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Research Article

Two Way Indicator Species Analysis and Distribution Pattern of Weeds of Maize Crop in District Swabi, Khyber Pakhtunkhwa, Pakistan

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Abstract: The present study explains Two Way Indicator Species Analysis (TWINSPAN) and distribution pattern of weeds of maize crop in district Swabi, Khyber Pakhtunkhwa, Pakistan during August-October, 2018. Weed flora of maize comprised 28 species belonging to 27 genera and 15 families. Based on modified TWINSPAN, Whittaker's beta-diversity and 5 pseudospecies cut levels (0, 2, 5, 10, 20) as classification parameters and Chi-square as fidelity measure, 5 weed communities were separated viz; *Cleome-Eleusine-Achyranthes* community, *Citrullus-Boerhavia-Commelina* community, *Parthenium-Leptochloa-Cynodon* community, *Digitaria-Cynodon-Echinochloa* community, and *Trianthema-Dactyloctenium-Cyperus* community. According to Oosting's scale, in site-1, six (6) species were observed very rarely (Class I), one (1) species rare (Class II), six (6) species infrequent (Class III), two (2) species abundant (Class IV) and three (3) species very abundant (Class V). In site-2, three (3) species were observed very rare (Class I), four (4) species rare (Class II), three (3) species infrequent (Class III), three (3) species abundant (Class IV), and one (1) species very abundant (Class V). In site-3, four (4) species were observed very rare (Class I), three (3) species rare (Class II), two (2) species infrequent (Class III), four (4) species abundant (Class IV), and two (2) species very abundant (Class V). Similarly, in site-4, four (4) species each were observed very rarely (Class I) and rare (Class II), five (5) species infrequent (Class III), one (1) species abundant (Class IV), and two (2) species very abundant (Class V). It was concluded that the most densely populated and frequently distributed weed species among all the selected sites were *Cynodon dactylon, Dactyloctenium aegyptium, Digitaria ciliaris, Echinochloa colona*, and *Euphorbia prostrata.* These weed plants infesting the maize crop that may cause a loss to crop yield. For acquiring better yield, it is necessary to take the appropriate chemical, mechanical and biological measurements for weed control.

Keywords: Distribution Pattern, TWINSPAN, Weeds, Maize, Swabi.

1. INTRODUCTION

District Swabi was declared and upgraded to the district on 1st July 1988. Before the up-gradation, it was a tehsil of district Mardan, Pakistan. It is lies between 33°-55' and 34°-23' North latitude and 72°-13' and 72°-49' East longitude. District Swabi is divided into 4 tehsils, namely Swabi, Lahor, Razar, and Topi. It is bounded on the north by district Buner, on the east by district Haripur, on the south by district Attock, and west by Mardan and Nowshera districts. The total area of the district is 1,543 square km. Swabi has 2 regions; the northern hilly area and southern plain. The soil of the district is fertile and shows great variation in color and texture. Swabi has an extreme climate with hot summer. A steep temperature rise occurred from May onward. The hottest month is August (40°C). From October onward temperature is gradually decreased. January is the coldest month (2°C). In monsoon, in July and August maximum rainfall (125.8 mm) occurred during which the weather becomes humid and hot [1].

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. There are almost 30,000 weed plants in the world, of them, more than 50 causing considerable damage to agricultural crops [2]. Weeds are strong competitors of crops due to

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their vigorous growth which competes with crops mainly for water, nutrients, space, and light and decreases quantity as well as the quality of crop [3]. 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 relationship with insect pollinators affecting various ecosystems and successfully invade new areas [4, 5]. The invasive weed species change the composition of native plants and as a result, creates pressure on ecological energetics [6]. Some weed plants secrete certain allelochemicals which affect the growth and germination of agricultural crops [7]. A variety of weed plants growing in the maize crop fields in the study area. The review reveals that there is no detailed study regarding the ecological characteristics of weed plants growing in the maize crop fields in district Swabi. Therefore, the aim and objectives of the present study were to explore the TWINSPAN classification and distribution pattern of weeds of maize crop in district Swabi, Khyber Pakhtunkhwa, Pakistan. This research will provide baseline knowledge about weed ecology and it will be helpful in future studies.

