Pak. J. Weed Sci. Res. 18(3): 319-330, 2012

WEED FLORA AND IMPORTANCE VALUE INDEX (IVI) OF THE WEEDS IN COTTON CROP FIELDS IN THE REGION OF KHANEWAL, PAKISTAN

Muhammad Tauseef[1]*, Fahad Ihsan[1], Wajad Nazir[2] and Jahanzaib Farooq

ABSTRACT

A survey of weeds of cotton fields from five locations along the Khanewal Road; 1-Rawan, 2-Rango, 3-Kabirwala, 4-Chak8 Kasi, 5-Chak-83/85 10-R was carried out during the year of 2010. Only the weed species in competition with cotton crops were studied; while 27 species from 19 genera and 11 families were identified impacting cotton crop fields of the region. Two important weeds including Cyperus rotundus L. and Echinochloa colona (L.) Link. were found with highest importance value index of 20.9 and 17.3, respectively having highest densities as well in the cotton fields. While in the water channels, two other species i.e. Marsilea minuta L. and Eclipta prostate L. were found in abundance. From all five locations, it was also estimated that crop sown on different dates i.e. April 15, 30, and May 15 and 30, 2010 have different broad-leaved and narrow-leaved weeds density after the raining months of June and July in the year 2010. Density of broad-leaved weeds and narrow leaved weeds were highest in the treatments of cotton crop sown in May 30, 2010. Weed to plant height ratio was 0.51 for April 15 sown crop, 0.69 for April 30 sown crop, 0.77 for May 15 sown crop and 0.86 for May 30 sown crop. Late sown cotton crop had greater competition with weeds especially with narrow-leaved as compared to early sown crop due to higher moisture and damp conditions in the month of July.

Key words: Cotton, *Cyperus rotundus*, *Echinochloa colona*, Importance Value Index, Khanewal, Pakistan.

INTRODUCTION

Khanewal with arid, sub-tropical continental climate, is located at 30°18'0 N 71°56'0 E with an altitude of 128 meters (Wikipedia.org, 2010) has best suited environmental factors (Temperature, Light, Sunshine) during April to June for successful cotton crop production. July is normally the starting month of monsoon season in Pakistan, while during this month, Southern Punjab (Khanewal) receives more or less of 80mm rain after which peak season of monsoon starts (Naheed anb Rasul, 2010) with green carpet of new tiny plants and covering the old ones, in crop fields and as well as along the roadsides. Some

[1]Assistant Research Officer, Agronomic Research Station, Khanewal
[2]Assistant Research Officer, Cotton Research Station, Multan
*Corresponding author's email: mtausf@gmail.com

weed species unlike most of crops, are well adapted to high soil moisture conditions (Bukan, 2005) while others are not. During July, increasing weed density and wet-logged condition developed because of uneven fields are mostly found in the climate of this region due to small farmer's community practices. Weeds compete with crop for water, nutrients and light and have been a matter of great concern to the cotton growers. According to Makhan-Kova and Voceodin (1984), the losses in cotton yields due to weeds could be in the range of 50 to 70%. They exhibit allelopathy, competition and parasitism (Hussain, 1980; 1983; Hussain *et al*., 1985; Hussain and Khan, 1987). This competition increases in the wet, hot, and humid monsoon season (July) and the ability of weeds to compete successfully with crops for light, water and nutrients depends on several interrelated factors. These include the timing of weed emergence in relation to crop emergence, the growth form of the weeds, and the density of the weeds present in the crop. The different environmental conditions determine the specific weed spectrum, composition and population of each region (Memon *et al*., 2007). The reduction in yield due to weed-crop competition mainly depends on weed species and their densities as well as crop species. As the distribution and infestation intensity of each weed is different, so the extent of crop yield reduction will mainly depend on the number and kind of weeds found in the field (Frisbie *et al*., 1989).

