Pak. J. Weed Sci. Res. 19(1): 59-70, 2013

TO INVESTIGATE THE MAJOR WEEDS OF WHEAT IN DIFFERENT AGRO-ECOLOGICAL ZONES OF KHYBER PAKHTUNKHWA PAKISTAN

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ABSTRACT

Weed infestation of wheat crop is a serious problem throughout the country as weeds cause huge yield losses. To investigate the major weeds of wheat in Khyber Pakhtunkhwa province, a comprehensive survey was conducted during January to June, 2012. Wheat fields at D.I. Khan, Lakki Marwat, Kohat and Peshawar were visited. Surveys were conducted when the growth of the weeds was at peak. Quadrate method was used to record relative density, relative frequency, relative canopy coverage and importance value index. Several fields were visited at each location and the data average was calculated. After putting the data in ecological formulae, the data obtained showed Avena fatua as a major weed of wheat at the above mentioned four locations. While, Rumex dentatus at D.I. Khan, Phalaris minor at Lakki Marwat and Peshawar, and Rumex crispus at Kohat were the second major weeds after A. fatua. During these comprehensive surveys, the major and most problematic weeds of wheat were identified and the importance value indices were calculated. The seeds of two major weeds that ranked first and second at each location were collected at maturity and thus were used for detailed experimentations.

Key words: Importance value index, quadrate, survey of KP zones, weeds, wheat.

INTRODUCTION

Wheat (*Triticum aestivum* L.) belongs to family Poaceae and is the most important winter crop of Pakistan. Wheat is primarily used as a staple food providing more protein than any other cereal crop. It is consumed in many forms like bread, cakes, biscuits, bakery products, and many confectionery products. Its straw is used as animal feed and also for manufacturing paper.

Global wheat production is concentrated mainly in Australia, Canada, China, European Union, India, Pakistan, Russia, Turkey, Ukraine and the United States, accounting for over 80% of world wheat production. Pakistan is the 8th largest wheat producer, contributing about 3.17% of the world wheat production from 3.72%

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of the wheat growing area. Weed infestation is a serious problem in wheat crop. Uncontrolled weeds can reduce wheat yield by 25-30% in Pakistan (Nayyar *et al.*, 1994) or even higher depending upon weed infestation (Anonymous, 1997). Wheat in Pakistan is a leading food grain and occupies a central position in agriculture and its economy.

In Pakistan, wheat being the staple diet is the most important crop and is cultivated on the largest acreages in almost every part of the country. It contributes 14.4 percent to the value added in agriculture and 3.0 percent to Gross Domestic Product.

Weed competition is the only constraint for the wheat yield because insects and diseases are not so significant problems in Pakistan. The weeds control is the basic requirement and the major component of crop management in the production system (Young *et al.*, 1996). Weeds cause one of the biggest problems in agriculture. They use the soil fertility, available moisture, nutrients and compete for space and sunlight with crop plant, which result in yield reduction. Weeds deteriorate the quality of farm produce and consequently reduce the market value (Pervaiz and Quazi, 1999).

Various weed management options have been employed in past that address weed management without threshold level of individual weed species. The underlining reason is that weed flora in wheat and their competitive abilities differ with changes in environment even at micro-climate level, which is again under the influence of crop canopy (light interception) etc. *Avena fatua*, *Phalaris minor*, and *Convolvulus arvensis* have already been declared as the major weeds in the country. However, due to herbicidal application weed shift, change in the spectrum of weeds has occured in an area. Reduction in wheat yield is dependent on many factors like weed species, crop stand and environmental factors. Several researchers have reported the importance of crop-weed competition models. Crop weed competition is always dependent on the density of each species (Khan and Marwat, 2006). They further added that weed reduced wheat yield chiefly by the indirect effect of decreasing wheat tillers, the earliest formed yield component. The weed density, which resulted in yield losses varied greatly with density and season. In similar studies, Khan *et al.* (2009) reported that increasing weed density significantly and linearly decreased the grain yield of wheat while higher seed rate of wheat suppressed the weed biomass. Wheat yield was reduced 47% at the highest density of 12 common milkweed (*Asclepias syriaca*) shoots m^{-2} (Yenish *et al*., 1997). Cereal crop species and varieties differ in competitive ability against weeds mainly as influenced by differences in canopy architecture (Olesen *et al.,* 2006). Siddiqui *et al*. (2010) reported that the competitive ability of different weeds was different in a field trial of wheat. Apart from yield reduction of grains it has been

reported that wild oat also decrease the protein content in wheat grain (Khan *et al., 2007*). In a similar studies, Armin and Asghripour (2011) claimed that increase in wild oat density results in the reduction of wheat yield through decrease in fertile tiller per plant and spike m^{-2}.

