivations in Punjab are classified into different zones. One such zone is Cotton-Wheat zone and it constitutes vast area (2.6 mha) of southern Punjab, where pesticides are quite frequent due to cultivation of cash crops like cotton, wheat and mustard. The flora and fauna of this zone are suspected to be affected mainly due to heavy use of chemicals. One year study was conducted in sugarcane, fodder, wheat and mustard crops. Various cropland localities around the peripheral area of Multan were selected

randomly. At each locality two acres each of the available crop of sugarcane, fodder, wheat and mustard were randomly selected. Fauna associated with the weed plants was collected by quadrate method (Ruby *et al.,* 2011). Three 1 x 1 m plots 10 m apart were sampled in each acre.

All the arthropods visible to naked eyes were collected from the weeds included immature and adults whether sitting, moving or residing (sticking on the foliage or stem) on weeds. Sampled specimens were kept in properly labeled vials containing laboratory grade alcohol with few drops of glycerin. Sampling was made by hand picking, hand net and automated sifters (60 s) per quadrate. The respective weed plants were also preserved for later identification.

For identification of weed species "Flora of Pakistan" (Nasir and Ali, 1972-94; Ali and Qaiser, 1995-2011; Cope *et al.,* 1982) was consulted. Faunal identification was done with the help of available, related taxonomic information in "Fauna of British India" and online electronic keys available on different websites. Museum of the Department of Agricultural Entomology, University of Agriculture, Faisalabad and Entomological Research Institute Jhang road Faisalabad was also consulted for this purpose. The trophic levels of each species (phytophagous, zoophagous and saprophagous) were confirmed with the help of recent available literature on internet. Canonical correspondence analysis was employed to get various inferences about preferences of various weed species by arthropods. The software was applied using Canoco Computer Package for Windows (version 4.5).

RESULTS

A total of fifteen weed species were reported from different crops of the area, out of which eleven species belonged to broad leaved category while four species were pointed leaved. The species reported were *Phylla nodiflora, Chenopodium album, Cnicus arvensis, Convolvulus arvensis, Cynodon dactylon, Chenopodium murale, Cyperus rotundus, Euphorbia hirta, Eclipta alba, Malvastrum coromandelianum, Oxalis corniculata, Phalaris minor, Rumex dentatus, Solanum nigrum* and *Trianthema partulacastrum.* Out of total fifteen species, 10 were observed in sugarcane, 7 in fodder, 4 in wheat and 3 in mustard crop (Table 1). Different faunal species (arthropods) were collected from the above discussed weeds and their grouping was discussed in the following:

***Sugarcane weeds*:** Fig. 1 shows CCA for the arthropods associated with 10 weeds of sugarcane field. A strong association of some arthropods with the weeds namely, *C. murale, E. hirta, C. arvensis* and *O. corniculatus* was observed. The species associated with *C. murale* were *Coccinella larvae, Micraspis allardi, Formica rufa,* other *Formica* spp., and *C. pipiens* among the predators while *Limepithema humile, Lucilia sericata* and *Discus rotundus* among the preys/pests. Similarly the species associated with *E. hirta* were *Lestes spp., Coenagrion spp., Phyllodermia spp., C. undecumpuctata, A. affinus,* and *Hippodemia convergens* among the predators while *Pyrilla perpusilla, Nezara viridula, R. padi,* and *E. pustulatus* among the preys/pests. The species associated with *C. arvensis* were *C. septumpunctata, A. punctata, B. suturalis, P. littoralis Oxyopes spp., C. lutescens* and *A. mellifera* among the predators while *Acrididae nymph, Schistocerca nitens, Chorthipus brunni, L. lineolaris, Galleria ganus* were among the preys/pests. Similarly the species associated with *O. corniculatus* were *Neoconocephalus ensiger, Cotesia*

Table 1. Summary of weed species reported from four crops of Southern Punjab

Weed species	Sugarcane	Fodder	Wheat	Mustard	Category
Aphylla mediflora		*			P
Chenopodium album				*	B
Cnicus arvensis			*	*	B
Convulvulus arvensis	*				B
Cynodon dactylon	*	*			P
Chenopodium murale	*		*		B
Cyperus rotundus	*		*	*	P
Euphorbia hirta	*	*			B
Eclipta alba		*			B
Malvastrum coromandelianum	*				B
Oxalis corniculata	*	*			B
Phalaris minor			*		P
Rumex dentatus	*	*			B
Olanum nigrum	*	*			B
Trianthema partulacastrum	*				B
Total weed species present in each crop	10	7	4		

