Pak. J. Bot., 44(3): 1053-1057, 2012.

WHEAT-WILD OATS INTERACTIONS AT VARYING DENSITIES AND PROPORTIONS

IJAZ AHMED KHAN[1*], GUL HASSAN[1], SHERAZ AHMED KHAN[2] AND S.M.A. SHAH[2]

[1]*Department of Weed Science, KPK Agricultural University, Peshawar 25130, Pakistan.*
[2]*Department of Plant breeding and Genetics, KPK Agricultural University, Peshawar 25130, Pakistan.*
[*]*Corresponding author e-mail: ijazahmadk@hotmail.com*

Abstract

Wild oats is a worst weed infesting winter cereals throughout the world. Pot experiment was conducted in the Weed Research Laboratory, Department of Weed Science, Khyber Pakhtunkhwa Agricultural University Peshawar, Pakistan during 2004-05 to quantify the mutual effects of the two species. Wheat and wild oats were planted in pots in the densities of 0 to 8 plants pot^{-1} of each species in the Replacement Series. The data were recorded on some morphological, physiological and agronomic traits of both species. The data indicated the density related decline in all the parameters of either species. A single plant of wild oats inflicted 10% decrease in Tillers plant^{-1}of wheat whereas 1.22 plants of wheat induced the same reduction in wild oats. Similar reduction in No. of leaves plant^{-1} in wheat was observed with the competition of 1.8 oat plants pot^{-} while only 1.3 wheat plants caused 10% reduction in wild oats No. of leaves plant^{-1}. Wild oats density of 2.8 plants reduced 10% spikelets per spike in wheat, whereas only half than that wheat plants induced 10% damage in wild oats. The data thus indicate that wheat as well as wild mutually inhibits their growth in mixture, but the inhibition is slightly more by wheat to the wild oats than the wild oats to wheat. Thus, wheat if planted at higher seeding rates under the wild oats infested situations can mitigate the damage caused to wheat by the wild oats. The observed suppression of wheat by wild oats also warrants its effective management strategies for harvesting potential yield of wheat.

Introduction

Weeds reduce the crop yield, deteriorate the quality of farm produce and hence reduce the market value of wheat. Weed management increases the cost of production and thus it is necessary to device such methods which could reduce not only the cost of production but also save time and labour. Among the weed control methods, the chemical control is one of the recent origins, which is being emphasized, in modern agriculture (Taj *et al*., 1986).

It has been estimated that crop losses due to weed competition throughout the world as a whole, are greater than those resulting from the combined effect of insect pests and diseases. Weeds may encourage the development of fungal diseases, provide shelter for pests of all kinds and act as host plants for parasitic nematodes. There are thus, several reasons for entirely eliminating weeds from the crop environment. As a matter of fact, with the rising costs of labour and power, the use of herbicides will be the only acceptable method of weed control in the future. The infested situations need the development of package of weed management technology, helpful to minimize the weed competition losses in our country. The control of weeds is basic requirement and major component of management in the production system (Young *et al.*, 1996).

Wild oat causes yield reductions directly by competing with the crop for moisture, light, and nutrients. Such losses occur early in the growing season. Most of the yield loss occurs before the crop is 45 to 50 days old. In addition to yield losses, wild oat may cause dockage at the elevator, increased tillage, reduced yields from delayed seeding, and increased expenditures for herbicides. Yield loss will depend on the number of wild oats per square meter and the stage of the wild oats and the crop. Wild oats is very competitive with wheat. 10 wild oat plants m^{-2} can reduce wheat by 20% (Thill *et al.*, 1994 and O' Donovan & Sharma, 1983). Khan *et al*., (2008) concluded that wheat yield decreased exponentially when wild oat population varied from 0 to 30 plants m^{-2}.

Wild oat infests 28 million acres of land in the United States, with annual losses ranging from $150 to $200million annually. Wild oat is extremely competitive and difficult to control because it has delayed germination, it shatters its seed before most crops are harvested and its growth habit is similar to that of wheat, barley, and domesticated oats. Khan *et al*., (2010) reported that wild oat decreased number of tillers in different wheat cultivars.

Materials and Methods

Laboratory experiment entitled “Wheat-wild oats interactions at varying densities and proportions” was conducted in Weed Science Research Laboratory during 2004-05. The experiment was planted on 16th day of November 2004 in 30 cm dia. Plastic pots. Each treatment comprised of a single plot. The experiment was laid out in Replacement Series as outlined by Redosevich *et al*., 1996. Each treatment was replicated six times. The treatment combinations were as under:

1. 8 wheat + 0 wild oats- wheat monoculture
2. 6 wheat + 2 wild oats
3. 4 wheat + 4 wild oats
4. 2 wheat + 6 wild oats
5. 0 wheat + 8 wild oats – wild oats monoculture

The data were recorded on the following parameters during the course of studies:

Wheat: Number of tillers wheat plant^{-1}, number of leaves tiller^{-1}, weight of spike (g), number of spikelets spike^{-1}, plant height (cm), number of grains spike^{-1} and spike length (cm).

Wild oats: Number of tillers plant^{-1}, number of leaves tiller^{-1}, weight of wild oat pancile^{-1}, leaf area of wild oats (cm^{2}), wild oat height (cm) and spikelets panicle^{-1}of wild oats. The data were subjected to regression analysis (Steel & Torrie, 1980) to figure out the association of wheat with the wild oats densities in pots and vice versa.

Results and Discussion

Number of tillers plant^{-1}: Wild oat densities had a significant effect on number of tiller/ wheat plant (Fig. 1).