No literature has been found on weed cotton community trend in continuous wheat-cotton rotation fields affected due to the rainy seasons in the months of June-July in Khanewal district of Pakistan. Present study is an initiative to record the weed density, frequency, distribution, infestation behavior in the cotton fields to know the ecological trend in the environment of the cotton crop fields. Though the present study has been conducted only during monsoon 2010, however, it may provide some initial data for detailed investigations in future. There is need of calculating the importance value index (IVI) of each species affecting the cotton crop plants to well evaluate their density, frequency and diversity in the cotton fields of the region, which will prove helpful in making improved weed management programs in future.

Canopy structure and height with reference to adjacent plants have long been recognized as the foremost factors determining the capture of resources and, ultimately, for determining winners and losers in closely spaced plant communities (Begon, 1986; Schwinning and Weiner, 1998). Moreover, early season height disparities are robust predictors of season-long growth. Precision management of weed individuals based on early season height differences may provide a reliable and practical basis for selective post-emergence weed

control that is relevant to both yield loss and longer-term seedbank considerations (Mcdonald *et al*., 2009). Objectives of this study were to get the knowledge of ecology and growth trends of the weed species found in the region under study, to make an inventory of the typical weed species found in the monsoon season, and to analyze the association between early and late season weed and plant height differences and their ultimate impacts on cotton crop.

MATERIALS AND METHODS

Five locations were selected for the study including the areas of Rawan, Rango, Kabirwala, Chak-8-Kasi and Chak-83-85 10R all of which are located within a 25 km radius of the Khanewal district. Temperature, humidity and rainfall records were kept in observation with the help of Pakistan Meteorological Department, and observatory at British Cotton Growing Association (BCGA) office located at the Chak 83-85 10R (Table-1).

The weed species were identified with the help of Flora of Pakistan (Nasir and Ali, 1974-1991; Stewart, 1972) and other available literature. The grasses were mostly identified within Poaceae (Cope, 1982). The nomenclature has been updated, following in general the Flora of Pakistan, and other taxonomic literature. Exact referencing of taxonomic names were considered from Universal Biological Indexer and Organizer (uBio) a Project by Marine Biological Laboratory (USA).

A total of 50 quadrates of 1 m^2 were thrown in the selected fields at each location under study and average count of different weeds were taken for record after identifying its family, genra and species. Densities and frequencies of each weed species were calculated according to Odum (1971).

$$\text{Frequency (\%)} = \frac{\text{Number of sampled areas where species occurred}}{\text{nubmer of total sampled areas}}$$

$$\text{Density (plants } m^{-2}) = \frac{\text{Total number of individual species}}{\text{Total sampled area}}$$

Importance Value Index (IVI) is a reasonable measure to assess the overall significance of a species since it takes into account several properties of the species in the vegetation. The IVI was calculated as per Curtis and McIntosh (1950). The parameters assessed for the purpose were density, frequency, and dominance, while importance value index (IVI) was calculated as:

IVI = Relative Frequency + Relative Density + Relative Dominance

Early season height differences and density of weed species are parameters, helpful in precision weed management program (Mcdonald *et al*., 2009). These two may also determine the idea of how much competition is there due to weeds invasion in the crop fields. Therefore keeping in mind the above given considerations, the weed to plant height ratios were taken from various fields (as per quadrates thrown) from all the five locations under study with different sowing dates of April 15, 30, and May 15, 30 generally used by the farmers. The averaged weed to plant height ratios were calculated with the following formula,

Weed to plant height ratio = (Avg. weeds height) / (Avg. crop plant height)

A checklist of weeds with details of scientific, vernacular and English names was made after interviewing the farmers and studying scientific literature. Growth Habit and Flowering times were also studied and given in Table-1.