* = Present, B= Broad leaved, P= Pointed leaved; CWZ= cotton-wheat zone

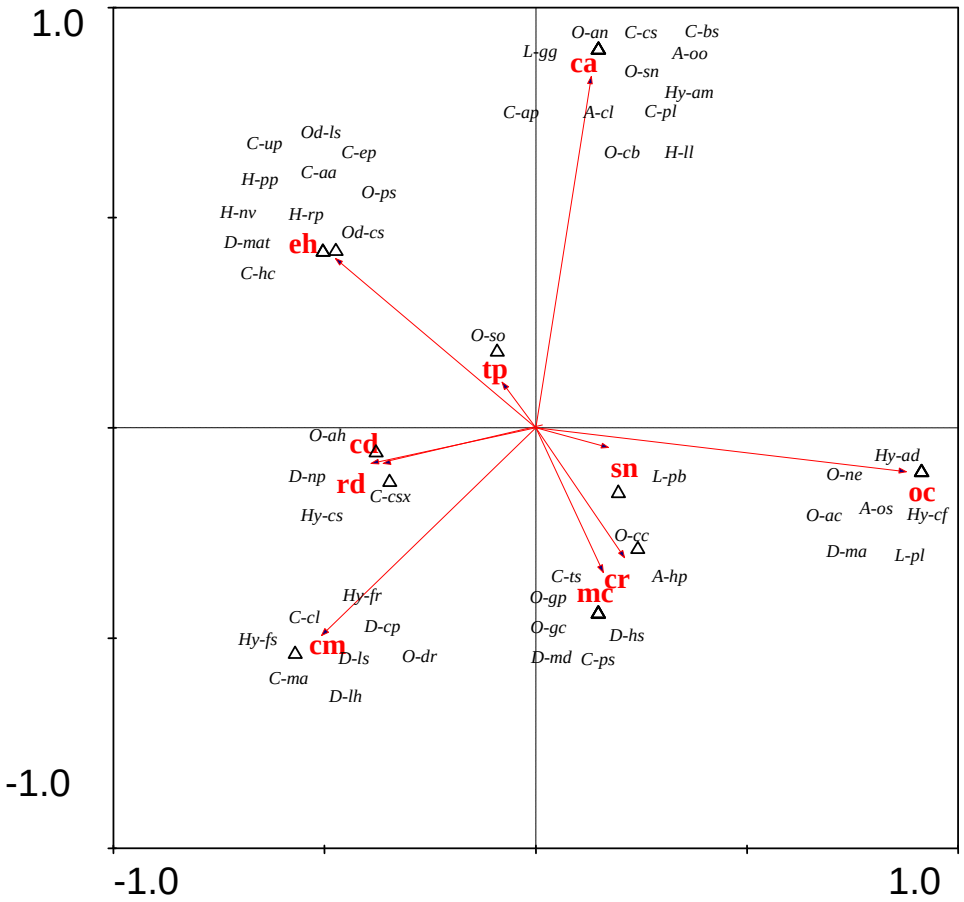

Figure 1. CCA ordination biplot showing the distribution of arthropod species on different weed of sugarcane crop in Multan.

[*Chenopodium murale* (cm), *Convolvulus arvensis* (ca), *Cynodon dactylon* (cd), *Cyperus rotundus* (cr), *Euphorbia hirta* (eh), *Malvastrum coromandelianum* (mc), *Oxalis corniculatus* (oc), *Rumex dentatus* (rd), *Solanum nigrum* (sn), *Trianthema partulacastrum* (tp)]