2. MATERIALS AND METHODS

2.1. Sites Selection and Field Survey

Maize fields in four sites were selected in the study area on the basis of floristic composition and physiognomy contrast during August-October, 2018. Field data was collected using the random sampling method [8]. A total of 50 quadrates/relevés (square-shaped) of 1m×1m size were studied. In each quadrat/relevé, the cover was recorded using a modified Braun-Blanquet scale [9].

2.2. Data Storage and Statistical Analysis

Data of 50 quadrates/*relevés* was stored as comma-delimited (CSV) format in MS excel and then exported to the JUICE program (Ver.7.0) [10]. The same data was stored and classified by using modified TWINSPAN, a divisive polythetic clustering technique, developed by [11] in the host JUICE program. For creating clusters, Whittaker's beta-diversity and 5 pseudospecies cut levels (0, 2, 5, 10, 20) were set as TWINSPAN parameters and Chi-square as fidelity measure. Fidelity values of important species in a short synoptic table were set as significant at $p \leq 0.05$ after Fischer exact test. Each community was named on the basis of the three foremost species with the highest percentage frequency and fidelity values. The number of weed species was counted in each quadrat and analytical quantitative characters i.e. density and frequency were determined for each weed species [8, 12].

2.3. Weed Species Distribution

The distribution of weed species was determined by using Oosting's scale [13]. The Oosting scale are; Class I= Very rare; Class II= Rare; Class III= Infrequent; Class IV= Abundant; Class V= Very abundant

3. RESULTS

3.1. TWINSPAN Classification

Five weed communities were separated on the basis of modified TWINSPAN. Fidelity values of important species which are significant at $p \leq 0.05$ after Fischer's exact test are showing in a short synoptic table. These communities were;
(1) *Cleome-Eleusine-Achyranthes* community,
(2) *Citrullus-Boerhavia-Commelina* community,
(3) *Parthenium-Leptochloa-Cynodon* community,
(4) *Digitaria-Cynodon-Echinochloa* community,
(5) *Trianthema-Dactyloctenium-Cyperus* community (Table 1, Fig. 1).

3.2. Weed Species Distribution

According to Oosting's scale, in site-1, six (6) species were observed very rare (Class I), one (1) species rare (Class II), six (6) species infrequent (Class III), two (2) species abundant (Class IV) and three (3) species very abundant (Class V). In site-2, three (3) species were observed very rare (Class I), four (4) species rare (Class II), three (3) species infrequent (Class III), three (3) species abundant (Class IV) and one (1) species very abundant (Class V). In site-3, four (4) species were observed very rare (Class I), three (3) species rare (Class II), two (2) species infrequent (Class III), four (4) species abundant (Class IV) and two (2) species very abundant (Class V). Similarly, in site-4, four (4) species each were observed very rare (Class I) and rare (Class II), five (5) species infrequent (Class

III), one (1) species abundant (Class IV) and two (2) species very abundant (Class V). Oosting's scale revealed that very abundant (Class V) weed species observed were *Cynodon dactylon* in site-1, site-3 and site-4, *Dactyloctenium aegyptium* in site-2, *Digitaria ciliaris* in site-4, *Echinochloa colona* in site-1 and site-3 while *Euphorbia prostrata* in site-1 (Table 2, Fig. 2).

3.3. Weed Species Density and Frequency

The highest species density (2.0) for *Cynodon dactylon* and (1.0) for *Digitaria ciliaris* was recorded in site-4. Similarly, the highest species density (2.0) was recorded for *Echinochloa colona* in site-3. In site-1, the highest species density (1.5) for *Euphorbia prostrata* and (1.0) for *Dactyloctenium aegyptium* was recorded in site-2. The most frequent weed species among the selected sites with frequency percentage (>70%) were *Convolvulus arvensis, Cynodon dactylon, Dactyloctenium aegyptium, Digitaria ciliaris, Echinochloa colona* and *Euphorbia prostrata* (Table 3).

