Pak. J. Bot., 39(7): 2585-2594, 2007.

EFFECT OF WILD OATS (*AVENA FATUA* L.) DENSITY ON WHEAT YIELD AND ITS COMPONENTS UNDER VARYING NITROGEN REGIMES

GUL HASSAN* AND HAROON KHAN

Department of Weed Science,
NWFP Agricultural University Peshawar-25130, Pakistan

Abstract

A field study was conducted at Malakandher Research Farm, NWFP Agricultural University, Peshawar during Rabi 2003-4 to quantify the competition between wheat and wild oats. The experiment was laid out in randomized complete block design with four replications under a split-plot arrangement. The experiment comprised of 3-nitrogen levels (75, 100 and 125 kg ha^{-1}), kept in main plots, while six wild oats densities (0, 10, 20, 30, 40 and 50 plants $m^{-2)}$ assigned to sub-plots. Ghaznavi-98 variety of wheat with a sub-plot size of 5x 1 m^2 was seeded in the 3rd week of November 2003. The data were recorded on density of wheat (m^{-2}), density of wild oats (m^{-2}), wheat and wild oats leaf area $plant^{-1}$ (cm^2), wheat and wild oats plant height at maturity (cm), wheat spike length (cm), number of grains $spike^{-1}$, grain weight $spike^{-1}$ (g), 1000 grains weight (g), biological yield (t ha^{-1}) and grain yield (t ha^{-1}). Moreover, grain and straw were also analyzed to estimate the uptake of nitrogen, phosphorus and potash by the test species. All the data except the chemical analyses were subjected to ANOVA technique using MSTATC Computer software. The data revealed significant differences for the wild oats densities for most of the traits studied, the differences for nitrogen levels and interaction were significant only in grain yield and spike length, respectively. The comparison of means revealed that density of wheat decreased with an increase in wild oats density. Only 150 plants m^{-2} was recorded under 50 wild oats seeded m^{-2} as compared to 262 plants m^{-2} in the monoculture of wheat. Plant height of wheat was also influenced by the oats density. At 50 wild oats, the wheat height was 83.333 cm as compared to 90.125 cm in the monoculture wheat. Similarly, the grain size was also affected by the presence of wild oats. As low as 12% lower sized grains were recorded under 50 oats plants m^{-2} as compared to monoculture of wheat. The adverse effect of oats on yield components reflected on the grain yield. More than 50% reduction in yield was noticed at the highest density of wild oats as compared to monoculture of wheat.

Introduction

Agriculture is the mainstay of Pakistan's economy. It employs 48% of the total labour force at the national level and its contribution to GDP and exports earnings is 24 and 75 %, respectively (MinFAL, 2007). Wheat keeps a unique position among the cultivated crops. Wheat supplies about 73% of the calories and proteins of the average human diet (Heyne, 1987).

At the national level, during 2006-07, the area under wheat cultivation in Pakistan was 8.4 million ha, with a production of 23.5 million tons with a mean production of 2798 kg ha^{-1} (MinFAL, 2007). Nation has faced a worst debacle of its kind in wheat supply during 2007 and the crisis is still persisting. The recent unending queues to purchase wheat flour warrant a special attention to increase wheat production. In Pakistan wheat yield ha^{-1} is unfortunately very low and actual farm yield is about 30-35% of the potential yield (Hassan & Marwat, 2001).

E-mail:hassanpk_2000pk@yahoo.com

Major weeds that are competitive with wheat crop in N.W.F.P., are *Avena fatua, Phalaris minor, Poa annua, Medicago denticulata, Convolvulus arvensis, Chenopodium album, Fumaria indica, Carthamus oxycantha,Galium aparine* and *Euphorbia helioscopia* (Hassan *et al., 2003).* But, *Avena fatua,* is the most competitive weed in agricultural crops including wheat (Rao, 2001).

