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Dynamics of Weed Communities in Gram Fields of Chakwal, Pakistan

Sikander Sultan and Zaheer Ahmad Nasir
Botany Department, Government Degree College for Boys, Township, Lahore, Pakistan

Abstract: In order to have the whole idea of variations in weed species assemblages within different weed communities through out the growing season of gram; two weed surveys were carried out in gram fields of district Chakwal during December, 1999 and March, 2000, respectively. On the basis of importance value; eight weed communities Viz., 1) *Lathyrus-Asphodelus-Vicia*; 2) *Asphodelus-Lathyrus-Vicia*; 3) *Trifolium-Rhynchosia-Medicago*; 4) *Anagallis-Carthamus-Medicago*; 5) *Asphodelus-Carthamus-Medicago*; 6) *Asphodelus-Medicago-Convolvulus*; 7) *Asphodelus-Carthamus-Convolvulus* and 8) *Asphodelus-Carthamus-Calendula*; were recognized at eight different localities of the district, during the first survey in December, 1999. In March, 2000 the weed communities at these sites were, 1) *Asphodelus-Vicia-Lathyrus*; 2) *Asphodelus-Sorghum-Medicago*; 3) *Asphodelus-Fumaria-Euphorbia* and *Vicia*; 4) *Asphodelus-Carthamus-Convolvulus*; 5) *Asphodelus-Convolvulus-Vicia*; 6) *Asphodelus-Convolvulus-Carthamus*; 7) *Asphodelus-Calendula-Convolvulus*. One site could not be surveyed due to early harvesting of the crop. *Asphodelus tenuifolius*, *Carthamus oxycantha*, *Convolvulus arvensis*, *Medicago denticulata* and *Vicia monantha* were dominant weed species with different capacities in different communities. A comparison of these communities revealed the changes in ecological status of weeds, due to interspecific competition among them, during the growth season of crop.

Key words: Weed communities, gram, Chakwal, Pakistan

INTRODUCTION

Pulses are a vital source of protein in Pakistan. Gram is an important pulse crop of district Chakwal grown over an area of 21210 acres during 99-2000 (DDAC, 2000). The region under study was arid and dry farmed agriculture was the main land use. The soils are generally homogenized with weak structure, moderately calcareous, with a pH value about 8.0. They are invariably low in organic matter. The shortage of moisture is key factor limiting the production (Malik, 1999). Temperature varies from 25 to 40.7°C during the growth season of the crop. The gram crop of the area received a rainfall of 250 mm (DDAC, 2000). Poor weed management in pulses is the most important factor holding up their productivity. Weed is any plant that is competitive, persistent, pernicious and interferes the human activity and as a result is undesirable. They compete with cultivated crops for light, soil moisture, space and other growth requirements (Karim, 2000), making cultural operation difficult (Majid *et al*., 1998), exhibits allelopathy (Roth *et al*., 2000), impair the grain quality (Ashiq *et al*., 1996) and reduce the human efficiency (Hussain, 1989). Weeds are, therefore, a major problem in agricultural production throughout the world (Rifai *et al*., 2000), especially in the countries where agriculture is the mainstay of their economy and this includes Pakistan as well.

Singh (1986) found that weed competition in rabi pulses such as gram, during initial 8-9 weeks caused grain yield suppression more than 80%. Various environmental factors viz., light, temperature, water, soil and microorganisms determine the specific weed spectrum, their distribution and growth (Barbour *et al*., 1980). As the environmental conditions vary from one region to another, geographical differentiation has characterized the weed species in each region (Peng, 1984).

Weed surveys are useful for determining the occurrence and relative importance of weed species in crop production systems (Frick and Thomas, 1992). A fundamental basis for sound weed management is to know the species present and the level of infestation (Labrada and Parker, 1994). Documenting the distribution, numeric abundance and weed communities can help to understand the interspecific diversity, size and extent of weed population in agricultural ecoregion of any area. The comparison of weed communities allows to observe the interspecific population shifts during the growth season of a crop. Documenting the relative importance of weed species also facilitates the establishment of priorities for research and extension. As regard the weed communities in gram fields of Chakwal, no reference is available from this where. The present work, was therefore, conducted in Chakwal gram fields in December, 99 and March, 2000. Thus the objectives of this study were to;

- document the distribution and numeric abundance of weed species.
- identify the ecologically operative weed communities.
- observe the weed population shifts during the growth season of the crop.