[Order Araneae- *Oxyopes spp* (A-os), *Oxyopes occidentalis* (A-oo), *Holoenemes pluchei* (A-hp), *Clubiona lutescens* (A-cl); Order Odonata- *Lestes spp.* (Od-ls), *Coenagrion spp.* (Od-cs); Order Orthoptera- *Chorthipus brumcus* (O-cb), *Chloealtis conspersa* (O-cc), *Shistocerca nitens* (O-sn), *Acrididae nymph* (O-an), *Gastrophysa cycanea* (O-gc), *Gryllus pennsylvanicus* (O-gp), *Discus rotundus* (O-dr), *Neoconocephalus ensiger* (O-ne), *Acrostema hilare* (O-ah), *Phyllodemia spp.* (O-ps), *Shistocerca obscura* (O-so), *Arphia conspersa* (O-ac); Order Hemiptera- *Nezara viridula* (H-nv), *Lygaeus linolaris* (H-ll), *Pyrilla perpusilla* (H-pp), *Rhopalosiphum padi* (H-rp); Order Coleoptera- *Coccinella septumpuncta* (C-cs), *Paederus littoralis* (C-pl), *Hippodermia convergns* (C-hc), *Adalia punctata* (C-ap), *Micraspis allardi* (C-ma), *Paederus spp* (C-ps), *Coccinella larvae* (C-cl), *Brumoides suturalis* (C-bs), *Cheilomenes sexmacnlata* (C-csx), *Coccinella undecimpunctata* (C-cu), *Exochomus pustulatus* (C-ep), *Attrecus affinus* (C-aa), *Tanymecus sciurus* (C-ts); Order Diptera- *Culex pipens* (D-cp), *Episyrphus baltaetus* (D-eb), *Limepithema humilc* (D-lh), *Musca domestica* (D-md), *Harplus spp.* (D-hs), *Ninenta pallida* (D-np), *Lucilia sericata* (C-ls), *Meliscava auricallis* (D.ma); *Musca autumnalis* (D-ma); Order Lepidoptera- *Galerira ganus* (L-gg), *Pyrallid larvae* (L-pl), *Pieris brassicae* (L-pb); Order Hymenoptera- *Formica spp* (Hy-fs), *Formica rufa* (Hy-fr), *Apis dorsata* (Hy-ad), *Apis mellifera* (Hy-am), *Camponohus sayi* (Hy-cs), *Cotesia flavipes* (Hy-cf)]

flavipes, *Apis dorsata*, and *Oxyopes sertatus* among predators while *Chloealtis conspersa*, *Pyrallid larvae* and *Melliscava auricallis* among the preys/pests.

***Fodder weeds*:** Figure 2 shows CCA for the arthropods associated with seven weeds of fodder field. A strong association of some arthropods with the weeds namely, *R. dentatus*, *C. dactylon* and *S. nigrum* was observed. The species associated with *R. dentatus* were *Lestes* spp., *N. ensiger*, *B. suturalis*, *C. flavipes*, *A. dorsata*, *Oxyopes spp.*, and *O. sertatus* among predators while *S. nitens*, *Arphia conspersa*, *C. brumcus*, *Pyrallid larvae*, and *M. domestica* among preys/pests. Similarly the species associated with *C. dactylon* were *C. septumpunctata*, *A. punctata* and *P. littoralis* among predators while *Acrididae nymph*, *Phyllodemia spp.*, *D. mimulus*, *M. autumnalis*, *P. brassicae* and *Porcellionides pruinosus* among preys/pests. The species associated with *S. nigrum* were *C. undecumpuctata*, *E. baltaetus*, *F. rufa*, and *C. pennsylvanicus* among predators while *Taylorilygus apicalis*, *P. perpusilla*, *Dysdercus voelkeri* and *Miridae nymph* were among the preys/pests.