4. DISCUSSION

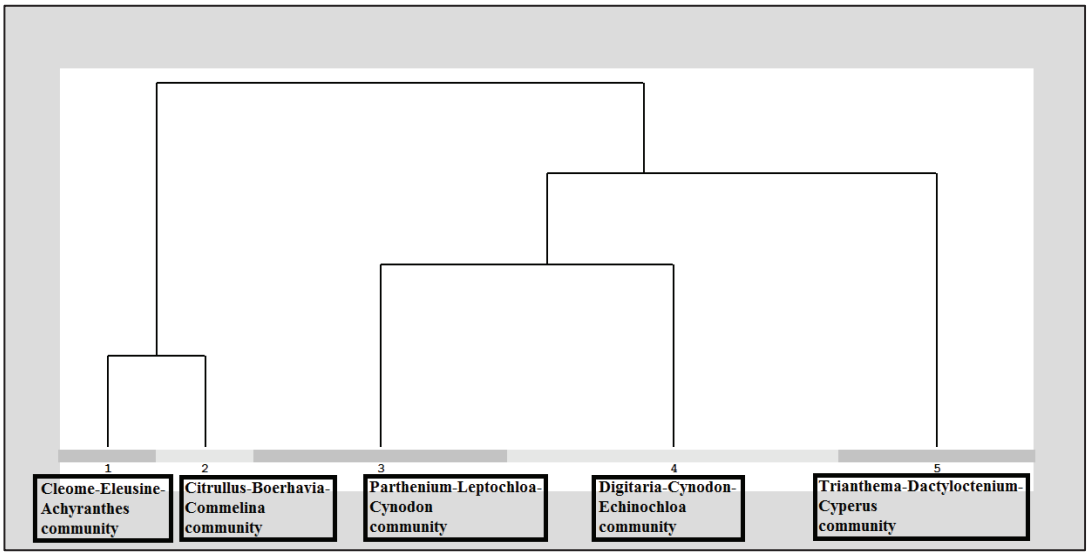

Fig.1. Cluster dendrogram of five weed communities of maize crop in district Swabi.

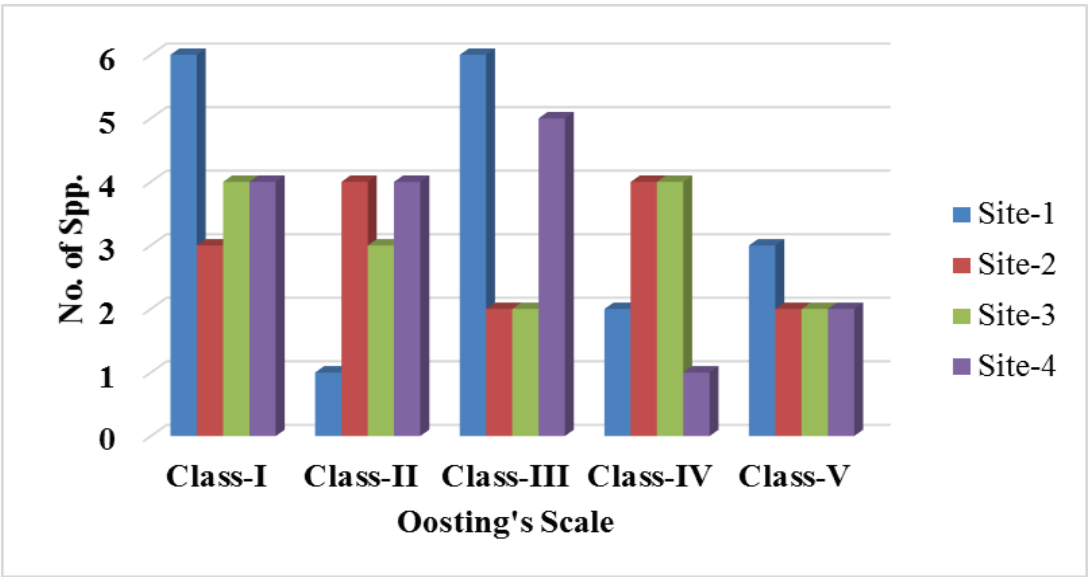

Fig. 2. Oosting's scale of weed species of maize crop in four selected sites of district Swabi