These findings will give an overall idea of dominant weeds and their growth relations to environmental conditions and helpful in developing effective and durable management programs. This information will also give assistance to resource managers, plant ecologists, the herbicide industry and agricultural policy makers.

MATERIALS AND METHODS

The gram production system involves 1-yr cycle in which crop is sown in Nov./Dec. and harvested in May/June. To have complete idea of dynamics of weed communities two surveys were conducted, first after 4 week of sowing in Dec., 99 and second in March, 2000 when the crop was at flowering stage.

Eight gram growing locations were chosen all over the district. Those sites were selected where gram production was maximum for last five years and at least 100 cultivated fields of gram were available. All these locations were rainfed and mostly sandy in nature. These includes 1) Bhaun, 2) Dudyal, 3) Pindi Gugran, 4) Balkasar (Tehsil Chakwal), 5) Jahtla, 6) Kot Sarang, 7) Taman, 8) Puchnand (Tehsil Tala Gang), all within radius of 40 Km from their respective tehsils. No herbicide was used at these sites throughout the growing season of crop. At each site 10 gram fields were selected randomly and were surveyed following the methodology of Thomas (1985) and McCully *et al*. (1991) with some modifications. Five 1x1m quadrats were randomly placed along an inverted "W" pattern in each field. The first quadrat was placed after walking 20 paces from one corner along the edge of the field, turning 90^0 and then moving 10 paces into fields. This was to avoid edge effect. The distance between each quadrat depended upon the size and shape of the field and any obstructions that may have been present in the fields. The larger the field was, the greater was the distance between quadrats. The identification, field uniformity, density and herbage coverage of each weed was recorded within each quadrat. Herbage coverage was measured as field uniformity and density were not sufficient to give a clear picture of dominant species. To determine the weed communities four quantitative measures were calculated for each weed at each location. Field uniformity and density were measured as outlined by Thomas (1985), while, herbage coverage and importance value was calculated following Smith and Smith (1998).

Field uniformity (FU) was calculated as percentage of the total number of quadrats sampled in which a species occurred (Thomas, 1985).

$$FUk = \frac{\sum_{1}^{n}\sum_{1}^{5} Xij}{5n} \times 100$$

Where FUk is the field uniformity for species k, Xij is the presence (1) or absence (0) of species k in quadrat j in field I and n is number of field surveyed. Density (D) of each species in a field was calculated by summing the number of plants in all quadrats and dividing by area of 5 quadrats (Thomas 1985).

$$DKi = \frac{\sum_{1}^{5} Zj}{Ai}$$

Where Dki = density (in numbers m^{-2}) of species k in field I, Zj is the number of plants of a species in quadrat j and Ai is the area in m^2 of 5 quadrat in field I.

Herbage coverage was determined ensuing Smith and Smith (1998) by estimating how much percent area of quadrat was covered by all individuals of a species as viewed from above. Thus herbage cover of a weed in a field was calculated by summing % herbage coverage of species in all quadrats and dividing by number of quadrats.

$$Hcki = \frac{\sum_{1}^{5} Cj}{5n}$$

Where Hcki is the herbage coverage (in % m^{-2}) of species k in field I, Cj is the % herbage coverage of all individuals of a species in quadrat j and n is the number of fields.

The importance value of species was calculated following Smith and Smith (1998). These values compared the individual weed species relative to each other. The importance value of each species was calculated by assuming that the field uniformity, density and herbage coverage measures were equally important in describing the relative importance of weed species. This was calculated as follow:

Relative field uniformity for Species k (RUk) =

$$\frac{\text{Field uniformity value of species k}}{\text{Field uniformity for all species}} \times 100$$

Relative density for species k (RDk) =

$$\frac{\text{Density value of species k}}{\text{Density values for all the species}} \times 100$$

Relative herbage coverage of species k (RCk) =

$$\frac{\text{Herbage coverage value of species k}}{\text{Herbage coverage values for all the species}} \times 100$$

Each of these three relative values indicate one aspect of the importance of species in the community but a better comparative picture can be painted by adding these relative values for every species to get importance values.