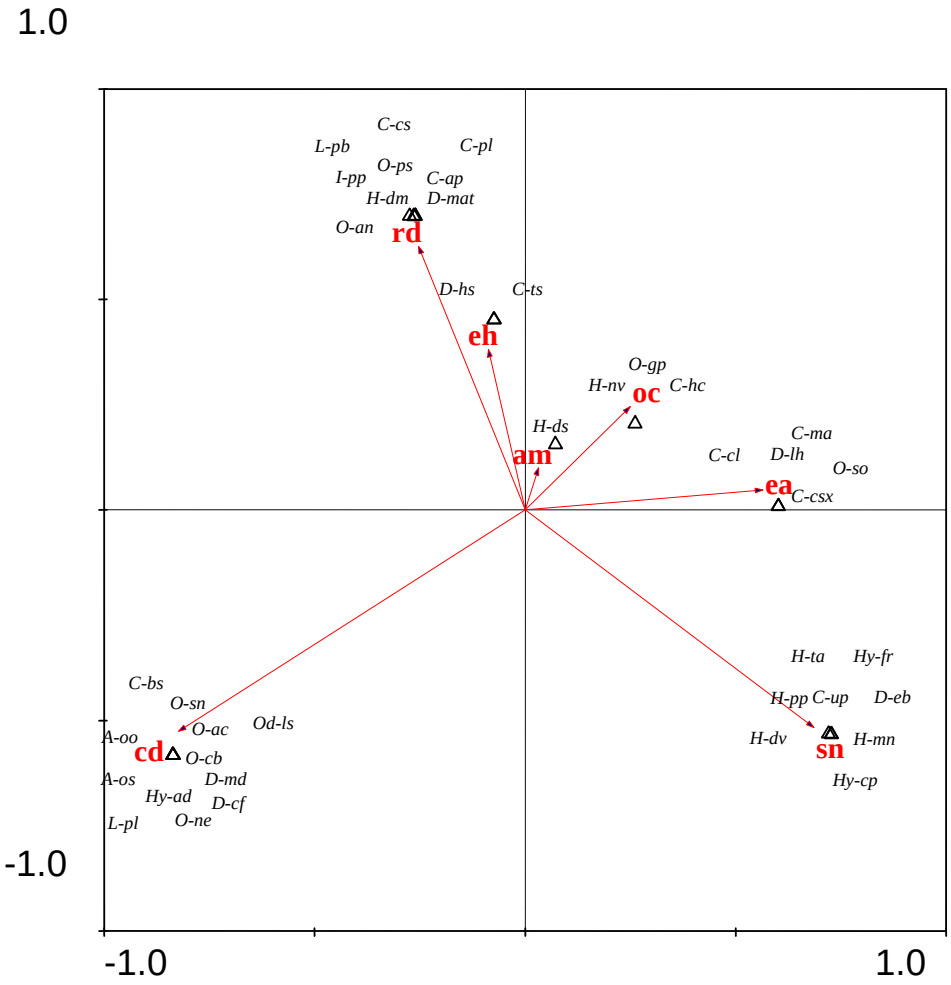

Figure 2. CCA ordination biplot showing the distribution of arthropod species on different weed of fodder crop in Multan.

[*Aphylla mediflora* (am), *Cynodon dactylon* (cd), *Eclipta alba* (ea), *Euphorbia hirta* (eh), *Oxalis corniculatus* (oc), *Rumex dentatus* (rd), *Solanum nigrum* (sn)]

[Order Araneae- *Oxyopes spp* (A-os), *Oxyopes occidentalis* (A-oo); Order Odonata- *Lestes spp.* (Od-ls); Order Orthoptera- *Chorthipus brumcus* (O-cb), *Shistocerca nitens* (O-sn), *Acrididae nymph* (O-an), *Gastrophysa cycanea* (O-gc), *Gryllus pennsylvanicus* (O-gp), *Neoconocephalus ensiger* (O-ne), *Phyllodemia spp.* (O-ps), *Shistocerca obscura* (O-so), *Arphia conspersa* (O-ac); Order Hemiptera- *Nezara viridula* (H-nv), *Lygaeus linolaris* (H-ll), *Pyrilla perpusilla* (H-pp), *Dysdercus singulatus* (H-ds), *Miridae nymph* (H-mn), *Taylorilygus apicalis* (H- ta), *Disdercus mimulus* (H-dm), *Dysdercus voelkeri* (H-dv); Order Coleoptera- *Coccinella septumpuncta* (C-cs), *Paederus littoralis* (C-pl), *Hippodermia convergns* (C-hc), *Adalia punctata* (C-ap), *Micraspis allardi* (C-ma), *Coccinella larvae* (C-cl), *Brumoides suturalis* (C-bs), *Cheilomenes sexmacnlata* (C-csx), *Coccinella undecimpunctata* (C-cu), *Tanymecus sciurus* (C-ts); Order Diptera- *Episyrphus baltaetus* (D-eb), *Limepithema humilc* (D-lh), *Musca domestica* (D-md), *Harplus spp.* (D-hs), *Musca autumnalis* (D-ma); Order Lepidoptera- *Galerira ganus* (L-gg), *Pyrallid larvae* (L-pl), *Pieris brassicae* (L-pb); Order Hymenoptera- *Formica rufa* (Hy-fr), *Apis dorsata* (Hy-ad), *Apis mellifera* (Hy-am), *Camponohus pennsylvanicus* (Hy-cp), *Cotesia flavipes* (Hy-cf); Order Isopoda- *Porcellionides pruinosus* (I-pp)]