Table 1. Synoptic table of weed communities of maize crop with percentage frequency and fidelity index (as superscripts) in district Swabi, Pakistan

Group No.		**1**	**2**	**3**	**4**	**5**
No. of relevés		**5**	**5**	**13**	**17**	**10**
S. No.	**Species/Communities Name**	**CEA**	**CBC**	**PLC**	**DCE**	**TDC**
1	*Cyperus rotundus*	20 ---	. ---	. ---	53 ---	100 4.3
2	*Commelina benghalensis*	. ---	100 4.4	31 ---	. ---	20 ---
3	*Brachiaria ramosa*	. ---	. ---	. ---	. ---	50 4.7
4	*Cynodon dactylon*	100 ---	. ---	100 2.1	100 2.5	50 ---
5	*Dactyloctenium aegyptium*	. ---	. ---	62 2.2	. ---	100 4.7
6	*Digitaria ciliaris*	. ---	100 ---	62 ---	100 3.2	60 ---
7	*Echinochloa colona*	. ---	100 ---	100 ---	100 ---	90 ---
8	*Eleusine indica*	100 2.6	100 2.6	31 ---	. ---	90 3.1
9	*Leptochloa panicea*	100 ---	100 ---	100 3.4	. ---	70 ---
10	*Sorghum halepense*	. ---	. ---	. ---	. ---	70 5.7
11	*Portulaca oleracea*	40 ---	80 ---	46 ---	35 ---	40 ---
12	*Trianthema portulacastrum*	. ---	. ---	. ---	29 ---	100 5.4
13	*Achyranthes aspera*	100 2.4	100 2.4	31 ---	29 ---	60 ---
14	*Alternanthera pungens*	. ---	. ---	. ---	53 2.3	70 2.9
15	*Amaranthus tenuifolius*	. ---	. ---	. ---	. ---	60 5.2
16	*Amaranthus viridis*	. ---	. ---	. ---	. ---	30 3.6
17	*Digera muricata*	20 ---	. ---	31 ---	. ---	50 2.7
18	*Parthenium hysterophorus*	. ---	. ---	100 5.4	29 ---	10 ---
19	*Cleome viscosa*	100 4.2	100 4.2	. ---	. ---	20 ---
20	*Convolvulus arvensis*	. ---	. ---	38 3.4	. ---	10 ---
21	*Ipomoea triloba*	. ---	20 ---	. ---	. ---	. ---
22	*Citrullus colocynthis*	. ---	100 7.1	. ---	. ---	. ---
23	*Euphorbia prostrata*	. ---	. ---	38 ---	53 2.8	. ---
24	*Sesbania concolor*	20 ---	. ---	31 ---	. ---	70 3.8
25	*Malvastrum tricuspidatum*	. ---	. ---	23 ---	. ---	50 3.3
26	*Boerhavia procumbens*	40 ---	100 5.8	. ---	. ---	. ---
27	*Physalis minima*	20 ---	. ---	. ---	24 2.3	. ---
28	*Corchorus olitorius*	. ---	. ---	. ---	. ---	30 3.6

Table 2. Distribution of weed species in maize crop according to Oosting's scale in four sites of district Swabi.