Importance values of species k (IVk) = RUk + RDk + RCk

A maximum value of 300 would be possible if only one species found in all the fields that were surveyed.

The communities were named after three dominant species at each site ensuing Hussain *et al.*, 1998. The similarity between resulted communities at each site during both surveys, using Sorensen coefficient of community, was also determined as outlined by Smith and Smith (1998).

$$\text{Coefficient of Community (CC)} = \frac{2C}{S_1 + S_2} \times 100$$

Where C is the number of species common to both the communities and S_1 and S_2 are the total number of species in community 1 and 2.

The data was summarized and discussed on location basis and nomenclature followed here was that of Stewart (1972) and Nasir and Ali (1971-1993).

RESULTS AND DISCUSSION

Weed populations are dynamic, constantly changing in response to sowing/planting period and ecoregions. So two surveys were carried out within same growing season to understand the dynamics of weed communities. A total of 47 weed species were identified during the both surveys. Broad leaf weeds were greater than grasses. During the first survey in Dec., 99, 44 weed species were recorded from gram fields of the study area. Eight weed communities viz., 1) *Lathyrus-Asphodelus-Vicia* in Bhaun; 2) *Asphodelus-Lathyrus-Vicia* in Dudyal; 3) *Trifolium-Rhynchosia-Medicago* in Pindi Gugran; 4) *Anagallis-Carthamus-Medicago* in Balkasar; 5) *Asphodelus-Medicago-Convolvulus* in Jahtla; 6) *Asphodelus-Carthamus-Convolvulus* in Kot Sarang; 7) *Asphodelus-Carthamus-Calendula* in Taman; and 8) *Asphodelus-Carthamus-Medicago* in Puchnand were recognized. *A. tenuifolius*, *C. oxycantha*, *M. denticulata* and *Convolvulus arvensis* were the dominants in almost all communities (Table 1). There dominance was probably due to very high seed output, ability to compete interspecifically, self compatibility and high capacity for acclimation to changing environment.

In Mar., 2000, seven new weed communities were encountered on these sites. In Bhaun, *Asphodelus-Vicia-Lathyrus*; in Dudyal *Asphodelus-Sorghum-Medicago*; in Pindi Gugran *Asphodelus-Fumaria-Euphorbia* and *Vicia*; in Balkasar *Asphodelus-Carthamus-Convolvulus*; in Jahtla *Asphodelus-Convolvulus-Vicia*; in Kot Sarang *Asphodelus-Convolvulus-Carthamus*; and in Taman *Asphodelus-Calendula-Convolvulus*; the Puchnand site could not be observed due to early harvesting (Table 1,2). Although few and almost same weed species dominated the communities at different sites during the both surveys, except the introduction of *Fumaria indica* and *Euphorbia helioscopia* at Pindi Gugran. during March, 2000 (Table 1). But at each site, kind and capacities of these dominants varied, consequently, weed communities at each site differ from each other during the both surveys. During March, 2000, 32 species were recorded. This decrease in the number of weeds was mainly because one site could not be studied during March, 2000 due to early harvesting of the crop.

The number of weed species at each site, during both surveys, ranged from 9-26 weed species. This reflected the floristic heterogenity and specific resource requirement of species. A fluctuation in weed flora composition was observed during both surveys. *Buglossoides arvensis*, *Silene arenosa*, *Spergula fallax* were new introductions while 15 weeds were absent during second survey (Table 1). This might be due to seasonal variation as each species has characteristic set of requirements for its germination and growth. *A. tenuifolius* was the top dominant during both the surveys. This shows its wide range of ecological amplitude. Such adaptability might be because of its high diversity in genotype, phenotype and fitness.