RESULTS AND DISCUSSION

Weeds' ecological behavior

Some weed species unlike most crop plants are well adapted to higher soil moistures while others are not so. Weed interference in annual cropping systems can be highly variable from year-to-year, as well as spatially heterogeneous (Mcdonald *et al*., 2009). The most persistent and abundant weeds are easily dispersed and persist a long time in the soils as dormant seeds (Bukun, 2004). Present study was an initiative to record the weed density, frequency, distribution, infestation behavior in the cotton fields to know the ecological trends in the particular cotton crop environments. During the study period, 27 species of weeds belonging to 11 families were collected and identified from 5 different cotton field localities in the Khanewal district of Pakistan (Table-1). During this period, high temperature and rainfall were recorded. Increasing temperature regimes were observed to favor invasive potential of alien and local weeds in monsoon (Kathiresan *et al.*, 2005). As evident from Table-1, raising temperature behavior with increasing relative humidity and rainfall from April to July has led to grow a variety of weeds in the cotton fields during 2010. Trends of weeds due to dumpy and standing water conditions of the monsoon, was looking like rice crop weeds invading the area. Rabbani and Bajwa (2001) reported 18 weed species that infested rice in different areas of the Punjab, Pakistan. Among these, *Cyperus rotundus*, *Cyperus difformis*, *Echinochloa colona*, *Paspalum paspaloides* and *Marsilea minuta* were found to be the most abundant weeds in rice fields. Similarly in another study it was seen that the

major weeds associated with the dry seeded rice were *Cyperus rotundus*, C. *iria*, C. *difformis*, *Eclipta prostrata* L., *Trianthema portulacastrum* and *Portulaca oleracea* (Mann *et al*., 2007) *Marsilea minuta* and *Eclipta prostrate* L. were found in water channels as well as in unleveled fields with standing rain water, having IVI of 6.3 and 8.2, respectively (Table-2).

Cyperaceae (Sedges) and others

The most common and densely populated weed species was a nut grass (*Cyperus rotundus*) in the field of study area with maximum IVI (importance value index) of 20.9 (Table-2). *Cyperus rotundus* is a creeping perennial member of the sedge family Cyperaceae and as widely distributed as agricultural weeds in the warm regions of the world. Raw crops especially cotton and potatoes are more seriously affected than are grains and hay crops. In these weed species, the production of flowers is regular, but setting of seed and viability is very low. The propagation is mainly by the tubers. The tuber germinates and it sends out a rhizome that grows to the surface and terminates in an aerial shoot (Rajput *et al.*, 2008). *Cyperus* spp. most probably to be found in unleveled fields and standing waters, rainfall during June may have increased its population in poorly drained fields. *Cynodon dactylon* was also found accompanying with nut grass with IVI value of 13.1 (Table-2). Hussain and Khan (1987) reported diversity of weed spectrum for the 12 cotton growing districts of the Punjab where *Cyperus rotundus*, *Convolvulus arvensis*, *Cynodon dactylon*, *Trianthema monogyna*, *Portulaca oleracea* and *Sorghum halepense* were found as dominant weed species.

Poaceae (true grasses) and others

Second important weeds with maximum density found after July rains were *Echinocloa* spp. in the territory under study. Probability of invasion and increasing density of this may be due to high rainfall and standing water during the month because moisture stimulated the density of some weed species i.e. *Echinocloa colona*, *Echinocloa crus-galli*, *Portulaca oleracea*, *Setaria verticillata*, *Sorghum halepense* and *Xanthium strumarium* are more stimulated species by the irrigation. *Echinochloa* spp. are among the most important damaging weeds of rice paddies (Motlagh and Javadzadeh, 2001) and especially grow well in moist conditions(Mennan and Işık, 2003; Bukun and Uygur, 2003). Parker (1997) reported that *Sorghum halepense* and *Echinocloacrus-galli* could be more problematic in future after irrigation. Bükün and Uygur (2003) indicated that weed species such as *Amaranthus albus*, *Cynodon dactylon*, *Echinocloa colona*, *Physalis angulata*, *Physalis philadelphica*, *Portulaca oleracea*, *Setaria verticillata* and *Xanthium strumarium* are well adapted and become more common species in cotton growing areas.