***Wheat weeds*:** Fig. 3 shows CCA for the arthropods associated with four weeds of wheat fields. A strong association of some arthropods with the weeds namely, *C. murale*, *C. dactylon* and *P. minor* was observed. The species associated with *C. murale* were *M. allardi*, *B. suturalis*, *C. septumpunctata*, *H. convergens*, *O. javanus*, *O. sertatus*, *C. inclusum*, *C. lutescens*, and *Oxyopes spp*. among predators while *Monomorium minimum*, *F. fusca*, *D. singulatus*, *Geocoridae nymph*, *Chlorops spp*. and *M. domestica* were among the preys/pests. Similarly the species associated with *C. rotundus* were *E. baltaetus*, *Hispa atra*, *C. sexmaculata*, *C. similare*, *C. sayi*, and *C. rostrata* among predators while *X. atrimaculatus*, *Blattela asahinai*, *Miridae nymph*, *E. servus*, *M. millenium* and *M. domestica* among preys/pests. Majority of the phytophagous species namely *X. californicus*, *H. armigera*, *O. olens*, *A. flava* and a single predator species *C. novemnotata* were associated with *P. minor*.

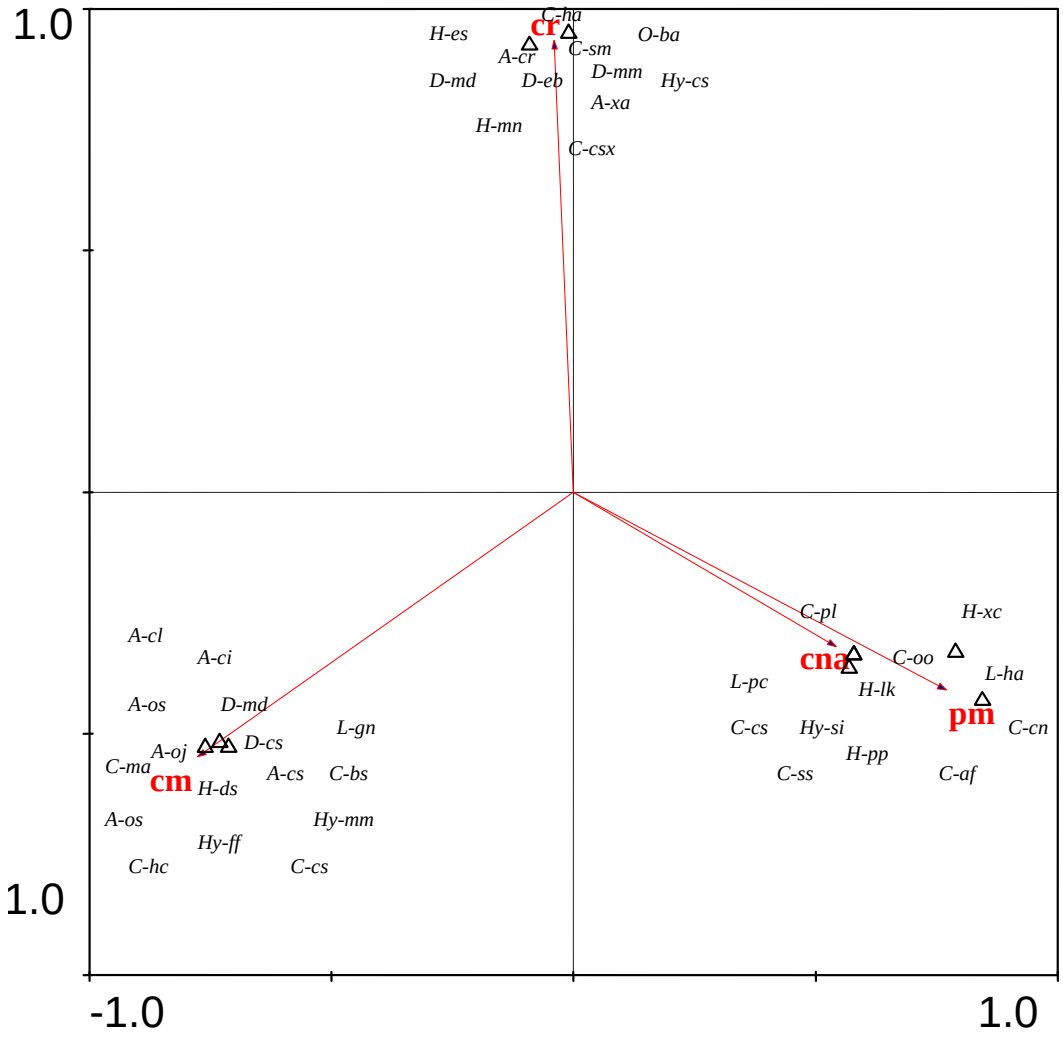

Figure 3. CCA ordination biplot showing the distribution of arthropod species on different weed of wheat crop in Multan.

[*Chenopodium murale* (cm), *Cnicus arensis* (ca), *Cyperus rotundus* (cr), *Phalaris minor* (pm)]

[Order Araneae- *Oonops spp* (A-os), *Oxyopes javanus* (A-oj), *Oxyopes sertatus* (A-os), *Cheiracanthium spp* (A-cs), *Clubiona lutescens* (A-cl), *Clubiona rostrata* (A-cr), *Cheiracanthium inclusum* (A-ci) *Xysticus atrimaculatus* (A-xa); Order Dermaptera- *Forficula auricularia* (D-fa); Order Orthoptera- *Blattela asahinai* (O-ba); Order Hemiptera- *Pyrilla perpusilla* (H-pp), *Dysdercus singulatus* (H-ds), *Miridae