S. No.	Species Name	Family	Sites/Oosting's scale			
			Site-1	Site-2	Site-3	Site-4
1	*Achyranthes aspera* L.	Amaranthaceae	-	-	I	-
2	*Alternanthera pungens* Kunth	Amaranthaceae	I	I	-	-
3	*Amaranthus tenuifolius* Willd.	Amaranthaceae	I	-	-	I
4	*Amaranthus viridis* L.	Amaranthaceae	-	III	-	-
5	*Boerhavia procumbens* Banks ex Roxb.	Nyctaginaceae	-	-	I	-
6	*Brachiaria ramosa* (L.) Stapf	Poaceae	III	-	-	III
7	*Citrullus colocynthis* (L.) Schrad.	Cucurbitaceae	I	I	III	III
8	*Cleome viscosa* L.	Capparidaceae	-	-	IV	-
9	*Commelina benghalensis* L.	Commelinaceae	III	II	-	I
10	*Convolvulus arvensis* L.	Convulvolaceae	IV	IV	-	III
11	*Corchorus olitorius* L.	Tiliaceae	-	-	I	-
12	*Cynodon dactylon* (L.) Pers.	Poaceae	V	IV	V	V
13	*Cyperus rotundus* L.	Cyperaceae	III	-	IV	II
14	*Dactyloctenium aegyptium* (L.) Willd.	Poaceae	III	V	II	II
15	*Digera muricata* (L.) Mart.	Amaranthaceae	-	IV	IV	III
16	*Digitaria ciliaris* (Retz.) Koeler	Poaceae	IV	III	-	V
17	*Echinochloa colona* (L.) Link	Poaceae	V	II	V	II
18	*Eleusine indica* (L.) Gaertn.	Poaceae	-	-	IV	IV
19	*Euphorbia prostrata* Aiton	Euphorbiaceae	V	II	-	-
20	*Ipomoea triloba* L.	Convulvolaceae	I	-	-	-
21	*Leptochloa panicea* (Retz.) Ohwi	Poaceae	I	-	-	II
22	*Malvastrum coromandelianum* (L.) Garcke	Malvaceae	-	-	I	-
23	*Parthenium hysterophorus* L.	Asteraceae	III	III	III	III
24	*Physalis minima* L.	Solanaceae	II	-	-	I
25	*Portulaca oleracea* L.	Aizoaceae	-	I	-	-
26	*Sesbania concolor* J.B. Gillett	Fabaceae	-	-	II	-
27	*Sorghum halepense* (L.) Pers.	Poaceae	I	-	-	-
28	*Trianthema portulacastrum* L.	Aizoaceae	III	II	II	I

Table 3. Density and Frequency of weed species of maize crop in different sites of district Swabi, Pakistan

S. No.	Species Name	Family	Site-1		Site-2		Site-3		Site-4	
			Density	Frequency	Density	Frequency	Density	Frequency	Density	Frequency
1	*Achyranthes aspera* L.	Amaranthaceae	-	-	-	-	0.1	10 %	-	-
2	*Alternanthera pungens* Kunth	Amaranthaceae	0.1	10 %	0.1	10 %	-	-	-	-
3	*Amaranthus tenuifolius* Willd.	Amaranthaceae	0.2	20 %	-	-	-	-	0.2	20 %
4	*Amaranthus viridis* L.	Amaranthaceae	-	-	0.5	50 %	-	-	-	-
5	*Boerhavia procumbens* Banks ex Roxb.	Nyctaginaceae	-	-	-	-	0.1	10 %	-	-
6	*Brachiaria ramosa* (L.) Stapf	Poaceae	0.5	50 %	-	-	-	-	0.6	60 %
7	*Citrullus colocynthis* (L.) Schrad.	Cucurbitaceae	0.2	20 %	0.1	10 %	0.5	50 %	0.6	60 %
8	*Cleome viscosa* L.	Capparidaceae	-	-	-	-	0.7	70 %	-	-
9	*Commelina benghalensis* L.	Commelinaceae	0.6	60 %	0.4	40 %	-	-	0.2	20 %
10	*Convolvulus arvensis* L.	Convulvolaceae	0.8	80 %	0.8	50 %	-	-	0.5	40 %
11	*Corchorus olitorius* L.	Tiliaceae	-	-	-	-	0.1	10 %	-	-
12	*Cynodon dactylon* (L.) Pers.	Poaceae	0.9	90 %	0.7	50 %	0.9	90 %	2.0	100 %
13	*Cyperus rotundus* L.	Cyperaceae	0.6	40 %	-	-	0.8	50 %	0.4	20 %
14	*Dactyloctenium aegyptium* (L.) Willd.	Poaceae	0.5	40 %	1.0	90 %	0.4	30 %	0.3	30 %
15	*Digera muricata* (L.) Mart.	Amaranthaceae	-	-	0.7	50 %	0.7	70 %	0.6	40 %