Due to competition between wild oats and wheat for nutrients, water, space and light, the wheat plant is weakened resulting in reduced yields. However, encouraging aspect is that due to interspecific competition between wild oats and wheat, the growth and physiology of wild oats is also affected due to the allelopathic effect of wheat. Tissue extract from living tissue of wheat significantly decreased the growth of wild oats. Shoot extracts significantly but root extract nonsignificantly affected the total biomass, pigments, carbohydrates and protein contents of wild oats (El-Khatib & Hegazy, 1999).

Increasing sowing rates of wheat seeds and sowing in narrow rows competed with wild oats more effectively and increased yield by 8% (Sodhi & Dhaliwal, 1998). Increasing the proportion of wheat or oat seed in mixture led to significant increase in the amount of above ground biomass and total seed weight for that species. The seed weight and the above ground biomass per culm or per planted seed decreased for wheat and wild oat as the proportion increased in mixture, indicating a competitive advantage for wild oat when grown with wheat (Khan & Thill, 1992; Pfleeger *et al.,* 1999).

The plant height has been evaluated to have a negative correlation with weeds; hence the taller cultivars of wheat were evaluated as more competitive with Italian ryegrass and wild oats as compared to the dwarfer cultivars (Appleby *et al.,* 1976; Pawar *et al.,* 1998).

Hashem & Radosevich (1991) quantified the interaction of Italian ryegrass and wheat in mixture and communicated that Italian ryegrass had more competitive ability than wheat. Carlson (1986) has reported similar behavior of wild oats with wheat. Borghain *et al.,* (1985), Riaz *et al.,* (1988) and Hassan *et al*., (1996) deciphered that Tribunil and Dicuran M.A 60 effectively controlled weeds in wheat crop.

Marquez *et al*., (1996) established 8 successive cohorts and concluded that a stronger competitive impact on wheat yield from the earlier wild oat populations was recorded. The studies of Ibrahim *et al.,* (1995) have further confirmed that early emerging wild oats was more vigorous and competitive.

In view of the importance of the wheat-wild oats competition, an experiment was conducted to investigate the impact of varying wild densities on wheat with these objectives, a) to investigate the competition between wheat and wild oats at various densities, b) to study the response of wheat and wild oats to different nitrogen levels and c) to decipher the interaction of wild oats and wheat at different nitrogen levels and populations.

Materials and Methods

An experiment on interspecific competition of wheat and wild oats as influenced by different nitrogen regimes was conducted at Malakandher Research Farm, N.W.F.P Agricultural University, Peshawar during Rabi 2003-4. The experiment was laid out in a Randomized complete block (RCB) design with a split-plot arrangement. The nitrogen levels were assigned to main plots and wild oats densities kept in sub-plots randomly. Each sub-plot measured 5 x 1 m^2. The seed of Ghaznavi-98 wheat variety was sown @ 120 kg ha^{-1} on 13th November 2003 with the help of a hand hoe. All the recommended

cultural practices were carried out uniformly in all the treatments during the experiment except for variables intended for studies.

The N level (75, 100 and 125 kg N ha^{-1}) were assigned to the main-plots while wild oats densities (0, 10, 20, 30, 40 and 50 plants m^{-2}) were kept into sub-plots. The data were recorded on wheat density m^{-2}, Wheat leaf area (cm^2) $plant^{-1}$, Wild oats leaf area (cm^2 $plant^{-1}$, Wheat plant height at maturity (cm), Wild oats plant height at maturity (cm), Wheat Spike length (cm), Number of grains $spike^{-1}$, Grain weight (g) $spike^{-1}$, 1000-grain weight (g), Biological yield (t ha^{-1}) and Grain yield (t ha^{-1}). The data recorded individually for each parameter except for the chemical analyses parameters were subjected to the ANOVA technique by using MSTATC computer software and the significant means were separated by using Fisher's Protected LSD test (Steel & Torrie, 1980).

