Research Article

Phytosociological study of weeds of wheat crop under edaphic variation: A case study from district Swabi, Khyber Pakhtunkhwa, Pakistan

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Abstract

The present study explains phytosociological attributes and communities structure of weeds of wheat crop under edaphic variation. This study was conducted in tehsil Razar district Swabi, Khyber Pakhtunkhwa, Pakistan during April 2016. A total of 200 quadrats having size (1x1 m²) were established in 20 randomly selected wheat fields. Analytical quantitative characters i.e. density, frequency and cover were calculated for each weed species. Twenty weed communities were recognized on the basis of highest importance value (HIV) of three leading species. For each community, importance values (IV) of weed species were added to obtained total important value (TIV) of three dominant species and the remaining associated species. Sorensen's index was used to study similarity between weed communities. Higher similarity (76.1%) was recorded between *Veronica-Papaver-Phalaris* community and *Trifolium-Cynodon-Melilotus* community while lower similarity (16.6%) was recorded between *Anagallis-Emex-Phalaris* community and *Veronica-Cerastium-Anagallis* community. Physico-chemical analysis of soil showed that texture ranged from sandy-loam to loam, sandy clay-loam, slit-loam and loamy-sand or sand. Soil pH ranged from 5.8 to 8.1. Electrical conductivity (EC) ranged from 0.06 dsm⁻¹ to 0.23 dsm⁻¹. Organic matter (OM) varied from 0.15% to 1.94%. While Calcium carbonates (CaCO₃) ranged from 5.5% to 23.5%. It was concluded that soil texture, pH, electrical conductivity, Calcium carbonates and organic matter were strong edaphic variables that gives rise to diverse weed species composition, richness and distribution. This research will provide baseline knowledge about the weed ecology and it will be helpful in future studies.

Keywords: Phytosociology; Razar; Similarity index; Soil analysis; Weeds; Wheat

Introduction

Phytosociology is the branch of botany which deals with the structure, composition and development of plant communities and the relationships between the species within

them. The term "Phytosociology" was first coined by "Jozef Paczoski" in 1896 [1]. According to many authors phytosociology is the branch of plant science which deals with the study of vegetation as such, with its

floristic structure, development and distribution. Phytosociology is a sub branch of plant ecology which deals with the co-occurrence of plant species in communities [2].

Weeds are unwanted plants growing in cultivated as well as in domesticated areas. Weeds are adapted to various edaphic and climatic conditions. These are distributed everywhere and no crop is free of weeds. Plant species of family Asteraceae, Brassicaceae, Fabaceae and Poaceae constitutes major weed flora in cultivated crops. [3] reported that there are almost 30,000 weed plant species in world, of them, more than 50 causing considerable damage to agricultural crops. Weeds are strong competitors and hidden enemies of crops due to their vigorous growth and compete with crops mainly for nutrients, space, water and light and also decreases quantity as well as quality of crops [4]. Seedlings of weed plants grow vigorously in crop fields and spread in an area within a short time because their seeds germinate earlier to crops. Weeds develop a mutualistic association with insect pollinators and successfully invade new area and affecting various ecosystems [5, 6]. [7] stated that the invasive weed species change the structure and composition of native plants and as a result creates pressure on food chain and food web. Some weed plants secrete certain allelochemicals which affect the growth and germination of agricultural crops [8]. The present study aimed to phytosociological attributes and communities structure of weeds of wheat crop under edaphic variation at tehsil Razar district Swabi, Khyber Pakhtunkhwa, Pakistan.

Materials and methods

Study area

Razar is recently announced tehsil in district Swabi Khyber Pakhtunkhwa, Pakistan. It lies from 34° 6' 0" to 34° 23' 0" North latitudes and 72° 12' 0" to 72° 27' 0" East

longitudes. The total area of tehsil Razar is approximately 385 Km² and its population is 583,936 as per census of 2017. The soil of the area is fertile and used for general cropping. It shows great variation in texture and color. Area has harsh climate. Summer is very hot. July and August records quite high temperature. Dust storms are very frequent at night during May and June. A rapid fall in temperature observed from October onwards. Winter is very cold. January is coldest month. Maximum rainfall is received in monsoon (July and August) during which the weather become humid and hot. Maximum humidity has been recorded in December [9].