Several researchers have reported the importance and density studies of individual weeds based on their competitiveness. There has been a tremendous work done on management of weeds in wheat in the recent past in this area but none of these have addressed the issue we are searching for. Huge grain yield losses have been estimated and reported in Pakistan that amount to Rs. 40 billion in wheat alone (Hassan and Marwat, 2001). All the previous weed management efforts made in past were never that effective. The foremost rationale is that weed flora in wheat and their competitive abilities differ in changing environments even at micro-climate levels.

Several researchers have reported the importance and density studies of individual weeds based on their competitiveness. The aim was to conduct field experiments in this aspect of weed science that looks towards maintaining profitability of farming operation and alertness of the farmers about the ill effects of these weed species under study. Such studies will facilitate the scientists and farmers in decision making processes of weed management.

In past only weed management through herbicides was focus of all weed management programs. Therefore in the instant study, the focus is to first investigate the weeds that are responsible for wheat grain yield reduction and then to decipher the potential of these weeds to quantify the level of yield reduction. This approach enabled us to decide the time of weed management and method of weed management to make the farming profitable.

The main objective of this survey was to categorize and enlist major weeds based on their importance values in different agro-climatic regions of Khyber Pakhtunkhwa and to figure out yield losses due to weeds in wheat for different regions of Khyber Pakhtunkhwa.

MATERIALS AND METHODS

The surveys were conducted in two phases in year 1 (Jan-June 2012) only. In first phase personal observations were carried out in the mid season of wheat crop to practically view the infestation of various weeds in wheat crop in each locality of the project. Relative Density, Relative frequency and Relative Canopy Coverage were determined by using the quadrate method during the documentation. In addition the available importance values determined by different workers for this area, if any, was taken into considerations., This helped us document the entire weed flora of wheat crop in various perspectives like weed composition, weed biomass, weed density,

frequency etc. In the next i.e. second phase, local farming community was interviewed using a specific format of a questionnaire in order to document their indigenous knowledge regarding the weed problems in wheat crop. The documentation of this information helped us do comparison with our personal observations. Comprehensive and reliable indigenous information was available in hand for all future scenarios. In addition, seed collection of the various noxious weeds of wheat was ensured for utilization in the next year field experimentations in the respective localities.

Quadrate was thrown several times in different fields at each location in W-shape so that the samples are reliable. Weeds inside the quadrate were identified, counted individually and inventories were done for determination of importance values. Personal observations were taken into account as many weeds have less density but their yield losses are greater due to bigger biomass. Apart from the weeds listed in tables, other weeds were also recorded but their density, frequency was not important to significantly affect the instant study. Therefore they were ignored.

The following were the formulae used for calculating relative density (RD), relative frequency (RF), relative canopy coverage (RCC) and importance value index (IVI). Using these formulea, the IVI and ranking of the weeds were determined.

$$RD = \frac{\text{Number of weeds of a particular species in the quadrate x 100}}{\text{Total number of weeds in that quadrate}}$$

$$RF = \frac{\text{Number of quadrates in which the particular species occurred x 100}}{\text{Total number of quadrates thrown}}$$

$$RCC = \frac{\text{Total canopy coverage of a species in a quadrate x 100}}{\text{Total canopy coverage of all species in a quadrate}}$$

$$IVI = RD + RF + RCC$$

RESULTS AND DISCUSSION

Field surveys were conducted in different locations of Khyber Pakhtunkhwa to check the Relative Density (RD), Relative Frequency (RF), Relative Canopy Coverage (RCC) and Importance Value Index (IVI) of different weed species found in wheat crop in Spring 2012. Data regarding all these parameters for different weed species is presented in the following tables.

Weeds survey in D.I. Khan

Field survey was conducted during February/ March, 2012 to record economically important and major weeds of wheat. Data recorded and presented in Table-1 showed the results of a survey conducted in Dera Ismail Khan to check the Relative Density (RD), Relative Frequency (RF), Relative Canopy Coverage (RCC) and Importance Value Index (IVI) of different weed species found in wheat.