Broad leaved weeds

Weeds of goosefoot family (*Chenopodium* spp.) are seen through the cotton crop fields. *Chenopodium album*, ranked among the most serious weeds of several major crops throughout the world (Bassett and Crompton, 1978), is an annual herb that is widely distributed as a weed, has a rapid growth rate (Pearcy *et al*., 1981), very plastic growth form (Morgan and Smith, 1981), and occurs under a wide variety of environmental conditions (Holm *et al*., 1977), making it particularly well suited to responses along water resource availability gradients and found with comparatively good IVI = 12 (Table-2) during the study month. *Chenopodium murale,* is reported to produce over 24,000 seeds/plant (Holm *et al*. 1997) and can persist through the summer if in shade (Felger, 1990). During the study survey, it was found with IVI of 14 (Table-2). *Trianthema portulacastrum* L. is a major weed of cotton all over Pakistan, blooming from May to October, indeterminate habit, vegetative and reproductive growth continues for the entire life span (Nayyar *et al*., 2001) but in spite of being major and most invading weed, it was found with a less IVI of 10.1 (Table-2). The reason might be that this weed is controlled mechanically, mostly with hand hoeing and the use of herbicides is the most effective and immediate solution that may reduce its population by 70-80% (Grichar, 2007; 2008), therefore most of the cotton fields are found with low density. *Sonchus* spp. cannot tolerate moisture stress, occur on a wide variety of soil types, preferring well-drained (Holm *et al*., 1997). Broadleaf species were found but less in number grassy weeds.

Weeds to plant height ratio

Survey of weed to plant height ratio declared that crop grown on April 15 had less broad leaf and narrow leaf weeds density as compared to sowing on April 30, May 15 and May 30. Maximum weed to plant height ratio (0.86) was obtained in the crop fields with sowing date of May 30. Table-4 indicated weed to plant height ratio of 0.51 for April 15 sown crop, 0.69 for April 30 sown crop, 0.77 for May 15 sown crop and 0.86 for May 30 sown crop. Same declining graph of density of these weeds can also be studied from Table-4 with similar pattern. Late sown cotton crop had greater competition with weeds especially narrow-leaved as compared to early sown crop due to high moisture and dampy conditions in the month of July. McDonald *et al*. (2009) analyzed 742 weeds and suggested that early season height disparities are robust predictors of season-long growth. Precision management of weed individuals based on early season height differences may provide a reliable and practical basis for selective post-emergence weed control that is relevant to both yield loss and longer-term seed bank considerations.

Table-1. Checklist of weeds with habit and flowering time found during monsoon 2010 in the cotton fields at Khanewal, Pakistan.

Narrow Leaved Weeds						
FN	**WN**	**Family/Species**	**Vernacular Name**	**English Name**	*****	**Flowering**
1.		**Cyperaceae**				
	1.	*Cyperus rotundus* L.	Dheela	Purple Nutsedge	PH	Round the Year
	2.	*Cyperus iria* L.	Bhoin	Umbrella Sedge	AH	Aug-Nov
2.		**Poaceae**				
	3.	*Cynodon dactylon*(L.) Pers.	Khabbal, Tala	Bermuda Grass	PG	Round the Year
	4.	*Dactyloctenium aegyptium* (L.) Willd.	Madhana	Crow-foot Grass	AG	Round the Year
	5.	*Digitaria adscendens* (Kunth) Henr.	Karabara	Crab Grass	PG	Round the Year
	6.	*Echinochloa colona* (L.)Link.	Jangli Swank	Jungle Rice Grass	AG	Aug-Nov
	7.	*Echinochloacrus-galli* (L.) P. Beauv.	Dhiddan, Kyada	Barnyard Grass	AG	Aug-Nov
	8.	*Panicum antidotile* Retz.	Bansi Ghas	Blue Panic	PW	Round the year
	9.	*Panicum glaucum* L.	Loomer Ghas	Yellow Foxtail	AG	May-Sept
Broad Leaved Weeds						
FN	**WN**	**Family/Species**	**Vernacular Name**	**English Name**		**Flowering**
3.		**Aizoaceae**				
	10.	*Trianthema portulacastrum* L.	It Sit, Boodal, Wisah	Horse Purslane	AH	May-Oct
4.		**Amaranthaceae**				
	11.	*Amaranthus spinosus* L.	Kandiali Cholai	Spiny amaranth	AH	May-Sept
	12.	*Amaranthus viridis* L.	Jangli Cholai	Slender amaranth	AH	May-Nov
	13.	*Digera muricata* (L.) Mart.	Tandla	Digera	AH	Aug-Oct
5.		**Asteraceae**				
	14.	*Sonchus arvensis* L.	Peeli Dhodak	Field Sowthistle	PS	Round the year
	15.	*Sonchus asper* (L.) Hill	Kandiali Dhodak	Spiny Sowthistle	AH	Feb-Sept
	16.	*Sonchus oleraceus* L.	Dhodak, Mahatra	Common Sowthistle	AH	Feb-Sept
	17.	*Cirsium arvensis* L.	Leh	Creeping Thistle	PH	Round the year
	18.	*Cirsium vulgare* (SAVI) Ten.	Moti Leh	Bull Thistle	BH	
	19.	*Eclipta prostate* L.	Daryai Booti	False Daisy	AH	Aug-Oct
6.		**Borginaceae**				
	20.	*Heliotropium europaeum* L.	Hathi-sund	Indian Heliotrope	AH	Aug-Sept
7.		**Cappariaceae**				
	21.	*Cleome viscosa* L.	Hul Hul	Spider Flower	AH	April-August
8.		**Chenopodiaceae**				
	22.	*Chenopodium album* L.	Bathu	Common goosefoot	AH	Round the year