S. No.	Species Name	Family	Site-1		Site-2		Site-3		Site-4	
			Density	Frequency	Density	Frequency	Density	Frequency	Density	Frequency
16	*Digitaria ciliaris* (Retz.) Koeler	Poaceae	0.7	70 %	0.6	50 %	-	-	1.0	90 %
17	*Echinochloa colona* (L.) Link	Poaceae	1.0	80 %	0.4	20 %	2.0	90 %	0.4	20 %
18	*Eleusine indica* (L.) Gaertn.	Poaceae	-	-	-	-	0.8	60 %	0.7	40 %
19	*Euphorbia prostrata* Aiton	Euphorbiaceae	1.5	80 %	0.4	20 %	-	-	-	-
20	*Ipomoea triloba* L.	Convulvolaceae	0.1	10 %	-	-	-	-	-	-
21	*Leptochloa panicea* (Retz.) Ohwi	Poaceae	0.2	20 %	-	-	-	-	0.4	30 %
22	*Malvastrum coromandelianum* (L.) Garcke	Malvaceae	-	-	-	-	0.1	10 %	-	-
23	*Parthenium hysterophorus* L.	Asteraceae	0.6	50 %	0.5	30 %	0.5	50 %	0.5	40 %
24	*Physalis minima* L.	Solanaceae	0.3	20 %	-	-	-	-	0.1	10 %
25	*Portulaca oleracea* L.	Aizoaceae	-	-	0.1	10 %	-	-	-	-
26	*Sesbania concolor* J.B. Gillett	Fabaceae	-	-	-	-	0.4	40 %	-	-
27	*Sorghum halepense* (L.) Pers.	Poaceae	0.2	20 %	-	-	-	-	-	-
28	*Trianthema portulacastrum* L.	Aizoaceae	0.6	50 %	0.3	20 %	0.3	10 %	0.2	20 %

Weeds are unwanted plants growing in cultivated as well as in domesticated areas. Weeds are strong competitors of crops due to their vigorous growth which competes with crops mainly for water, nutrients, space, and light and decreases quantity as well as the quality of the crop. In the study area a variety of weeds infesting maize crop. The present study revealed a total of 28 weed species distributed in 27 genera and 15 families were reported from the study area. Poaceae and Amaranthaceae were leading families followed by Aizoaceae and Convolvulaceae. Comparing with Muhammad et al [14] they reported 39 weed species distributed in 21 families from maize crop of FR Bannu, Pakistan; Ullah et al [15] recorded 31 weeds species of 15 families from maize fields of Mankail valley, Hindukush, Pakistan; Ullah et al [16] reported 46 weed species of 39 genera representing 22 families from maize fields of district Dir (Lower), Pakistan; Afridi et al [17] recorded 25 weed species distributed in 11 families from maize crop in district Mardan, Pakistan. Similarly, Ahmad et al [18] listed 29 weed species distributed in 27 genera and 15 families from maize fields of district Mardan, Pakistan. Among them, Poaceae and Amaranthaceae were dominant families.

Two Way Indicator Species Analysis (TWINSPAN) is a classification technique, which is used to achieve the classification of species and communities [19]. It is one of the most widely used techniques for polythetic divisive classification [20, 21]. Based on information of all species, polythetic divisive classification divides quadrats, stands, or communities into clusters. In this method, the total data unit is progressively subdivided into smaller groups by dichotomous divisions [19, 22-23]. This technique used to classify samples as well as species makes possible a tabular matrix arrangement and also constructs a key to the classification of the samples by identifying one to several species [19].