Table-1. RD, RF, RCC and IVI of weed species in D.I. KHAN

Name of Weed Species	RD	RF	RCC	IVI
Avena fatua	22.58	21.06	34.09	77.73
Rumex dentatus	12.90	15.79	27.27	55.97
Medicago denticulate	22.58	21.06	11.36	55.00
Melilotus indica	19.35	13.69	5.68	38.72
Chenopodium album	9.68	11.58	11.36	32.62
Convolvulus arvensis	3.23	7.37	4.55	15.14
Malva parviflora	3.23	4.21	3.41	10.85
Cyperus rotundus	6.45	5.26	2.27	13.99

RD = relative density, RF = relative frequency, RCC = relative canopy coverage, IVI = importance value index

It is obvious from the table that IVI of *Avena Fatva* was found to be highest (77.73) as compared to other weeds species found in the wheat fields in D.I. Khan. Similarly the RD (22.58 %), RF (21.06 %) and RCC (34.09 %) values were also significantly higher than the rest of the weed species recorded. It was followed by *Rumex dentatus and Medicago denticulata*, which gave the IVI value of 55.97 and 55.0, respectively. It is also observed that the IVI of *Melilotus indica*, *Chenopodium album* and *Convolvulus arvensis* were found to be 38.72, 32.62 and 15.14, respectively which are in lower range than the former two species of weeds. The minimum IVI of 10.85 and 13.99 were observed in *Malva parviflora* and *Cyperus rotundus*. The table also revealed that the total density, frequency and canopy coverage of all the discussed species of weeds were 31, 316.67 and 88 plants m^{-2}, respectively. *Avena fatua* is a grassy weed and has already been reported as the major weed that decreases the grain yield of wheat in Pakistan. That is the reason that grass killer herbicides are extensively used for killing the *A. fatua*. However, it seems that resistance has been created in this weed against grass killer herbicides because herbicide with the same mode of action is used repeatedly in the same field and same crop. *Rumex dentatus* is a broadleaf weed and attain higher biomass. Therefore proper management of this weed needs to be addressed. It is a highly competitive weed and can cause drastic yield reduction (Chhokar *et al*., 2007; Anjum and Bajwa, 2007;

Mehmood *et al*., 2007). In a similar study conducted at the same location, Usman *et al.* (2010) reported that *Avena fatua* and *Rumex dentatus* were the major weeds infesting the wheat fields in D.I. Khan. These results are in agreement with the findings of Siddiqui and Shad (1991) and Qazi *et al*. (2003). Apart from the above mentioned weeds, few other weeds were also recorded. However, due to inconsistency and low density, their density was not included in the study. Two weeds (*Avena fatua* and *Rumex dentatus*) ranked first and second and thus were selected for future studies and experimentations. The seeds of these two species were selected at maturity and stored at room temperature.

Weeds survey in Lakki Marwat

This field survey was also conducted during February/ March, 2012 to record economically important and major weeds of wheat. Data presented in Table 2 showed the results of the survey conducted in Lakki Marwat to check the Relative Density (RD), Relative Frequency (RF), Relative Canopy Coverage (RCC) and Importance Value Index (IVI) of different weed species found in wheat. Finally the importance value index of each weed was calculated based on these results it is clear from the Table-2 that IVI of *Avena Fatva* and *Phalaris minor* was found to be highest having a value of (86.06) and (85.29), respectively as compared to other weeds species found in the wheat fields in Lakki Marwat. Moreover the values of RD (23.68, 26.32 %), RF (24.74, 28.87 %) and RCC (37.63, 30.11 %), respectively for *Avena Fatva* and *Phalaris minor* were also significantly higher than the rest of the weed species recorded. It was followed by *Fumaria indica L*. and *Medicago denticulata*, which gave the IVI value of 26.67 and 32.40, respectively. It is also observed that the IVI of *Sisybrium irio L., Carthamus oxyacantha M.* and *Malva neglecta L*. were found to be 15.24, 18.51 and 18.93, respectively which are in lower range than the former two species of weeds. The minimum IVI of 11.63 were observed in *Vicia sativa L*. The table also revealed that the total density, frequency and canopy coverage of all the discussed species of weeds were 33, 393.3 and 93 plants m^{-2}, respectively. *Avena fatua* is a species of grass in the oat genus. It is known as the common wild oat. This oat is native to Eurasia but it has been introduced to most of the other temperate regions of the world. It is naturalized in some areas and considered a noxious weed in others crops as well *Avena fatua* is a grassy weed and has already been reported as the major weed that decrease the grain yield of wheat in Pakistan. That is the reason that grass killer herbicides are extensively used for killing the Avena fatua. However, it seems that resistance has been created in this weed against grass killer herbicides because herbicide with the same mode of action is used repeatedly in the same field and same