Results and Discussion

Wheat density m^{-2}: Statistical analysis of the data showed that wild oats densities have a significant effect while nitrogen levels and their interaction have non-significant differences on wheat density. The data exhibit that among the nitrogen levels, maximum (209.42) wheat density was recorded in 125 N kg ha^{-1} while minimum (189.83) wheat density was recorded in 75 N kg ha^{-1} nitrogen level treated plots (Table 1). Among the wild oats densities maximum (262.00) wheat density was recorded in 0 (control), while minimum (150.58) wheat density was recorded in 50 wild oats seed m^{-2}. For interaction of nitrogen with the wild oats densities, the maximum (286.75) wheat density was recorded in N_2 X D_I while minimum wheat density (145.750) was recorded in N_2 X D_6 treatments. As we increased the density level of wild oats wheat density was reduced due to interspecific competition. Our result are in line with the work of Ibrahim *et al.,* (1995) who have confirmed that early emerging wild oats was more vigorous and competitive with wheat.

Wheat leaf area (cm^2) $plant^{-1}$: Statistical analysis of the data showed that wild oats densities, nitrogen levels and their interaction have non-significant effect on wheat leaf area $plant^{-1}$ (Table 2). Data exhibit that for the nitrogen levels, maximum (39.562) wheat leaf area $plant^{-1}$ was recorded in 125 N kg ha^{-1} while minimum (34.127) wheat leaf area $plant^{-1}$ was recorded in 75 kg N $ha^{-1.}$ Among the wild oats densities, maximum (40.972) wheat leaf area $plant^{-1}$ was recorded in 0 (control), while minimum (34.742) wheat leaf area $plant^{-1}$ was recorded in 50 wild oats seed m^{-2} treatment. For interaction of nitrogen with the wild oats densities, the maximum (43.213) wheat leaf area $plant^{-1}$ was recorded in (N_2 X D_1) while minimum wheat leaf area $plant^{-1}$ (29.668) was recorded in N_1 X D_6.

Wild oats leaf area $plant^{-1}$ (cm^2): Statistical analysis of the data revealed that wild oats densities have a significant effect while nitrogen levels and their interaction have non-significant effect on wild oats leaf area $plant^{-1}$ (Table 3). Data show that for the nitrogen levels, maximum (56.731) wild oats leaf area $plant^{-1}$ was recorded in 125 N kg ha^{-1} while minimum (49.752) wild oats leaf area $plant^{-1}$ was recorded in 75 N kg ha^{-1}. Among the wild oats densities maximum (67.144) wild oats leaf area $plant^{-1}$ was recorded in 20 wild oats seed m^{-2}, while minimum (57.323) wild oats leaf area $plant^{-1}$ was recorded in 10 wild oats seed m^{-2} treatments. For interaction of nitrogen with the wild oats densities, the maximum (78.192) wild oats leaf area $plant^{-1}$ was observed in N_2 X D_3 while minimum wild oats leaf area $plant^{-1}$ (44.280) was observed in N_2 X D_2 treatment.

Table 1. Wheat density m^{-2} as affected by different nitrogen levels and wild oats densities.

N level ($kg\ ha^{-1}$)	*Avena fatua* densities m^{-2}						N Mean
	0	10	20	30	40	50	
75	243.50n.s.	205.25	188.00	195.75	154.75	151.75	189.83 n.s.
100	286.75	184.00	166.25	223.50	188.75	145.75	199.17
125	255.75	222.00	248.25	192.25	184.00	154.25	209.42
Density means	262.00a	203.75b	200.83b	203.83b	175.83bc	150.58c	

n.s. = Non-significant at $p \leq 0.05$.

Table 2. Wheat leaf area (cm^2) as affected by different nitrogen levels and wild oats densities.

N level ($kg\ ha^{-1}$)	Wild oats (*Avena fatua*) densities m^{-2}						N Mean
	0	10	20	30	40	50	
75	40.533n.s.	32.050	34.083	37.305	31.122	29.668	34.127n.s
100	43.213	35.668	36.318	35.878	36.680	31.597	36.559
125	39.170	39.058	38.410	40.780	36.995	42.960	39.562
Density means	40.972n.s	35.592	36.270	37.988	34.933	34.742	

n.s. = Non-significant at $p \leq 0.05$.

Table 3. Wild oats (*Avena fatua*) leaf area (cm^2) as affected by different nitrogen levels and wild oats densities.