Phytosociological study

A total of 20 wheat fields were selected randomly in the study area. At each field, 10 quadrats (square shaped) having size of (1×1m²) were placed systematically [10]. The number of weed species were counted in each quadrat and analytical quantitative characters i.e. density, frequency and cover were determined for each weed species. The relative value (RV) of each parameter for weed species were added to get the importance value (IV) [10, 11]. Weed communities were named after the three leading species having the highest importance value (HIV). For each community, importance values (IV) of weed species were added to obtained total important value (TIV) of three dominant species and the remaining associated species. Index of similarity was calculated according to Sorensen's index [12].

Soil analysis

Soil samples were collected from 0-20 cm depth at all 20 selected fields. Soil texture was determined by Hydrometer method [13]. Texture classes were determined using texture triangle [14]. Soil pH was determined with the help of pH meter [15, 16]. Electrical conductivity (EC) was determined with the help of electrical conductivity meter [16]. Soil organic matter was determined after

[17]. Calcium carbonate was determined by acid neutralization method [18].

Results and discussion

Phytosociology/Communities structure

Twenty weed communities were named and recognized on the basis of highest importance value (HIV) of three leading species. For each community, importance values (IV) of weed species were added to obtained total important value (TIV) of three dominant species and the remaining associated species (TIV= 3 dominant species; remaining associated species). These communities were 1) *Cynodon-Veronica-Medicago* community (TIV=126.42;172.86), 2) *Stellaria-Poa-Anagallis* community (TIV=97.12;202.37), 3) *Coronopus-Anagallis-Polygonum* community (TIV=66.23;233.08), 4) *Veronica-Papaver-Phalaris* community (TIV=120.75;178.85), 5) *Poa-Anagallis-Avena* community (TIV=90.2;209.69), 6) *Galium-Anagallis-Phalaris* community (TIV=83.6;216.07), 7) *Medicago-Cynodon-Polygonum* community (TIV=101.76;197.76), 8) *Cynodon-Anagallis-Polygonum* community (TIV=60.83;238.64), 9) *Cynodon-Medicago-Cerastium* community (TIV=101.38;198.83), 10) *Poa-Medicago-Anagallis* community (TIV=134.34;165.34), 11) *Trifolium-Cynodon-Melilotus* community (TIV=134.58;149.82), 12) *Chenopodium-Emex-Phalaris* community (TIV=117.54;182.11), 13) *Anagallis-Emex-Phalaris* community (TIV=131.81;149.98), 14) *Medicago-Anagallis-Coronopus* community (TIV=132.17;177.41), 15) *Veronica-Cerastium-Anagallis* community (TIV=142.89;156.92), 16) *Medicago-Veronica-Parthenium* community (TIV=134.4;180.27), 17) *Medicago-Fumaria-Phalaris* community (TIV=132.85;166.83), 18) *Anagallis-*

Medicago-Fumaria community (TIV=68.43;230.59), 19) *Melilotus-Medicago-Ranunculus* community (TIV=121.47;177.31) and 20) *Polypogon-Ranunculus-Veronica* community (TIV=158.11;141.44) (Table 1; Figure 1). While studying weeds of wheat, [19-23] named and recognized weed communities on the basis of highest importance values (HIV) of three dominant species in wheat crop at different parts of Pakistan. Based on highest total importance values (TIV > 100), the dominant weed species of these communities were *Medicago polymorpha*, *Anagallis arvensis*, *Cynodon dactylon*, *Veronica persica*, *Poa annua*, *Phalaris minor*, *Cerastium dichotomum*, *Stellaria media*, *Melilotus indica*, *Ranunculus muricatus*, *Avena sativa*, *Coronopus didymus*, *Polygonum plebeium*, *Fumaria indica*, *Polypogon monspeliensis*, *Emex spinosa* and *Parthenium hysterophorus*. The total and average importance values (TIV; AIV) of these weed species in communities were (545.39; 27.27), (463.45; 23.17), (389.27; 19.46), (346.05; 17.3), (288.21; 14.41), (260.89; 13), (260.71; 13), (232.72; 11.63), (212.54; 10.62), (202.29; 10.11), (161.82; 8), (149.56; 7.48), (147; 7.35), (146; 7.68), (144.15; 7.21), (127.44; 6.37) and (114.71; 5.73) respectively (Figure 2). The present findings support the results of [24-30] who listed *Avena sativa*, *Anagallis arvensis*, *Coronopus didymus*, *Chenopodium album*, *Cynodon dactylon*, *Emex spinosa*, *Fumaria indica*, *Melilotus indica*, *Medicago polymorpha*, *Phalaris minor*, *Polypogon monspeliensis*, *Polygonum plebeium*, *Parthenium hysterophorus*, *Poa annua*, *Ranunculus muricatus*, *Stellaria media* and *Veronica persica* as dominant weed species based on highest important values (HIV).