	23.	*Chenopodium murale* L.	Kurund	Nettle-leaved	AH	Round the year
9.		**Cucurbitaceae**				
	24.	*Mukia maderaspatana (L.) M. Roem.*	Chibber	Wild Cucurbit	AH	April-oct
10		**Fabeaceae**				
	25	*Alhagi maurorum* Medik.	Juvahn	Prickly Clover	PS	April-Sept
	26	*Cassia occidentalis* L.	Chawwar, Ksondi	Coffee Weed	PS	May-Sept
11		**Marsiliaceae**				
	27	*Marsilea minuta* L.	Chopatti	Water Clover	PH	Round the Year

Weather Report, Monson 2010

Month	Temperature			No of Stress Days			Moisture	
	Avg.	Max	Min	Min≤0°C	Max≥35°C R.H≤30%	Max≥35°C R.H≥30%	Rainfall (mm)	Relative Humidity
April	31.3	39.7	22.9	---	05	05	3	36
May	34.5	42.5	26.5	---	13	12	4.31	33
June	34.75	40.9	28.6	---	2	2	38.1	43
July	33.65	38.4	28.9	---	---	---	57.15	60

Weather Report from Pakistan Meteorological Department, Agro-bulletin, Year 2010

Table-2. Importance Value Index (IVI) Weeds of Cotton Fields in Different Localities of Khanewal During Monsoon, 2010.

Weed #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
IVI=1	20.5	7.1	12.7	7.7	3.6	16.9	5.4	3.1	2.9	9.7	8.6	3.9	9.7	5.9	3.7	3.5	4.4	3.2	7.8	3.9	5.1	11.6	13.6	11.6	1.7	5.8	5.9
IVI=2	20.7	7.3	12.9	7.9	3.8	17.1	5.6	3.3	3.1	9.9	8.8	4.1	9.9	6.1	3.9	3.7	4.6	3.4	8.0	4.1	5.3	11.8	13.8	11.8	1.9	6.0	6.1
IVI=3	20.8	7.4	13.0	8.0	3.9	17.2	5.7	3.4	3.2	10.0	8.9	4.2	10.0	6.2	4.0	3.8	4.7	3.5	8.1	4.2	5.4	11.9	13.9	11.9	2.0	6.1	6.2
IVI=4	21.1	7.7	13.3	8.3	4.2	17.5	6.0	3.7	3.5	10.3	9.2	4.5	10.3	6.5	4.3	4.1	5.0	3.8	8.4	4.5	5.7	12.2	14.2	12.2	2.3	6.4	6.5
IVI=5	21.4	8.0	13.6	8.6	4.5	17.8	6.3	4.0	3.8	10.6	9.5	4.8	10.6	6.8	4.6	4.4	5.3	4.1	8.7	4.8	6.0	12.5	14.5	12.5	2.6	6.7	6.8
Average	20.9	7.5	13.1	8.1	4.0	17.3	5.8	3.5	3.3	10.1	9.0	4.3	10.1	6.3	4.1	3.9	4.8	3.6	8.2	4.3	5.5	12.0	14.0	12.0	2.1	6.2	6.3