A comparison of weed communities during both surveys depicted that there was an interspecific population shifts with the weed communities at each site. *A. tenuifolius* along with *Lathyrus sativus*, *Trifolium polycerata* and *Anagallis arvensis* was the first dominant during Dec., 99 while, during Mar., 2000 *A. tenuifolius* hold the first position at all the sites (Table 2). The fluctuation in capacities of these weeds might be due to interspecific competition and environmental variability as interspecific competition results in an unstable equilibrium among species while environmental variability may give each species a temporary advantage, promoting

Table 1: Importance values of weeds in the gram fields of district Chakwal during December, 1999 and March 2000

Name of species	December, 1999							
Localities	Bu	Du	Pi	Ba	Pu	Ja	Ko	Ta
Aerva javanica (Burm. F.) Juss.							2.41	
Anagallis arvensis L.	4.65	23.91		36.6a				
Arnebia hispidissmimma (Lehm) D.C.					2.94			
Artemesia scoparia Waldst and Kit.	4.89			10.83		4.24		
Asphodelus tenuifolius Cavan.	46.2b	67.5a	28.26	20.71	40.5a	83.4a	52.5a	97.75a
Astragalus auganus Burnage.	3.18				7.48			
Calendula arvensis L.				10.46				41.84
Calotropis procera (Willd.) R.Br.					17.93			
Carthamus oxycantha M.B.	19.27	14.4	32.74	31.5b	37.4b	37.52	51.5b	60.1b
Cenchrus ciliaris L.					27.6			
Chenopodium album L.		6.01	26.99	22.97				
C. murale L.				23.64			17.84	20.52
Convolvulus arvensis L.	10.4	17.86		24	27.37	44.4c	35.5c	10.92
Conyza ambigua D.C.								1.78
Coronopus didymus (L.) Sm.				5.28				
Cousinea thomosonii C.B. Clarke.					13.07	4.24	31.59	1.94
Cynodon dactylon (L.) Pers.	1.84		7.89					
Dactyloctenium aegyptium (L).P.Beaur	1.39		7.68					
Datura stramonim L.	2.49					1.76		
Dicanthium annulatum (Frossk) Stapf.							10.83	
Digera muricata (L.) Link	2.17			16.45			8.28	
Echinochloa colonum (L.) Link					9.61			
Eleusine indica (L.) Gaertn.	2.57						4.52	
Emex australis Steinch.				13.1	9.99	20.17		
Eragrostis poaeoides P.Beauv.	1.17						9.71	
Euphorbia helioscopia L.	2.45	25.27		13.37				
E. prostrata Ait.	2.01		4.48					
Fumaria inidca (Hausskn.) H.N.	6.98		13.09	6.16		36.31	16.41	11.31
Heliotropium europeaeum L.								6.3
Ipomoea eriocarpa R.Bv.							5.56	
Lathyrus aphaca L.	3							
L. satvus L.	50.2a	51.5b	18.22				4.08	
Launaea nudicaulis N.K.F. (nonless)					23.25	9.84	27.44	
Malva parviflora L.	0.79			24.97				41.32
Medicago parviflora L.	24.92	23	46.1c	29.6c	35.6c	51.5b	5.95	
Rhynchosia capitata (Heyne ex Roth) D.C.	11.27		48.2b				11.14	
Rumex dentatus L.				16				
Solanum xanthocarpum Schard and Wendil.					27.46			
Sonchus asper (L.) Pers.				8.17				
Sorghum halepense (L.) Pers.	7.92		17.91	4.48	28.08			
Trifolium polycerata L.	3.94		48.44					
Vicia monantha L.	36.1c	41.7c	16.13	17.29		6.39	4.39	
Withania somnifera (L.) Dunal.	2.01							
Xanthium strumarium L.	2.9							

Table 1: Continue

Name of species	March, 2000						
Localities	Bh	Du	Pi	Ba	Ja	Ko	Ta
Aerva javanica (Burm. F.) Juss.			15.9				
Anagallis arvensis L.	20.7	26.59		11.1			
Artemesia scoparia Waldst and Kit.	5.98			9.4			
Asphodelus tenuifolius Cavan.	70.09a	68.6a	58.2a	45.5a	80.3a	56.9a	92.8a
Buglossoides arvensis (L.) Johnston.	9						
Calendula arvensis L.	13.05		27.9	10.8	11.44	22.23	36.4b
Carthamus oxycantha M.B.	15.47	23.3		28.6b	22.17	35.8c	27.01
Cheopodium album L.	12.12	29.06	21.9		15.58	24.42	
C. murale L.	7.72			8.3	8.63		18.97
Convolvulus arvensis L.				23.4c	43.1b	50.6b	30.5c
Coronopus didymus (L.) Sm.				12			
Cousinea thomosonii C.B. Clarke.					8.97	22.52	
Dicanthium annulatum (Frossk) Stapf.					1.84		
Digera muricata (L.) Link				15.3			
Emex australis Steinch.		8.8		10			27
Eragrostis poaeoides P.Beauv.				8			
Euphorbia helioscopia L.	9.3		31.6c	12.1			
Fumaria inidca (Hausskn.) H.N.	4.62	26.87	50.9b		28.72	15.74	
Heliotropium europeaeum L.							13.59
L. satvus L.	22.93c	7.65		11.2			