Weeds provide food and cover for animals. Livestock generally depends on weeds for survival as food. Khan et al [24] reported that weeds are considered unwanted plants but many weeds growing in maize fields are utilized for various purposes including medicinal, fodder, and as a fuel source. The medicinal weeds can be used for curing various common human ailments i.e. anthelmintic, asthma, diarrhea, fever, cough, kidney, and skin disorders. In the present study, grasses were reported as very abundant weed species in maize fields. Grasses are very abundant and common in the monsoon season during August to October in cultivated as well as in non-cultivated lands and are wider than any other flowering plants. They are an ecologically dominant group of flowering plants covering an estimated 40% of the Earth's land surface, as grasslands or bamboo forests [25]. Oosting's scale indicated that very abundant (Class V) grass weed species observed were *Cynodon dactylon, Dactyloctenium aegyptium, Digitaria ciliaris,* and *Echinochloa colona.* Similarly, Muhammad et al [14] studied the distribution pattern of weed species of maize using Oosting's scale in FR Bannu who recorded *Cynodon dactylon* as a very dominant and most frequent weed species. In the study of Afridi et al [17], the most frequently occurring weeds in maize crop were *Sorghum halepense, Cynodon dactylon,* and *Digera muricata* and the most densely populated weed species was *Sorghum halepense*. Grasses exceed all others in the significance of their products. It provides food in the form of cereals for man and forages for most animals. Zereen et al [26] reported that *Cynodon dactylon, Dactyloctenium aegyptium, Digitaria ciliaris,* and *Echinochloa colona* are not only used as forage and fodder species but also contribute significantly to the treatment of several health complaints.

5. CONCLUSION

In the present investigation, the most densely populated and frequently distributed weed species among all the selected sites were *Cynodon dactylon, Dactyloctenium aegyptium, Digitaria ciliaris, Echinochloa colona,* and *Euphorbia prostrata.* The present findings suggested that a large number of weed plants infesting maize crops in the study area may cause loss to crop yield. For acquiring better yield, it is important to take the appropriate chemical, mechanical and biological measurements for weed control. Chemical weed control involves using different types of herbicides. Physical or mechanical weed control involves the use of fire, weed pulling, mowing, mulching, tillage, soil solarization, and flooding while biological weed control involves using living organisms, such as insects, nematodes, bacteria, or fungi, to reduce

weed populations. These measures are practicable and economic to farmers.