N level ($kg\ ha^{-1}$)	*Avena fatua* densities m^{-2}						N Mean
	0	10	20	30	40	50	
75	0.000n.s	58.222	57.960	58.490	65.117	58.722	49.752n.s
100	0.000	44.280	78.192	67.375	67.275	74.200	56.470
125	0.000	69.465	65.280	69.508	68.245	67.890	56.731
Density means	0.000b	57.323a	67.144a	65.124a	66.879a	66.937a	

n.s. = Non-significant at $p \leq 0.05$.

Wheat plant height at maturity (cm): Statistical analysis of the data showed that wild oats densities have a significant effect while nitrogen levels and their interaction have non-significant effect on wheat plant height (cm). The data (Table 4) exhibit that for the nitrogen levels, maximum (87.283) wheat plant height was recorded in 75 N kg ha^{-1} while minimum (85.425) wheat plant height was recorded in 125 N kg ha^{-1} nitrogen regime. Among the wild oats densities maximum (90.125) wheat plant height was recorded in 0 (control), while minimum (83.825) wheat plant height was recorded in 20 wild oats seed m^{-2}. For interaction the maximum (90.500) wheat plant height was recorded in N_2 x D_4 while minimum wheat plant height (80.800) was recorded in N_3 X D_3 treatments. The check plant height was probably higher due to no competition with oat plants. Our results are not in conformity with the work of Appleby *et al.,* (1976) and Pawar *et al.,* (1998), who reported that the plant height had a negative correlation with weeds, hence the taller cultivars of wheat were evaluated as more competitive with Italian ryegrass and wild oats as compared to the dwarfer cultivars.

Table 4. Wheat height at maturity (cm) as affected by different nitrogen levels and wild oats densities.

N level (kg ha^{-1})	*Avena fatua* densities m^{-2}						N Mean
	0	10	20	30	40	50	
75	89.700n.s	88.300	87.400	89.100	85.150	84.050	87.283n.s.
100	90.225	85.750	83.275	90.500	87.350	83.650	86.792
125	90.450	87.700	80.800	84.650	85.150	83.800	85.425
Density means	90.125a	87.250abc	83.825c	88.0830ab	85.883bc	83.833c	

n.s. = Non-significant at p≤0.05.

Table 5. Wild oats (*Avena fatua*) height (cm) as affected by different nitrogen levels and wild oats densities.

N level (kg ha^{-1})	*Avena fatua* densities m^{-2}						N Mean
	0	10	20	30	40	50	
75	0.000n.s	136.00	123.350	138.100	134.900	132.150	110.750n.s
100	0.000	128.600	142.150	135.850	133.350	137.800	112.958
125	0.000	133.675	119.000	135.000	127.300	120.700	105.946
Density means	0.000b	132.758a	128.167a	136.317a	131.850a	130.217a	

n.s. = Non-significant at p≤0.05.

Wild oat height at maturity (cm): Statistical analysis of the data showed that wild oats densities have significant effect while nitrogen levels and their interaction have non-significant effect on wild oats plant height (cm). The data (Table 5) exhibit that for the nitrogen levels, maximum (112.958) wild oats plant height was recorded in 100 N kg ha^{-1} while minimum (105.946) wild oats plant height was recorded in 125 N kg ha^{-1}. Among the wild oats densities, maximum (136.317) wild oats plant height was recorded in 30 wild oats seed m^{-2}, while minimum (128.167) wild oats plant height was recorded in 20 wild oats seed m^{-2}. For interaction the maximum (142.150) wild oats plant height was recorded in N_2 x D_3 while minimum wild oats plant height (119.000) was recorded in N_3 X D_3 treatments. All other treatments numerically had similar values. Hashem & Radosevich (1991), quantified the interaction of Italian ryegrass and wheat in mixture and communicated that Italian ryegeass had more competitive ability than wheat. Carlson (1986) has reported similar behaviour of wild oats with wheat. El-Khatib & Hegazy, (1999), were of the opinion that competition between wild oats and wheat for nutrients, water, space and light the wheat plant is weakened resulting in reduced yields. However, encouraging aspect is that due to interspecific competition between wild oat and wheat, the growth and physiology of wild oat is also affected due to the allelopathic effect of wheat. Tissue extract from living tissue of wheat significantly decreased the growth of wild oat. Shoot extracts significantly but root extract non significantly affected the total biomass, pigments, carbohydrates and protein contents of wild oats