Table 1: Continue

Name of species	March, 2000						
Localities	Bh	Du	Pi	Ba	Ja	Ko	Ta
Launaea nudicaulis N.K.F. (nonless)		13.42			33.83	30.64	
Malva parviflora L.	4.9	11.32	14.5	16.1			
Medicago parviflora L.	13.84	39.98c		21.7			28.1
Rumex dentatus L.				18.1			
Silene arenosa C, Koch.			24.1				
Solanum xanthocarpum Schard and Wendil.				11.5			
Sonchus asper (L.) Pers.	18.49						
Sorghum halepense (L.) Pers.	1.87	41.7b	22.7	13.37	11.72	28.82	
Spergula fallax (Lowe) E.H.L. Krause.	4.62						
Trifolium polycerata L.	9	10.77		9.9			25.45
Vicia monantha L.	31.65b		31.6c	12.9	42.9c		
Withania somnifera (L.) Dunal.	22.86						

Key: Bh (Bhaun), Dud (Dudyal), Pi (Pindi Gugran), Ba (Balkasar), Pu (Puchnand), Ja (Jahtla), Ko (Kot Sarng), Ta (Taman), a (Fist dominant), b (Second dominant), c(Third dominant)

Table 2: Comparison of the weed communities established in gram fields of district Chakwal during December, 1999 and Mar., 2000

Site	Weed communinties during Dec., 99.	No of Spp.	Weed communities during Mar., 2000.	No of Spp.	C.C.
Bh	*Lathyrus-Asphodelus-Vicia*	26	*Asphodelus-Vicia-Lathyrus*	19	62%
Dud	*Asphodelus-Lathyrus-Vicia*	9	*Asphodelus-Sorghum-Medicago*	12	57%
Pi	*Trifolium-Rhychosia-Medicago*	13	*Asphodelus-Fumaria-Euphorbia and Vicia*	10	43%
Ba	*Anaglis-Carthamus-Medicago*	18	*Asphodelus-Carthamus-Convolvulus*	20	84%
Pu	*Asphodelus-Carthamus-Medicago*	14	●	-	-
Ja	*Asphodelus-Medicago-Concolvulus*	11	*Asphodelus-Convolvulus-Vicia*	11	63%
Ko	*Asphodelus-Carthamus-Concolvulus*	17	*Asphodelus-Convolvulus-Carthamus*	10	51%
Ta	*Asphodelus-Carthamus-Calendula*	11	*Asphodelus-Calendula-Convolvulus*	9	60%

Key: Bh (Bhaun), Dud (Dudyal), Pi (Pindi Gugran), Ba (Balkasar), Pu (Puchnand), Ja (Jahtla), Ko (Kot Sarng), Ta (Taman),
●This site could not be surveyed in March, 2000 because of early harvesting of the crop

coexistence (Smith and Smith, 1998). According to Rao (1983) persistence of weeds is largely influenced by climatic, edaphic and biotic factors, which affect their occurrence, abundance, range and distribution. The distribution and population dynamics of weeds depends on local geographical conditions, cropping pattern and agronomic practices. The ecological status of weeds varies throughout growing season and also with the time of survey, habitat conditions and local farmer behaviour. This was clear by change in capacities of *Lathyrus*, *Vicia* and *Convolvulus*, which was mainly due to their usage as fodder in the area. The other factors being also operative.

Among climatic factors, light (Einarsson and Milberg, 1999), temperature and photoperiod (Swanton *et al*., 2000), rainfall (Tomado and Milberg, 2000) and wind (Rao, 1983) are important factors and have a profound effect on phenological developments and species persistance and distribution. There was heavy rainfall before second survey. Therefore, soil moisture also played its role in changing of ecological status of weeds.