Table 1. Total number of species and total importance values of weed communities of wheat crop at tehsil Razar, district Swabi, Pakistan.

S. No.	Weed Communities	Total species in the community	Total Importance Values (TIV)	
			3 dominant species	Associated species
1	<i>Cynodon-Veronica-Medicago</i> community	21	126.42	172.86
2	<i>Stellaria-Poa-Anagallis</i> community	32	97.12	202.37
3	<i>Coronopus-Anagallis-Polygonum</i> community	34	66.23	233.08
4	<i>Veronica-Papaver-Phalaris</i> community	22	120.75	178.85
5	<i>Poa-Anagallis-Avena</i> community	26	90.2	209.69
6	<i>Galium-Anagallis-Phalaris</i> community	23	83.6	216.07
7	<i>Medicago-Cynodon-Polygonum</i> community	32	101.76	197.76
8	<i>Cynodon-Anagallis-Polygonum</i> community	41	60.83	238.64
9	<i>Cynodon-Medicago-Cerastium</i> community	25	101.38	198.83
10	<i>Poa-Medicago-Anagallis</i> community	21	134.34	165.34
11	<i>Trifolium-Cynodon-Melilotus</i> community	20	134.58	149.82
12	<i>Chenopodium-Emex-Phalaris</i> community	22	117.54	182.11
13	<i>Anagallis-Emex-Phalaris</i> community	21	131.81	149.98
14	<i>Medicago-Anagallis-Coronopus</i> community	26	132.17	177.41
15	<i>Veronica-Cerastium-Anagallis</i> community	15	142.89	156.92
16	<i>Medicago-Veronica-Parthenium</i> community	15	134.40	180.27
17	<i>Medicago-Fumaria-Phalaris</i> community	21	132.85	166.83
18	<i>Anagallis-Medicago-Fumaria</i> community	27	68.43	230.59
19	<i>Melilotus-Medicago-Ranunculus</i> community	21	121.47	177.31
20	<i>Polypogon-Ranunculis-Veronica</i> community	25	158.11	141.44

Figure 1. Total Important Values of three dominant and associated species in each weed community. For abbreviations of communities' names refers to Table 1.

Figure 2. Total Important Values and Average Important Values of dominant weed species.

Similarity index

Higher similarity (76.1%) was observed between *Veronica-Papaver-Phalaris* community and *Trifolium-Cynodon-Melilotus* community followed by (75.5%) in *Cynodon-Medicago-Cerastium* community and *Trifolium-Cynodon-Melilotus* community, *Trifolium-Cynodon-Melilotus* community and *Veronica-Cerastium-Anagallis* community had similarity index (74.2%), *Trifolium-Cynodon-Melilotus* community and *Medicago-Veronica-Parthenium* community (74.2%), *Poa-Medicago-Anagallis* community and *Cynodon-Medicago-Cerastium* community (73.9%), *Galium-Anagallis-Phalaris* community and *Poa-Anagallis-Avena* community (73.4%), *Poa-Medicago-Anagallis* community and *Trifolium-Cynodon-Melilotus* community (73.1%), *Medicago-Veronica-Parthenium* community and *Poa-Medicago-Anagallis* community (72.2%), *Medicago-Cynodon-Polygonum* community and *Cynodon-Anagallis-Polygonum* (71.2%), *Medicago-Fumaria-*

Phalaris community and *Anagallis-Medicago-Fumaria* community (70.8%), *Poa-Anagallis-Avena* community and *Cynodon-Medicago-Cerastium* community (70.5%), *Stellaria-Poa-Anagallis* community and *Veronica-Papaver-Phalaris* community (70.3%), *Veronica-Papaver-Phalaris* community and *Veronica-Cerastium-Anagallis* community (70.2%) and *Cynodon-Medicago-Cerastium* community and *Medicago-Veronica-Parthenium* community (70.0%). Other communities showed similarity less than 70.0%. While lower similarity less than 27.2% was observed between *Anagallis-Emex-Phalaris* community and *Medicago-Veronica-Parthenium* community (22.2%) followed by (21.7%) in *Anagallis-Emex-Phalaris* community and *Polypogon-Ranunculus-Veronica* community and (16.6%) in *Anagallis-Emex-Phalaris* community and *Veronica-Cerastium-Anagallis* community (Table 2). Index of Similarity is used for comparing different plant communities in specific area. High similarity between plant

communities is due to similarity in soil textures, pH, electrical conductivity, nutrients and organic matter. Least similarity between plant communities is due to variation in climate and soil conditions. [31] studied index of similarity between different weed communities of wheat at district Swat, Pakistan. Similarly, [23] determined similarity index for weed communities of wheat at village Lahor, district Swabi, Pakistan, which strongly support the present findings.