IVI 1 = Rawan, IVI 2= Rango, IVI 3 = Kabirwala, IVI 4 = Chak 8 Kasi, IVI = Chak 83/85 10-R

1. *Cyperus rotundus* L.
2. *Cyperus iria* L.
3. *Cynodon dactylon* (L.) Pers.
4. *Dactyloctenium aegyptium* (L.) Wild.
5. *Digitaria adscendens* (Kunth) Henr.
6. *Echinochloa colona* (L.) Link
7. *Echinochloa crus-galli* (L.) P. Beauv.
8. *Panicum antidotile* Retz.
9. *Panicum glaucum* L.
10. *Trianthema portulacastrum* L.
11. *Amaranthus spinosus* L.
12. *Amaranthus viridis* L.
13. *Digera muricata* (L.) Mart.
14. *Sonchus arvensis* L.
15. *Sonchus asper* (L.) Hill
16. *Sonchus oleraceus* L.
17. *Cirsium arvensis* L.
18. *Cirsium vulgare* (Savi) Ten.
19. *Eclipta prostata* L.
20. *Heliotropium europaeum* L.
21. *Cleome viscose* L.
22. *Chenopodium album* L.
23. *Chenopodium murale* L.
24. *Mukia maderaspatana* (L.) M.
25. *Alhagi maurorum* Medik.
26. *Cassia occidentalis* L.
27. *Marsilea minuta* L.

Table-3. Average BLW, NLW, WPH across different Sowing Dates by Farmers.

Sowing Date	Broad Leaf Weed Density	Narrow Leaf Weed Density	Weed Height /Plant Height Ratio
15-Apr	4	4.2	0.51
30-Apr	5.4	5.6	0.69
15-May	8.8	9.2	0.77
30-May	9.2	11	0.86

*BLW= Broad Leaf Weed Density, NLW= Narrow leaf Weed Density, WPH= Weed to Plant Height Ratio.

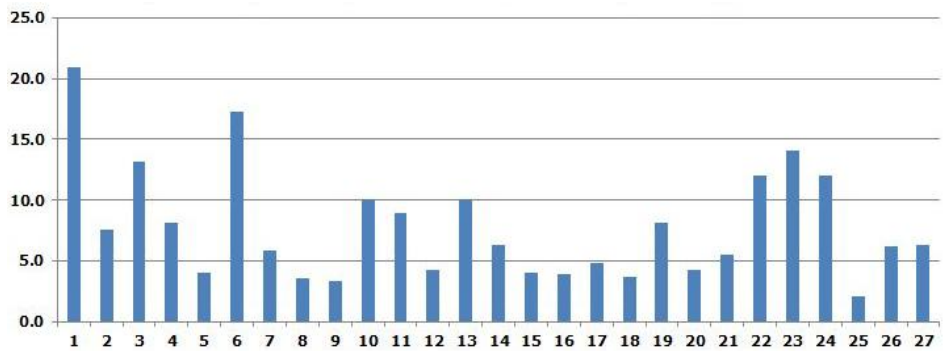

Figure 1. Average IVI graph of different species durin Monsoon, 2010 Khanewal.