The observed changes in weed communities might be due to differences in sowing date, tillage practices, crop management factors, soil variability and temporal trends. These factors vary from site to site in the study area. Milberg *et al*. (2001) demonstrated that, the composition of weed flora varied depending on sowing date. The gram crop was cultivated on sandy soils and according to Tomado and Milberg (2000) altitude, month of planting, number of weeding and sandy soil are major factors influencing the species distribution. According to Rydberg and Milberg (2000) organic fields have much more weeds. The type and amount of fertilizer used by farmer varied from site to site and generally the manure was applied. So the differences in fertility level might have affected the weed communities of gram fields.

Hallgren *et al*. (1999) reported that sowing season of crops, geographic region and soil types had an over whelming influence on the weed flora composition. There were significant temporal trends in weed flora of autumn-sown crops. These lines also justify the changes in weed communities of gram during both the surveys. Fischer and Milberg (1997) reported that the extensification of field margin can also enhance flora diversity. These findings were also observed in fields of Chakwal. Many grasses were entered into fields from field margin by their extensification during ploughing. Ugen and Wortmann (2001) reported that weed composition varies with soil properties and relative densities of weed species varied with the length of the post fallow period, landscape position and drainage. Tillage system may also influence the weed flora (Swanton *et al*., 1999) But recently Felix and Owan (2001) claimed that tillage and crop rotation did not influence seed bank nor they interact with weed management treatments. Derksen *et al*. (1993) concluded that changes in weed communities were more likely dependent upon species, location and environment rather than solely on tillage systems.

Hence, many factors are responsible for changes and establishment of a particular weed community and community structure depends upon the fundamental niche of weed species. Simth and Smith (1998) described that species differ in the range of conditions they tolerate.

As environmental conditions change in both time and space the possible distribution and abundance of species will also change.

In short, the variation in weed flora during both surveys was mainly due to tolerance limits of species as when changes exceeds the tolerance limits of a species, it gave way to species more tolerant to those environmental conditions. According to Smith and Smith (1998) the community is a spatial concept and each species has a continuous response along an environmental gradient. The patterns of spatial variation in the physical environment across the landscape interact with species responses to determine distribution and abundance. This was probably the most certain reason of observed fluctuation in capacities of weeds during Dec., 99 and Mar., 2000. The coefficient of community showed that the two weed communities at each site differs in their species diversity (species richness). This was due to difference in time of surveys and reflected the fluctuation in floristic composition of weeds through out the growing season of crop. The highly diverse community was recorded at Pindi Gugran with 43% coefficient of community, while, at Balkasar coefficient of community value was 84%. Coefficient of community at rest of locations ranged from 51-62%. It was observed that although species composition differs from site to site, only few species have been found to participate in community formation as dominants and co-dominants. The present study revealed that *Asphodelus, Carthamus*, *Medicago* and *Convolvulus* were the most prevalent weeds of the area and there was unstable equilibrium among the species. Along with many motives, high seed output might be one of the reasons for their dominance. Ashiq *et al*. (1996) reported that average seeds produced per plant by *Asphodelus* (391), *Carthamus* (582), *Medicago* (4600) and *Convolvulus* (52) are very high in number as compared to gram plant. These seeds remain viable in soil for long time. The character and shape of seed plays important role in their survival and germination strategy of weeds and their management (Khalid and Shad 1990; Khalid *et al*., 1991). The time of emergence of weed indicates when it might become serious problem (Ogg and Dawison, 1984). The number of weeds that germinate at a particular time depends on seed bank, dormancy, longevity and periodicity (Reddy and Reddi, 2001).

The conditions inherent in our cropping systems make weed success inevitable. Natural selection, diversification, evolution and adaptation are important events that weed population have experienced for the history of agriculture. No single weed species dominates an agroecosystem. Usually several weed species co-exist in a field to exploit the diverse resources unused by crop plants (interspecific diversity). The worst weeds that we have today are the winner of this selection-adaptation-evolution process. The present study reports the worst weeds of gram fields from Chakwal.

So the bio-ecological features of these weeds must be worked out to design optimal control methods. No single method is successful under all weed situations, an integrated approach give effective and economic control. However, we cannot totally eradicate the weeds. To overcome the deleterious effects of weeds, it is imperative that weed population in cultivated crops must be kept below the economic threshold level.

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