Wheat spike length (cm): Statistical analysis of the data showed that nitrogen levels and wild oats densities have non-significant effect; interaction has significant effect on wheat spike length (cm) (Table 6). Data exhibit that for the nitrogen levels, maximum (8.755 cm) wheat spike length (cm) was recorded in 125 N kg ha^{-1} while minimum (8.413) wheat spike length (cm) was recorded in 100 N kg ha^{-1}. Among the wild oats densities maximum (8.986 cm) wheat spike length (cm) was recorded in 0 (control), while minimum (8.383) wheat spike length (cm) was recorded in 10 wild oats seed m^{-2} treatments. For interaction of nitrogen with the wild oats densities, the maximum (9.875 cm) wheat spike length (cm) was recorded in N_3 x D_1 while, minimum wheat spike length (cm) (7.775 cm) was recorded in N_2 x D_2. The data exhibit that the leaf area in wheat is strictly under genetic control and not significantly influenced by the environment.

Number of grains $spike^{-1}$: Statistical analysis of the data exhibit that wild oats densities, nitrogen levels and their interaction have non-significant effect on number of grains $spike^{-1}$. The data exhibit that among the nitrogen levels, maximum (53.962) number of grains $spike^{-1}$ were recorded in 100 N kg ha^{-1} while minimum (51.083) number of grains $spike^{-1}$ were recorded in 125 N kg ha^{-1}(Table 7). Among the wild oats densities maximum (57.083) number of grains $spike^{-1}$ were recorded in 0 (control), while minimum (50.042) number of grains $spike^{-1}$ were recorded in 20 wild oats seed m^{-2}. For interaction of N with the wild oats densities, the maximum (66.250) number of grains $spike^{-1}$ were recorded in N_3 x D_1 while minimum number of grains $spike^{-1}$ (43.100) were recorded in N_3 X D_5.

Grain weight $spike^{-1}$ (g): Statistical analysis of the data showed that wild oats density, nitrogen treatment and their interaction have non-significant effect on grains weight $spike^{-1}$(Table 8). The data exhibit that among the nitrogen levels, maximum (1.835) grain weight $spike^{-1}$ was recorded in 100 N kg ha^{-1} while minimum (1.786) grain weight $spike^{-1}$ was recorded in 125 N kg ha^{-1} treated plots. Among the wild oats densities maximum (1.953) number of grains weight $spike^{-1}$was recorded in 0 wild oats seed m^{-2} (control), while minimum (1.713) number of grains weight $spike^{-1}$ was recorded in 30 wild oats seed m^{-2}. For interaction of nitrogen with the wild oats densities, the maximum (2.202) grain weight $spike^{-1}$ was recorded in N_3 x D_1 while minimum number of grain weight $spike^{-1}$ (1.535) was recorded in N_2 X D_4. Our findings reveal that grain weight per spike is strictly governed by the genetics of wheat and the micro-environment has little influence in determining grain weight.

1000 grain weight (g) of wheat: Statistical analysis of the data showed that wild oats density have significant while nitrogen treatment and their interaction have non-significant effect on 1000-grain weight (g). The data in (Table 9) exhibit that among the nitrogen levels, maximum (32.530) 1000-grain weight was recorded in 75 N kg N ha^{-1} while minimum (31.764) 1000-grain weight was recorded in 125 N kg ha^{-1} treated plots. Among the wild oats densities maximum (34.379) 1000-grain weight was recorded in 0 wild oats seed m^{-2} (control), while minimum (30.142) 1000-grain weight was recorded in 50 wild oats seed m^{-2} treatments. For interaction of nitrogen with the wild oats densities, the maximum (35.088) number of 1000-grains weight was recorded in N_1 X D_4 while minimum number of 1000-grain weight (31.197) was recorded in N_2 X D_5. Our findings depict that the weight was directly proportional to the wild oats density. Under the lesser densities, the wheat was able to make better use of soil and environmental resources and partition higher photosynthate to the grains resulting in bolder grains.