nymph* (H-mn), *Lygaeus kalmii* (H-lk), *Eustichus servus* (H-es), *Xynosius californicus* (H-xc); Order Coleoptera- *Coccinella septumpuncta* (C-cs), *Paederus littoralis* (C-pl), *Hippodermia convergns* (C-hc), *Micraspis allardi* (C-ma), *Brumoides suturalis* (C-bs), *Cheilomenes sexmacnlata* (C-csx), *Stenolopus spp* (C-ss), *Calosoma spp.* (C-cs), *Calosoma similare* (C-cm), *Ocyphus olens* (C-oo), *Hispa atra* (C-ha), *Aphthona flava* (C-af), *Coccinella novemnotata* (C-cn); Order Diptera- *Episyrphus baltaetus* (D-eb), *Melanostoma millenium* (D-mm), *Chlorops spp.* (D-cs), *Musca domestica* (D-md); Order Lepidoptera- *Helicoverpa armigera* (L-ha), *Pyrallid larvae* (L-pc), *Geocoridae nymph* (L-gn); Order Hymenoptera- *Formica fusca* (Hy-ff), *Camponotus sayi* (Hy-cs), *Monomorium minimum* (Hy-mm), *Solenopsis invicta* (Hy-si)]

***Mustard weeds*:** Figure 4 shows CCA for the arthropods associated with three weeds of mustard crop. A strong association of fauna was observed with all these weeds. The species associated with *C. album* were *A. turita* and *B. asahinai* among preys/pests while *H. convergens, C. rostrata, Clubiona spp., O. javanus* and *F. fusca* were among the predators. Similarly the species associated with *C. rotundus* were *Acrididae nymph, P. perpusilla, X. californicus, H. armigera, A. flava, S. spp.* among preys/pests while *P. littoralis, M. allardi, C. septumpunctata, C. lutescens* and *Araneae nymph* were among the predators. The species associated with *C. arvensis* were *A. conica, D. cingulatus, L. kalmii, M. mellinium, M. domestica* among preys/pests while *C. septumpuctata, B. suturalis, E. baltaetus, C. sayi, S. invicta* and *O. saradae* were among the predators.