6. REFERENCES

1. M. Anwar, W. M. Khan, M. S. Khan, W. Murad, and S. Ali. Taxonomic study of Family Papilionaceae of District Swabi, Khyber Pakhtunkhwa, Pakistan. *Pure and Applied Biology* 4(1):125-128 (2015).
2. T.Z. Mahmood, and S.A. Niaz. "Weeds in Cropped Land at Islamabad," NARC, Identification and control of weeds manual, national training course, *Pakistan Agriculture Research Council, Islamabad,* pp.79 (1992).
3. L.R. Dangwal, A. Singh, T. Singh, A. Sharma, and C. Sharma. "Common weeds of Rabi (winter) crops of Tehsil Nowshera, District Rajouri (Jammu and Kashmir), India." *Pakistan Journal of Weed Science Research* 16(1):39-45 (2010).
4. L.C. Jesse, K.A. Moloney, and J.J. Obrycki. Insect visitors of invasive plant Rosa multiflora (Rosaceae), In Lowa, USA. *Weed Biology and Management* 6: 235-340 (2006).
5. C.L. Morale, and M.A. Aizen. Invasive mutualism and the structure of plant-pollinators interaction in temperate forest of northwest Patagonia, Argentina. *Journal of Ecology* 94: 171-180 (2006).
6. P. Pysek, and D.M. Richardson. Traits associated with invasiveness in alien plants: where do we stand? In: Nentwig W (ed) Biological invasions. Springer. Berlin, pp. 97-126 (2007).
7. P. Oudhia, and R.S. Tripathi. Allelopathic effects of Parthenium hysterophorus L. on kodo, mustard and problematic weeds. *1st Int. Conf. Parthenium* management UAS, Dhaward, India, 6-8 Oct. 1997: 136-139 (1998).
8. F. Hussain. Field and Laboratory Manual for Plant Ecology. *University Grants Commission, Islamabad* (1989).
9. J.J. Barkman, H. Doing and S. Segal. Kritische bemerkungen und vorschläge zur quantitativen Vegetations analyse. *Acta Botanica Neerlandica* 13(3): 394-419 (1964).
10. L. Tichý. JUICE, software for vegetation classification. *Journal of Vegetation Science* 13: 451-453 (2002).
11. J. Roleček, L. Tichý, D. Zelený, and M. Chytrý. Modified TWINSPAN classification in which the hierarchy respects cluster heterogeneity. J*ournal of Vegetation Science* 20(4): 596-602 (2009).
12. M. Ahmad, and S.S. Shaukat. A text book of Vegetation Ecology. *Abrar Sons Karachi, Pakistan,* pp. 29-76 (2012).
13. H.J. Oosting. The study of plant communities. 2nd ed. W.H. Freeman and company, San Francisco, pp. 440 (1956).
14. Z. Muhammad, S. M. Wazir, A. Farooq, S. Ullah, and Z. Hussain. Distribution and checklist of weeds in maize crop of Frontier Region Bannu, Khyber Patunkhwa, Pakistan. *Pakistan Journal of Weed Science Research* 17(4): 373-379 (2011).
15. A. Ullah, and A. Rashid. A checklist of the weeds growing in the maize crop at Mankial valley Hindukush range, Pakistan. *Pakistan Journal of Weed Science Research* 19(4): 481-492 (2013).
16. F. Ullah, A. Ullah, A. Sohail, and R. Khan. Diversity, distribution and ecological importance of weeds in the maize crop at Maidan Valley, Dir (L), Khyber Pakhtunkhwa, Pakistan. *Pakistan Journal of Weed Science Research* 21(4): 543-553 (2015).
17. S.G. Afridi, S. Sultan, Z. A. Butt, and H. Ahmad. Ecological prevalence of the weed species growing in maize and sugarcane fields of district Mardan, Pakistan. *Journal of Biodiversity and Environmental Sciences* (JBES) 7(5):1-7 (2015).
18. Z. Ahmad, S. M. Khan, E. F. A. Allah, A. A. Alqarawi, and A. Hashem. Weed species composition and distribution pattern in the maize crop under the influence of edaphic factors and farming practices: A case study from Mardan, Pakistan. *Saudi Journal of Biological Sciences* 23:741-748 (2016).
19. M.O. Hill. TWINSPAN; A Fortran program for arranging multivariate data in an ordered two-way table by classification of the individuals and attributes, Cornell University, Ithaca, New York (1979).
20. M.O. Hil. TWINSPAN: A FORTRAN program for arranging multivariate data in an ordered two-way table by classification of the individuals and attributes. Ecology and Systematics, Cornell University, Ithaca, New York (1979).
21. H.G. Gauch, and R.H. Whittaker. Hierarchical classification of community data. *Journal of Ecology* 69: 135-52 (1981).
22. D.R. Causton. Introduction to Vegetation Analysis. *London Allen and Unwin,* pp. 342 (1988).
23. D.W. Goodall. Numerical Classification. *Classification of Plant Communities.* (Ed. Whittaker, R.H.), Junk, Hague, pp. 147-286 (1978).
24. M.A. Khan, A. Ullah, L. Badshah, and M. Hamayun. Ethnobotanical and ecological characteristics of weeds growing in the maize fields at Chaghar Matti,

district Peshawar. *Pakistan Journal of Weed Science Research* 23(3): 291-301 (2017).

25. D.J. Gibson. Grasses and Grassland Ecology. UK: Oxford University Press (2008).
26. A. Zereen, T. Z. Bokhari, and Z.U.D. Khan. Ethnobotanical usages of grasses in central Punjab-Pakistan. *International Journal of Scientific and Engineering Research* 4(9): 452-461 (2013).