1. *Cyperus rotundus*
2. *Cyperus iria*
3. *Cynodon dactylon*
4. *Dactyloctenium aegyptium*
5. *Digitaria adscendens*
6. *Echinochloa colona*
7. *Echinochloa crus-galli*
8. *Panicum antidotile*
9. *Panicum glaucum*
10. *Trianthema portulacastrum*
11. *Amaranthus spinosus*
12. *Amaranthus viridis*
13. *Digera muricata*
14. *Sonchus arvensis*
15. *Sonchus asper*
16. *Sonchus oleraceus*
17. *Cirsium arvensis*
18. *Cirsium vulgare*
19. *Eclipta prostata*
20. *Heliotropium europaeum*
21. *Cleome viscose*
22. *Chenopodium album*
23. *Chenopodium murale*
24. *Mukia maderaspatana*
25. *Alhagi mauroru*
26. *Cassia occidentalis*
27. *Marsilea minuta*

CONCLUSION

It is concluded from the study that early season growths of cotton plants have less competition with summer weeds due to dominative effect over resources before weeds. There is a change in weed flora with respect to sowing time. It is important that weed management program should be according to the sowing time and the particular weed flora of the area under study.

REFERENCES CITED

Bassett, I.J. and C.W. Crompton. 1978. The biology of canadian weeds; 32. *Chenopodium album* L. Can. J. Plant Sci. 58: 1061-1072.

Begon, M. 1986. Density and individual fitness: asymmetric competition. *In*: Evolutionary Ecology (ed. B SHORROCKS), 175–194. Blackwell, Oxford, UK.

Bukun, B. and F.N. Uygur. 2003. The impact of irrigation on weed species composition and density in cotton plantations of Harran Plain (Turkey). Proc. 7th EWRS Mediteranean Symp. Adana, Turkey. Pp. 143-144.

Bukun, B. 2004. Critical periods for weed control in cotton in Turkey. Weed Res. 44: 404-412.

Bukan, B. 2005. Weed flora changes in cotton growing areas during the last decade after irrigation of Harran plain in şanliurfa, Turkey. Pak. J. Bot. 37(3): 667-672.

Cope, T.A. 1982. Poaceae. Flora Pak. 143: 1-678.

Curtis, J.T. and R.P. McIntosh. 1950. The interrelations of certain analytic and synthetic phytosociological characters. Ecol. 31: 434-455.

Felger, R.S. 1990. Non-native plants of Organ Pipe Cactus National Monument, Arizona. Technical Report No. 31. U.S. Geological Survey, Cooperative Park Studies Unit,The University of Arizona and National Park Service, Organ Pipe Cactus National Monument. 93 pp.

Frisbie, R.E., K.M. El-Zik and L.T. Wilson. 1989. Integrated Pest Management System and Cotton Production. 359 p.

Grichar, W.J., 2007. Horse purslane (*Trianthema portulacastrum*), smell melon (*Cucumis melo*) and palmer amaranth (*Amaranthus palmeri*) control in Peanut with post emergence herbicides. Weed Technol. 21: 688–691.

Grichar, W.J. 2008. Herbicide systems for control of horse purslane (*Trianthema portulacastrum* L.), smell melon (*Cucumis melo* L.) and palmer amaranth (*Amaranthus palmeri* S. Wats) in Peanut. Peanut Sci. 35: 38–42.

Holm, L.G., D.L. Plunkettj, V. Pachnoand and J.P. Herberger. 1977. The world's worst weeds, distribution and biology. University Press of Hawaii, Honolulu. 609p.

Holm, L., J. Doll, E. Holm, J. Pancho, and J. Herberger. 1997. World weeds; natural histories and distribution. John Wiley & Sons, Inc., New York, New York. 1129 pp.

Hussain, F. 1980. Allelophathic effects of Pakistani Weeds: Euphorbia granulate Forssk.Oecolosia (Berl), 45: 26p.

Hussain, F. 1983. Biochemical inhibition (allelopathy) a less understood ecological factor in agro ecosystem. Prog. Farm. 3: 33-37.

Hussain, F., S.R. Chughtai and A.A. Dasti. 1985. Studies on the weeds of wheat in Quetta, Baluchistan. Pak. J. Agri. Res., 6: 1-7.