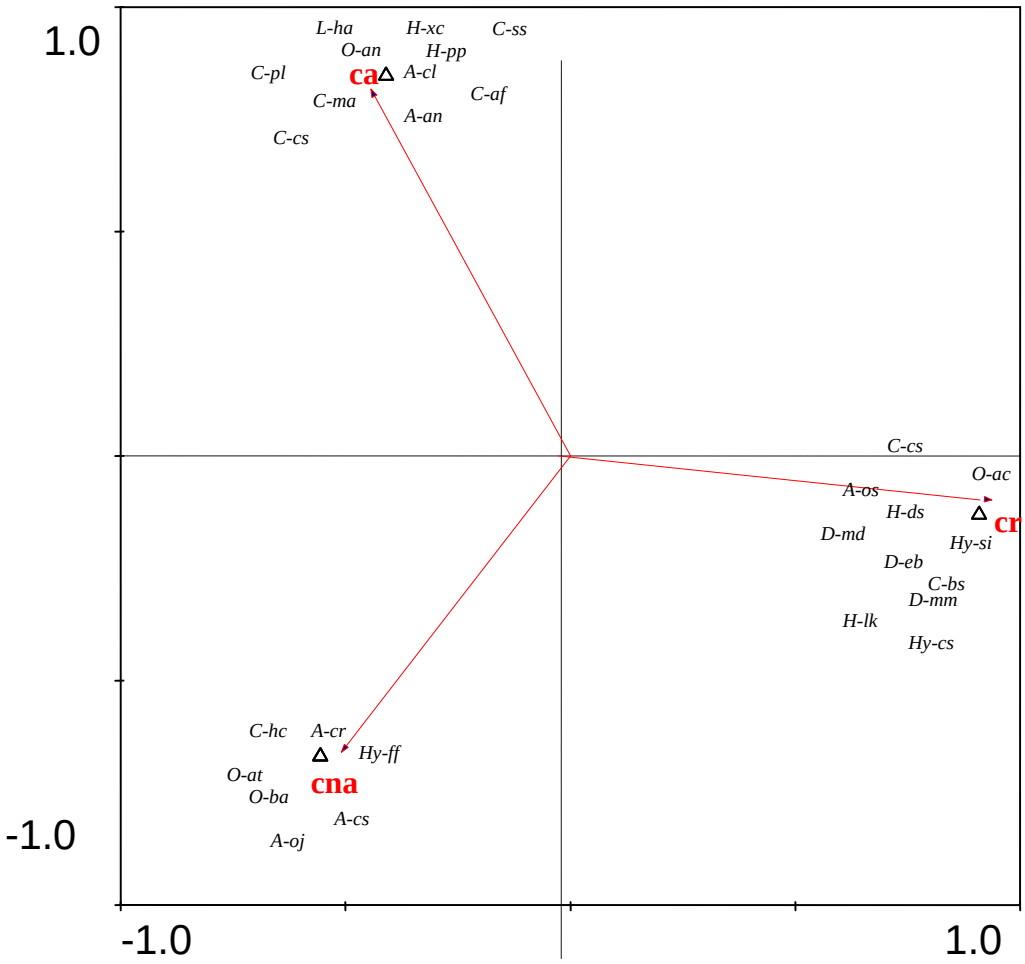

Figure 4. CCA ordination biplot showing the distribution of arthropod species on different weed of mustard crop in Multan

[*Chenopodium album* (ca), *Cnicus arvensis* (cna), *Cyperus rotundus* (cr)]