Table 6. Wheat spike length (cm) as affected by different nitrogen levels and wild oats densities.

N level (kg ha^{-1})	*Avena fatua* densities m^{-2}						N Mean
	0	10	20	30	40	50	
75	8.600ab	8.675ab	8.650ab	9.100ab	8.905ab	8.525ab	8.743n.s.
100	8.482b	7.775b	8.675ab	8.275b	8.720ab	8.550ab	8.413
125	9.875a	8.700ab	8.600ab	8.533ab	8.250b	8.575ab	8.755
Density means	8.986n.s.	8.383	8.642	8.636	8.625	8.550	

n.s. = Non-significant at p≤0.05.

Table 7. Number of grains spike^{-1} as affected by different nitrogen levels and wild oats densities.

N level (kg ha^{-1})	*Avena fatua* densities m^{-2}						N Mean
	0	10	20	30	40	50	
75	48.550n.s.	49.150	52.500	54.950	49.225	53.150	51.254n.s.
100	56.450	54.200	53.825	45.950	63.700	49.650	53.962
125	66.250	52.250	43.800	52.600	43.100	48.500	51.083
Density means	57.083n.s.	51.867	50.042	51.167	52.008	50.433	

n.s. = Non-significant at p≤0.05.

Table 8. Grains weight (g) spike^{-1} as affected by different nitrogen levels and wild oats densities.

N level (kg ha^{-1})	*Avena fatua* densities m^{-2}						N Mean
	0	10	20	30	40	50	
75	1.770n.s.	1.565	1.912	2.010	1.673	1.845	1.796n.s.
100	1.887	1.973	1.855	1.535	2.203	1.555	1.835
125	2.202	1.692	1.595	1.595	1.765	1.865	1.786
Density means	1.953n.s.	1.743	1.788	1.713	1.880	1.755	

n.s. = Non-significant at p≤0.05.

Table 9. 1000 grain weight (g) of wheat as affected by different nitrogen levels and wild oats densities.

N level (kg ha^{-1})	*Avena fatua* densities m^{-2}						N Mean
	0	10	20	30	40	50	
75	34.318n.s	33.332	31.920	35.088	30.150	30.375	32.530n.s
100	34.740	32.127	33.150	30.398	31.197	29.557	31.862
125	34.080	30.390	31.907	31.943	31.768	30.495	31.764
Density means	34.379a	31.950ab	32.326ab	32.476ab	31.038b	30.142b	

n.s. = Non-significant at p≤0.05.

Table 10. Biological yield (t ha^{-1}) as affected by different nitrogen levels and wild oats densities.

N level (kg ha^{-1})	*Avena fatua* densities m^{-2}						N Mean
	0	10	20	30	40	50	
75	2.900n.s.	3.050	4.100	3.850	4.000	4.100	3.667n.s.
100	3.050	4.950	5.050	4.450	4.600	4.300	4.400
125	4.250	3.850	4.750	5.050	4.700	4.750	4.558
Density means	3.4000b	3.950ab	4.633a	4.450a	4.433a	4.383a	

n.s. = Non-significant at p≤0.05.

Table 11.Grain yield (t ha^{-1}) as affected by different nitrogen levels and wild oats densities.

N level (kg ha^{-1})	*Avena fatua* densities m^{-2}						N Mean
	0	10	20	30	40	50	
75	1.958n.s.	1.588	2.133	1.313	1.707	0.875	1.595ab
100	1.782	1.625	1.575	1.420	1.468	0748	1.436b
125	2.815	1.813	2.250	1.468	1.862	1.136	1.891a
Density means	2.185a	1.675bc	1.986ab	1.400c	1.679bc	0.920d	

n.s. = Non-significant at p≤0.05.