Hussain, F. and T.W. Khan. 1987. Allelopathic effects of Pakistani weeds. *Cynodon dactylon* (L.) Pers. Pak. J. Weed Sci. Res., 1.

Kathiresan, R.M., I. Gnanavel, R. Anbhazhagan, S.P. Padmapriya, N.K. Vijayalakshmi and M.P. Arulchezhian. 2005. Ecology and control of Parthenium invasion in Command Area. *In*: Proc. 2nd Inter. Conf. Parthenium Manag. Bangalore, India. Pp. 77-80.

Makhan-Kova, T.A. and A.V. Voecodin. 1984. The harmfulness of weeds in cotton. Byulteton Vsesoyusnogo, issledovated Skago. Institute Zashchity Restenii, 58: 55-60.

Mann, R.A., S. Ahmad, G. Hassan and M.S. Baloach. 2007. Weed management in direct seeded rice crop. Pak. J. Weed Sci. Res. 13(3-4): 219-226.

McDonald, A.J., S.J. Riha and A. Ditommaso. 2009. Early season height differences as robust predictors of weed growth potential in maize: new avenues for adaptive management? Weed Res. 50: 110-119.

Memon R. A., G. R. Bhati, S. Khalid, R. Soomro and S. Ahmad. 2007. A survey of weeds found in cotton fields of the Khairpur district, Sindh, Pakistan. Pak. J. Bot. 39(7): 2265-2274.

Mennan, H. and D. Işık. 2003. Invasive weed species in onion production systems during the last 25 years in Amasya, Turkey. Pak. J. Bot. 35(2): 155-160.

Morgan, D. C. and H. Smith. 1981. Control of development in *Chenopodium album* L. by shade light: the effect of light quantity (total influence rate) and light quality (red: far red ratio). New Phytol., 88: 239-248.

Motlagh, M.R.S. and A. Javadzadeh. 2011. Evaluation of the reaction of major weeds and some rice cultivars to *Colletotrichum graminicola*. J. American Sci. 7(2):179-185.

Naheed, G. and G. Rasul. 2010. Recent water requirement of cotton crop in Pakistan. Pak. J. Meteor. 6(12):75-84.

Nasir, E and S.I. Ali. 1974-1991. Flora of Pakistan, Department of Botany, University of Karachi & Agri. Res., Council, Isamabad, Pakistan.

Nayyar, M.M., M. Ashiq and J. Ahmad. 2001. Manual on Punjab Weeds. Directorate Agron. Ayub Agric. Res. Inst. Faisalabad-Pakistan, pp. 51-52.

Odum, E.P. 1971. Fundamentals of Ecology, 3rd Edition, Saunders, Philadelphia. 574 pp.

Parker, K.F. 1972. An illustrated guide to Arizona weeds. The University of Arizona Press, Tucson, AZ. 338 pp.

Parker, C. 1997. Prediction of new weed problems especially in developing world. Proc. 18th Symp. Br. Ecol. Soc., Blackwell Scientific, Bangor Wales, 249p.

Pearcy R., W.N. Tumosa and K. Williams. 1981. Relationships between growth, photosynthesis and competitive interactions for a C3 and a C4 plant. Oecologia, 48:371-376.

Rabbani, N. and R. Bajwa. 2001. Weed distribution in Rice fields of five districts of the Punjab. Pak. J. Bot. 33: 541-549.

Rajput, M.T., S.S. Tahir, B. Ahmad and M.A. Arain. 2008. Checklist of the weeds found in cotton crops, cultivated in Taluka Ubauro, district Sukkur, Pakistan. Pak. J. Bot. 40(1): 65-70.

Stewart, R.R. 1972. An Annotated Cataloge of Vascular Plants of West Pakistan and Kashmir. Fakhri Printing Press, Karachi.

Schwinning, S. and J. Weiner. 1998. Mechanisms determining the degree of size asymmetry in competition among plants. Oecologia, 113: 447–455.

Wikipedia.org. 2010. Searched Khanewal City of Punjab Pakistan. Accessed on September 10, 2010.