crop. *Phalaris minor* is also a grassy weed and due to dense population it affect yield of crops, especially wheat. Therefore proper management of this weed needs to be addressed. The same findings were reported by Nasir and sultan (2004), who reported that these weeds established themselves in cutivated fields and effect crops growth and yield. (Dagar *et al*., 1976; Hussain *et al*., 1992; Navie *et al*., 1996; Singh *et al*., 2005; Batish *et al*., 2007). Similarly, Siddiqui and Shad (1991) reported that the grain yield of wheat declined with the increase in weed density under both rainfed as well as irrigated conditions Apart from the above mentioned weeds, few other weeds were also recorded. However, due to inconsistency and low density, their density was not included in the study. The seeds of these two species of *Avena fatua* and *Phalaris minor* were selected at maturity and stored at room temperature for future experiments in next year.

Table-2. RD, RF, RCC and IVI of weed species in Lakki Marwat.

Name of Weed Species	RD	RF	RCC	IVI
Avena fatua	23.68	24.74	37.63	86.06
Phalaris minor	26.32	28.87	30.11	85.29
Fumaria indica	7.89	13.40	5.38	26.67
Medicago denticulata	10.53	16.50	5.38	32.40
Sisybrium irio	7.89	4.12	3.23	15.24
Vicia sativa	5.26	2.06	4.30	11.63
Malva neglecta	5.26	7.22	6.45	18.93
Carthamus oxyacantha	7.89	3.09	7.53	18.51

RD = relative density, RF = relative frequency, RCC = relative canopy coverage, IVI = importance value index

Weeds survey in Kohat

Data presented in Table 3 shows the results of the survey conducted in Kohat to check the Relative Density (RD), Relative Frequency (RF), Relative Canopy Coverage (RCC) and Importance Value Index (IVI) of different weed species found in wheat fields. This field survey was also conducted during February-March, 2012 to record economically important and major weeds of wheat. Finally the importance value index (IVI) of each weed was calculated. Based on these results it is clear from the table that IVI of *Avena Fatua* and *Rumex crispus* was found to be highest having a value of (75.96) and (67.87), respectively as compared to other weeds species found in the wheat fields in Kohat. Similarly the values of Relative density (20.00, 23.33 %), Relative frequency (23.41, 21.28 %) and Relative canopy coverage (32.56, 23.26 %), respectively for *Avena fatva* and *Rumex crispus* were also significantly higher than the rest of the weed species recorded in district Kohat. As these values are averages of all

quadrates sampled. Therefore major weeds were recorded and reported. Finally a decrease in IVI was observed and it was noted that *Medicago denticulata* and *Phalaris minor* which gave the IVI value of 47.05 and 38.07, respectively. It was also observed that the IVI of *Convolvulus arvensis, Silybum marianum* and a *Fumaria Indica* were found to be 23.42, 16.69 and 20.94, respectively which are in lower range than the former discussed species of weeds. The minimum IVI of 10.01 was observed in Lathyrus. *Avena fatua* can become troublesome in agriculture when wheat is planted consecutively in the same field and thus lowers the quality of a field crop, or competes for resources with the crop plants. *Rumix crispus* is also a broad leaf weed and due to its higher population many flowers and seeds are produced in clusters on branched stems, with the largest cluster being found at the apex. It affect yield of crops, especially wheat due to bigger biomass under moist conditions. Therefore proper management of this weed needs to be addressed. These results are in consistency with Taylor *et al*. (1995), who reported that these weeds establish in crops and effect yield. Moreover Jalis (1987) studied the predominating influence of *Phalaris minor* and *Avena fatua* in wheat. Similar results were also found by Whish *et al.* (2002). Apart from the above mentioned weeds, few other weeds were also recorded. However, due to inconsistency and low density, their density was not included in the study. The seeds of these two species of *Avena fatua* and *Rumex crispus* were also selected at maturity and stored at room temperature as there is drastic shift from vegetables to crops and vice-versa. Therefore the weeds are also changed. Therefore it was observed that many weeds reported by earlier scientists are no more problematic weeds; while, new weeds have resulted in a threat to wheat production.