Biological yield (t ha^{-1}): Statistical analysis of the biological yield (t ha^{-1}) revealed that wild oats densities have significant while nitrogen levels and their interaction have non-significant responses. The data in (Table 10) show that for the nitrogen levels, maximum (4.558) biological yield (t ha^{-1}) was observed in 125 N kg ha^{-1} while minimum (3.667) biological yield (t ha^{-1}) was recorded in 75 N kg ha^{-1} treatments. Among the wild oats densities maximum (4.633) biological yield (t ha^{-1}) was recorded in 20 wild oats seed m^{-2} while minimum (3.400) biological yield (t ha^{-1}) was recorded in 0 wild oats seed m^{-2} (control). For interaction of nitrogen with the wild oats densities, the maximum (5.050) biological yield (t ha^{-1}) was observed in $N_2X\ D_3$ and $N_3X\ D_4$ treatments while 2.900 t ha^{-1}, the least biological yield (t ha^{-1}) was observed in $N_1\ X\ D_1$ treatment.

Increasing the proportion of wheat or oat seed in mixture led to significant increase in the above ground biomass and total seed weight for that species. The seed weight and the above ground biomass per culm or per planted seed decreased for wheat and wild oat as the proportion increased in mixture, indicating a competitive advantage for wild oat when grown with wheat (Khan & Thill, 1992; Pfleeger *et al.*, 1999). Seed rates at 200 kg per hectare recorded significantly higher grain and straw yield of wheat than 150 and 100 kg seeds per hectare (Thakur *et al.*, 1999; Ahmad *et al.*, 1995).

Grain yield (t ha^{-1}): Statistical analysis of the data revealed that nitrogen levels and wild oats densities were significant statistically, while their interaction was non-significant for grain yield (t ha^{-1}). The data in (Table 11) show that for the nitrogen levels, maximum (1.891 t ha^{-1}) grain yield was observed in 125 N kg ha^{-1}, which however was statistically comparable with the grain yield produced by 75 kg N ha^{-1} (1.595 t ha^{-1}). The yield however of the later treatment in turn was statistically with the grain yield (t ha^{-1}) recorded in 100 N kg ha^{-1} (1.436). Among the wild oats densities maximum (2.185 t ha^{-1})

grain yield was recorded in 0 wild oats seed m^{-2} (control), which however was statistically at par with the wild oats density 30 seed m^{-2} (1.986 t ha^{-1}). The minimum (0.92 t ha^{-1}) grain yield was recorded in 50 wild oats seed m^{-2} treatments. For interaction of nitrogen with the wild oats densities, although non-significant statistically the highest numerical yield (2.815 t ha^{-1}) was observed in N_3 X D_1, while minimum grain yield (0.748 t ha^{-1}) was observed in N_2X D_6. Marquez *et al.,* (1996) established 8 successive cohorts and concluded that a stronger competitive impact on wheat yield from the earlier wild oat populations was recorded. Increasing sowing rates of wheat seeds and sowing in narrow rows competed with wild oats more effectively and increased yield by 8% (Sodhi & Dhaliwal, 1998). The increased seed rates minimize weed infestation and enhance grain yield of wheat (Alam *et al.,* 1994).

References

Ahmad, G., P. Shah and A. Bari. 1995. Effect of different seed rates on yield and yield components of wheat CV. Pirsabak 85. *Sarhad J. Agric.,* 11(5): 569-573.

Alam, M.T., M.A. Gaffar and M.A. Kashem. 1994. Critical Period of weed competition in wheat *(Triticum aestivum* L.*)* as influenced by different seed rates. *Bangladesh J. Scient. Indust. Res.,* 29(2): 63-70.

Appleby, A.P., P. Olson and D. Colbert. 1976. Winter wheat yield reduction from interference by Italian ryegrass. *Agron. J.,* 68: 463-66.

Borghain, M., L.P. Upadhaya and N. Deori. 1985. Herbicidal control of weeds in wheat. *Pesticides,* 19(1): 18-19.

Carlson, H.L. 1986. Wild oat competition with spring wheat. *Dissertation Absts.,* 5(2): 1180.