Soil analysis

Physico-chemical analysis of soil showed that the texture ranged from sandy-loam to loam, sandy clay-loam, slit-loam and loamy-sand or sand. Soil pH ranged from 5.8 for *Poa-Anagallis-Avena* community to 8.1 for *Cynodon-Anagallis-Polygonum* community. Electrical conductivity ranged from 0.06 dsm^{-1} for *Poa-Medicago-Anagallis* community to 0.23 dsm^{-1} for *Melilotus-Medicago-Ranunculus* community. Organic matter varied from 0.15% for *Polypogon-Ranunculus-Veronica* community to 1.94% for *Medicago-Veronica-Parthenium* community. While CaCO_3 ranged from 5.5% for *Cynodon-Medicago-Cerastium* community to 23.5% for *Anagallis-Emex-Phalaris* community (Table 3). Soil is main

abiotic ecological factor that play important role in the distribution of plant communities in particular area. Soil texture, electrical conductivity, pH, organic matter and carbonates play key role in weed species diversity and distribution. [26] stated that texture, electrical conductivity, pH, organic matter and carbonates play an important role in weed species diversity. [32] reported that soil organic matter is main soil fertility factor that affects the distribution of plant diversity. Furthermore, [33] reported that soil texture control infiltration rate, water holding capacity, availability of moisture and plant nutrition. Soil texture, organic carbon and salinity are main three factors for weed species richness and composition [34-36]. Generally, the soil of the study area is basic and rarely acidic. Compare to [25] who found same type of soil pH ranges 6.5-7.5 from Doon Valley India while studying weed communities of wheat fields, which strongly support our findings. [20] analyzed three soil series for texture, electrical conductivity, pH, and organic matter. Similarly, [27] studied phytosociology of weeds of wheat crop under the edaphic variations i.e. Soil texture, electrical conductivity, pH and organic matter.

Table 2. Similarity between weed communities of wheat crop at tehsil Razar, district Swabi, Pakistan.

Weed Communities																			
<i>Cynodon-Veronica-Medicago</i> community	X																		
<i>Stellaria-Poa-Anagallis</i> community	56.6	X																	
<i>Coronopus-Anagallis-Polygonum</i> community	58.1	66.6	X																
<i>Veronica-Papaver-Phalaris</i> community	65.1	70.3	67.8	X															
<i>Poa-Anagallis-Avena</i> community	63.8	58.6	56.6	62.5	X														
<i>Galium-Anagallis-Phalaris</i> community	50.0	61.8	52.6	62.2	73.4	X													
<i>Medicago-Cynodon-Polygonum</i> community	56.6	59.3	66.6	48.1	58.6	54.5	X												
<i>Cynodon-Anagallis-Polygonum</i> community	58.0	57.5	64.0	50.7	50.7	56.2	71.2	X											
<i>Cynodon-Medicago-Cerastium</i> community	56.5	66.6	64.4	68.0	70.5	66.6	63.1	54.5	X										
<i>Poa-Medicago-Anagallis</i> community	52.3	52.8	50.9	65.1	59.5	54.5	49.0	48.3	73.9	X									
<i>Trifolium-Cynodon-Melilotus</i> community	53.6	69.2	66.6	76.1	60.8	69.7	50.0	52.4	75.5	73.1	X								
<i>Chenopodium-Emex-Phalaris</i> community	60.4	55.5	64.2	50.0	41.6	53.3	55.5	57.1	51.0	46.5	57.1	X							
<i>Anagallis-Emex-Phalaris</i> community	33.3	30.1	43.6	32.5	34.0	27.2	49.0	38.7	39.1	33.3	29.2	27.9	X						
<i>Medicago-Anagallis-Coronopus</i> community	42.5	37.9	53.3	41.6	46.1	44.8	58.6	53.7	58.8	51.0	47.8	45.8	55.3	X					
<i>Veronica-Cerastium-Anagallis</i> community	55.5	46.8	48.9	70.2	58.5	57.8	38.3	42.8	60.0	66.6	74.2	54.0	16.6	39.0	X				
<i>Medicago-Veronica-Parthenium</i> community	50.0	46.8	44.9	59.4	58.5	63.1	51.0	42.8	70.0	72.2	74.2	48.6	22.2	48.7	66.6	X			
<i>Medicago-Fumaria-Phalaris</i> community	57.1	64.1	54.5	69.7	51.0	54.5	49.0	51.6	65.2	57.1	68.2	41.8	42.8	46.8	55.5	50.0	X		
<i>Anagallis-Medicago-Fumaria</i> community	58.3	61.0	62.3	65.3	60.3	60.0	54.2	64.7	69.2	58.3	63.8	57.1	37.5	60.3	47.6	52.3	70.8	X	
<i>Melilotus-Medicago-Ranunculus</i> community	42.8	56.6	54.5	60.4	59.5	59.0	52.8	51.6	62.5	61.9	63.4	41.8	38.0	46.8	50.0	50.0	61.9	54.1	X
<i>Polypogon-Ranunculis-Veronica</i> community	30.4	42.1	40.6	34.0	47.0	50.0	42.1	36.3	60.0	43.4	57.7	38.3	21.7	31.3	30.0	40.0	39.1	46.1	52.1