Weeds survey in Peshawar

Weeds are at active growth stage during Feb-March at Peshawar, therefore this survey was also conducted in Peshawar when weeds growth was at peak. Quadrate was randomly thrown in different fields by using the concept of " W" shape and the weeds inside the quadrate were identified and counted to calculate RD, RF, RC and IVI. Data presented in Table 4 show the results of a the survey conducted in Peshawar to check the Relative Density (RD), Relative Frequency (RF), Relative Canopy Coverage (RCC) and Importance Value Index (IVI) of different weed species found in wheat. Finally the importance value index of each weed was calculated based on these results It is cleared from the table that IVI of *Avena Fatua* and *Phalaris minor* was found to be highest having a value of (82.02) and (57.62), respectively as compared to other weeds species found in the wheat fields in Peshawar. Moreover the values of RD (22.50, 15.00 %), RF

(26.19, 22.62 %) and RCC (33.33, 20.00 %), respectively for *Avena fatua* and *Phalaris minor* were also significantly higher than the rest of the weed species recorded. It was followed by *Melilotus parviflora* and *Anagallis arvensis*, which gave the IVI value of 56.87 and 27.74, respectively. It is also observed that the IVI of *Coronopus didymus*, *Fumaria indica*, and *Euphorbia helioscopia* were found to be 22.18, 17.70 and 19.72, respectively which are in lower range than the other species of weeds.

Table-3. RD, RF, RCC and IVI of weed species in Kohat.

Name of Weed Species	RD	RF	RCC	IVI
Avena fatua	20.00	23.41	32.56	75.96
Rumex crispus	23.33	21.28	23.26	67.87
Phalaris minor	16.67	7.45	13.95	38.07
Convolvulus arvensis	6.67	7.45	9.30	23.42
Medicago denticulate	16.67	23.41	6.98	47.05
Silybum marianum	3.33	6.38	6.98	16.69
Fumaria indica	10.00	7.45	3.49	20.94
Lathyrus	3.33	3.19	3.49	10.01

RD = relative density, RF = relative frequency, RCC = relative canopy coverage, IVI = importance value index

The minimum IVI of 16.15 were observed in *Convolvulus arvensis.* The table also revealed that the total density, frequency and canopy coverage of all the discussed species of weeds were 40, 280 and 90 plants m^{-2}, respectively. *Avena fatua* is known as the common wild oat. This oat is native to Eurasia but it has been introduced to most of the other temperate regions of the world. It is naturalized in some areas and considered a noxious weed in others crops. *Avena fatua* is a grassy weed and has already been reported as the major weed that decrease the grain yield of wheat in Pakistan. That is the reason that grass killer herbicides are extensively used for killing the *Avena fatua*. However, it seems that resistance has been created in this weed against grass killer herbicides because herbicide with the same mode of action is used repeatedly in the same field and same crop. *Phalaris minor* is also a grassy weed and due to dense population it affect yield of crops, especially wheat. Therefore proper management of this weed needs to be addressed. The same findings were reported by Odum (1971), who reported that these weeds established themselves field crops and effect growth and yield. These results are in great analogy with the work of Sultan and Nasir (2004) Apart from the above mentioned weeds, few other weeds were also recorded. However, due to inconsistency and low density, their density

was not included in the study. Two weeds (*Avena fatua* and *Phalaris minor*) ranked first and second were selected for future studies and experimentations. The seeds of these two species were selected at maturity and stored at room temperature. Due to changing rainfall and cropping system, there is shift in weed species in Peshawar. Therefore they ranked first and second in our studies are different from other scientists that they have recorded.

Table-4. RD, RF, RCC and IVI of weed species in Peshawar

Name of Weed Species	RD	RF	RCC	IVI
Avena fatua	22.50	26.19	33.33	82.02
Phalaris minor	15.00	22.62	20.00	57.62
Melilotus parviflora	27.50	23.81	5.56	56.87
Anagallis arvensis	17.50	3.57	6.67	27.74
Coronopus didymus,	7.50	3.57	11.11	22.18
Fumaria indica,	5.00	7.14	5.56	17.70
Convolvulus arvensis	2.50	4.76	8.89	16.15
Euphorbia helioscopia	2.50	8.33	8.89	19.72

RD = relative density, RF = relative frequency, RCC = relative canopy coverage, IVI = importance value index

CONCLUSIONS

Comprehensive and extensive survey was conducted to determine the importance value index of major weeds of wheat in KP province during Spring 2012. The findings of the survey exhibited that there is a significant differences in relative frequency, relative density, relative canopy coverage and consequently the importance value index of the different weeds found in different locations of KP province. It is more obvious from these results that *Avena fatua* in combinations with some other weed species is having high importance value as *Avena fatua* was found cosmopolitan weed. It was observed that grassy as well as broadlef weeds are found in the wheat crop that cause huge losses.

ACKNOWLEDGEMENT

The authors do acknowledge the Agricultural Linkages Program (ALP), Pakistan Agricultural Research Council (PARC) Islamabad for financial support of this study.

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