Cheema, M.S. 1991. *Competition of wild oats with wheat*. Ph.D. Dissert mention. Department of Agron. University of Agric., Faisalabad, Pakistan.

El-Khatib, A.A. and A.K. Hegazy. 1999. Growth and physiological responses of wild oats to the allelopathic potential of wheat. *Acta-Agronomica Hungarica,* 47(1): 11-18.

Hashem, A. and S.R. Radosevich. 1991. *Effect of density, proportion and spatial arrangement on winter wheat and Italian ryegrass.* Ph.D. Dissert mention. Oregon State. Univ., Corvallis, USA.

Hassan, G. and K.B. Marwat. 2001. Integrated weed management in Agricultural crops. Paper presented in *National Workshop on Technologies for Sustainable Agriculture*, Sept. 24-26, 2001, NIAB, Faisalabad, Pakistan.

Hassan, G., B. Faiz, K.B. Marwat and M. Khan. 2003. Effects of planting method and tank mixed herbicides on controlling grassy and broad leaf weeds and their effect on wheat cv Fakhr-e-sarhad. *Pak .J. Weed Sci. Res*., 9: 1-11.

Hassan, G., N.U. Khan and Q. Nawaz. 1996. Weed management in spring wheat *(Triticum aestivum)* under D.I. Khan conditions. *First Crop Prot. Conf., Crop Protection Association of Pakistan*, held at NWFP Agricultural University, Peshawar 20-22 April, 1996.

Heyne, E.G. 1987. *Wheat and Wheat Improvement.* 2nd ed. Madison, Wisconsin, USA.

Ibrahim, H.M., A.S. Kholosy, M.K. Zahran and E.E. Hassanein. 1995. Study of wild oat *(Avena fatua)* competition with wheat *(Triticum* sp.*). Annals Agric. Sci. Cairo*, 40 (2): 683-696.

Khan, S. and D.C. Thill. 1992. *Interspecific competition between wild oats and wheat*. Ph.D. Dissert., University of Idaho, Moscow, Idaho, USA.

Marquez, M.J., A.J. Salas, D.C.L. Fuentes and T.G.A. Plaza. 1996. Assessment of competition impact from different cohorts of wild oats *(Avena fatua)* on the yields of a commercial wheat crop *(Triticum aestivum). Agronomia Colombiana,* 13(1): 30-39.

MinFAL. 2007. *Agricultural Statistics of Pakistan*. Ministry of Food, Agriculture and Livestock, Govt. of Pakistan, Islamabad.

Pawar, L.D., N.T. Yaduraju and K.N. Ahuja. 1998. Population dynamics of weeds and their growth in tall and dwarf wheat as influenced by sub-optimal levels of irrigation and nitrogen. *Indian J. Ecol.,* 25(2): 146-154.

Pfleeger, T.G., C.C. Mundt, MA-da. Luz and M.A. Luz. 1999. Effects of wheat leaf rust on interactions between wheat and wild oats planted at various densities and proportions. *Can. J. Bot.*, 77(11): 1669-1683.

Rao, V.S. 1983. *Principles of Weed Science.* Oxford and IBH publishing Co. New Delhi. P-317

Riaz, M., A.Wadud, G. Hassan and A. Latif. 1988. Effect of different doses of herbicides in wheat. *Gomal Univ. J. Res.,*8(1&2): 85-89.

Sodhi, P.S. and B.K. Dhaliwal. 1998. Effect of crop density and cultivars on competitive interaction between wheat and wild oats (*Avena ludoviciana* Durr.). *Indian J. Ecol.,* 25(2): 138-145.

Steel, R.G.D. and J.H. Torrie. 1980. *Principles and procedures of statistics: a biological approach.* 2nd ed. McGraw Hill Book Co., Inc. New York, USA

Thakur, S.S., I.B Pandey and S.S. Mishra. 1999. Effect of organic manure, fertilizer and seed rate on yield and quality of late planted wheat *(Triticum aestivum). Indian J. Agron.,* 44(4): 754-759.

(Received for publication 14 February 2006)