[Order Araneae- *Araneae nymph* (A-an), *Oxyopes javanus* (A-oj), *Oxyopes sertatus* (A-os), *Cheiracanthium spp* (A-cs), *Clubiona lutescens* (A-cl), *Clubiona rostrata* (A-cr); Order Orthoptera- *Acrididae nymph* (O-an), *Acrida conica* (O-ac), *Acrida turita* (O-at), *Blattela asahinai* (O-ba); Order Hemiptera- *Pyrilla perpusilla* (H-pp), *Dysdercus singulatus* (H-ds), *Lygaeus kalmii* (H-lk), *Xynosius californicus* (H-xc); Order Coleoptera- *Coccinella septumpuncta* (C-cs), *Paederus littoralis* (C-pl), *Hippodermia convergns* (C-hc), *Micraspis allardi* (C-ma), *Brumoides suturalis* (C-bs), *Cheilomenes sexmacnlata* (C-csx), *Stenolopus spp* (C-ss), *Calosoma spp*. (C-cs), *Aphthona flava* (C-af); Order Diptera- *Episyrphus baltaetus* (D-eb), *Melanostoma millenium* (D-mm), *Musca domestica* (D-md); Order Lepidoptera- *Helicoverpa armigera* (L-ha); Order Hymenoptera- *Formica fusca* (Hy-ff), *Camponotus spp*. (Hy-cs), *Solenopsis invicta* (Hy-si)]

DISCUSSION

Generally the weed plants are considered as nutrient competitors within the crop fields (Jabran *et al*., 2012; Kahliq and Matloob, 2012; Saqib *et al*., 2012) but there is another view that they add phytomorphic heterogeneity which helps to maintain many arthropod populations including phytophagous species by providing food and helps in neutralizing the potential pest attack on crop plants (Muhammad *et al*., 2013). Some zoophagous species use these weeds as an alternate host during different stages of life cycle, for shelter, and also obtain their preys which used to feed on these plants (Newton, 2004; Abbas *et al*., 2012). Moreover, weed seeds are a favorite food of many granivorous birds. In this way weeds play an important role in the complex structure of crop systems. Present study is an attempt to access the positive role of various weeds occurring within the four major crop plantations. A great increase in the yield has been observed in diversified cropping systems of the world. Ecological studies suggested that more diverse floral communities responded positively to the changes produced in result to environmental perturbation During the present study fifteen weed species were reported from the selected cropland of southern Punjab (Multan). The

presence of four pointed leaved weed species in the area is an indication of changed soil conditions which in turn has a marked effect on floral taxa of the area. Ashiq *et al.* (2003) has reported nearly 50 weed species in the cropland of Punjab of which only fifteen were pointed leaved. The applications of agrochemicals, fertilizers, herbicides and weedicides are considered to be responsible for these changes. In addition the farming practices and tillage also has a great impact on weed flora (Siddiqui, 2005).

Majority of the phytophagous species were suspected weed feeder thus diluting the pest attack on crop plants. Rest of the species belonged to high trophic level also share the weed plants as provision of cover, reproduction sites and structure within the crop system as indicated by Brown and Hyman (1995). The predator-prey relationship among the arthropods is of particular importance in the management of sustainable agro-ecosystem. Thus, the presence of phytophagous and zoophagous species is of clear indication that certainly they have some role within the cropland. Outstanding diversity and abundance of different predator groups could be interpreted in term of their high resistant power against certain specific type of stress. Araneae, Coleoptera and some Hymenoptera predators were the best example of this trend which shared fairly in the sample. Their existence could be interpreted in the light of findings of Feber *et al.* (1998) who concluded that the abundance and diversity of these taxa was directly affected by the increased levels of under story vegetation in the crop fields.

There had been records about few weed species like *C. album, A. arvensis, R. dentatus* and *F. indica* supporting 31, 50, 8 and 3 species of insects respectively. These faunal species belonged to the group of known crop pests and their natural controlling agents 'predators' **(**Marshall *et al.,* 2003). The weed species of family Polygonaceae, Magnoliaceae and Chenopodiacea are a part of food of many birds (Buxton *et al.,* 1998). Whereas, insects constituted 42% of the food items taken by little spotted owl (*Athene bramalso*) and 33% of small Indian mongoose (*Herpestes auropunctatus*) in the cropland of district Sheikhupura and Faisalabad (Mushtaq-ul-Hassan *et al.,* 2003; Rana *et al.,* 2005). Thus weeds and their fauna are playing a key role in the stability and sustainability of an agro-ecosystem.

***Conclusion*:** The weed plants are suspected to enhance the floral diversity thus, act as an important component of cropping system. They are also used as an alternate food, breeding site and safe haven by majority of arthropod species. It is suspected that such floral species are of prime importance in creating an ecological balance.

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