Table 3. Physico-chemical characteristics of soil of different weed communities of wheat crop at tehsil Razar, district Swabi, Pakistan.

S. No.	Communities	pH (1:5)	EC (1:5)	O.M	CaCO ₃	Sand	Silt	Clay	Textural Class
-----	-----	-----	ds ^m ⁻¹	%		%			-----
1	CVM	7.8	0.13	0.77	18.5	62.2	22.6	15.2	Sandy loam
2	SPA	7.7	0.12	1.03	19.5	52.2	28.6	19.2	Sandy loam
3	CAP	7.4	0.15	0.25	17.2	78.0	18.8	3.2	Loamy sand
4	VPP	7.3	0.16	1.13	16.6	89.4	1.4	9.2	Sandy
5	PAA	5.8	0.14	1.81	12.5	49.6	27.2	23.2	Sandy clay-loam
6	GAP	7.6	0.20	1.03	16.8	74.0	8.8	17.2	Sandy loam
7	MCP	7.8	0.11	1.29	22.2	68.8	14.0	17.2	Sandy loam
8	CAP	8.1	0.08	1.03	18.7	82.4	4.2	13.4	Loamy sand
9	CMC	6.9	0.13	0.51	5.5	33.4	54.8	11.8	Silt loam
10	PMA	7.4	0.06	0.51	11.0	81.4	5.4	13.2	Sandy loam
11	TCM	7.4	0.15	0.77	6.5	53.2	29.8	17.0	Sandy loam
12	CEP	6.0	0.14	1.38	10.7	53.4	26.0	20.6	Sandy clay-loam
13	AEP	7.2	0.16	0.25	23.5	41.6	49.8	8.6	Loam
14	MAC	7.3	0.14	1.03	10.5	78.2	4.6	17.2	Sandy loam
15	VCA	6.5	0.12	1.24	10.5	75.4	8.6	16.0	Sandy loam
16	MVP	6.8	0.10	1.94	6.5	83.4	4.4	12.2	Loamy sand
17	MFP	7.8	0.10	0.39	14.2	47.6	48.6	3.8	Sandy loam
18	AMF	7.6	0.15	1.60	13.0	88.8	2.0	9.2	Loamy sand
19	MMR	7.6	0.23	1.03	14.6	70.0	6.8	23.2	Sandy clay-loam
20	PRV	7.9	0.17	0.15	16.0	43.4	52.0	4.6	Silt loam

Note: For abbreviations of communities' names refers to Table 1 & 2.

Conclusion

It was concluded that soil texture, pH, electrical conductivity (EC), Calcium carbonates and organic matter were the strong edaphic variables for diverse weed species composition, richness and distribution. The present finding suggests that a variety of weed plants infesting wheat crop in the study area that may cause losses to yield of wheat crop. For acquiring the better yield, it is necessary to take appropriate biological, chemical and mechanical measures for weed control.

Authors' contributions

Conceived and designed the experiments: N Akhtar, Performed the experiments: M Anwar, Analyzed the data: M Anwar, Contributed reagents/ materials/ analysis tools: S Khalid, Wrote the paper: M Anwar.

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