Number of tillers/ wheat plant was the highest at 0 density of wild oats. As wild oats densities increase the number of tillers wheat plant^{-1} decrease linearly. Wheat yield losses due to weed competition can primarily be attributed to a decrease in tillering. Irrespective of soil fertility or crop seeding rate, wheat tillering gradually declined with an increase in wild oat density. At the maximum limit of data set (6 wild oats pot^{-1}) 60% decline in tillering has been observed as compared to monoculture wheat (0 wild oats plant^{-1}). Our results are in accordance with the work of khan *et al*., (2008).

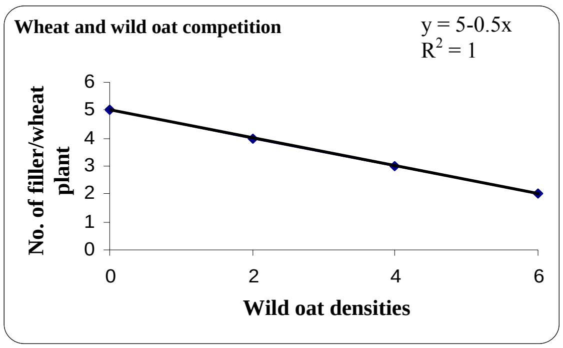

Fig. 1. Regression of No. of tillers wheat plant^{-1} with different densities of wild oats.

Number of leaves tiller^{-1}: Fig. 2 shows that slope of linear regression between wheat and wild oat densities declined with increases wild oat densities. In our study maximum number of leaves tiller^{-1} were observed at 0 density of wild oats, while minimum number of leaf / tiller was recorded at 6 density of wild oats. At the maximum density (6 wild oats plants pot^{-1}) 33.33% decline in the number of wheat leaves is predicted by the derived linear regression equation (Fig. 2). Leaves are the photosynthetic machinery of plants. A decline in leaf number will no doubt has a strong bearing on the ultimate economic yield.

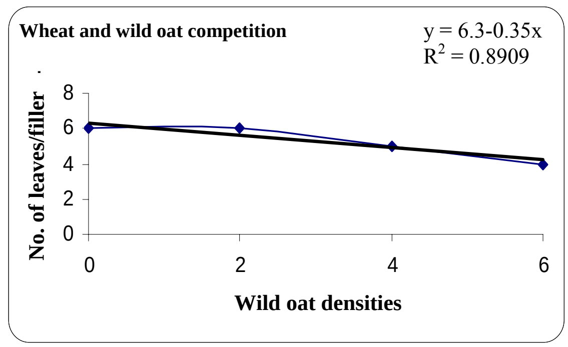

Fig. 2. Regression of No. of leaves tiller^{-1} with different densities of wild oats.

Weight of wheat spike (g): The regression line (Fig. 3) depicts that when wheat was exposed to different densities of wild oats, it produced smaller spikes ultimately resulting into lower yields. The derived equation for the parameter under reference exhibits that a 10% decline in wheat spike is discerned with about 1.5 wild oats plants on average in competition. These findings are in agreement with the work of Cudney *et al*., (1989) and Khan *et al*., (2010).

Number of spikelets spike^{-1}: Fig. 4 shows that the wild densities had a strong impact on number of spikelets spike^{-1}. The equation derived depicted that about 3 wild oats plants reduced 10% spikelets spike^{-1} in wheat. The reduction in spikelets will finally be reflected in grain yield of wheat. These findings are in agreement with the work of Ibrahim *et al*., (1995), Radford *et al*., (1980) and Martin *et al*., (1987), who correlated wheat parameters with wild oats densities in their studies.

Plant height (cm): Wild oats densities had almost no effect on plant height (Fig. 5). There was a general spread in the data and no pattern of relationship of wild oats density vs. wheat height could be detected. Our results are at variance 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 dwarf cultivars. Similar results has also been reported by Korres *et al*., (2002).

Number of grains spike^{-1}: Fig. 6 shows that maximum grains were recorded at 0 density of wild oats. Number of grains spike^{-1} started decreasing when density of wild oats went up. About 2 wild oats plants per pot dwindled the number of grains spike by 10%. Our findings are in a great analogy with the finding of Wilson & Peters, (1982), who reported that *A. fatua* competition decreased the number of fertile tillers per plant and grains per ear of wheat and barley, and reduced individual grain size. Similar results were also communicated by Carlson & Hill, (1985) and Khan *et al*., (2006).

Spike length (cm): Wild oats density strongly influenced the wheat spike length. Very strong correlation of wild oats density was established when the data were subjected to regression analysis. The coefficient of determination (R^2) of 0.97 or 97% depicted an extremely high relationship determining spike length. The regression equation predicts a 10% decline in spike length with about mean density of 2.6 wild oats (Fig. 7). These findings are in line with Ibrahim *et al*., (1995) and O'Donovan & Sharma (1983).

Number of tillers wild oat plant^{-1}: Fig. 8 shows that wild oat canopy was also drastically influenced with wheat competition. The wild oats tillers were not influenced with 2 wheat plants in competition. But, at 4 and 6 densities of wheat a drastic decline in wild oats tillers is evident. Slightly higher than one plant (1.22) of wheat on the average inflicted a decline of 10% in the wild oats tillers plant^{-1}. It is thus very encouraging that by increasing wheat seeding rate we can increase the interspecific competition to suppress the wild oats. While comparing the competitive ability of wild oats with wheat in the mutual suppression of tillering, the wild oats is more competitive because only 1 plant of wild oats can reduce the 10% tillering in wheat as compared to 1.22 wheat plants are required to induce the same damage in wild oats.

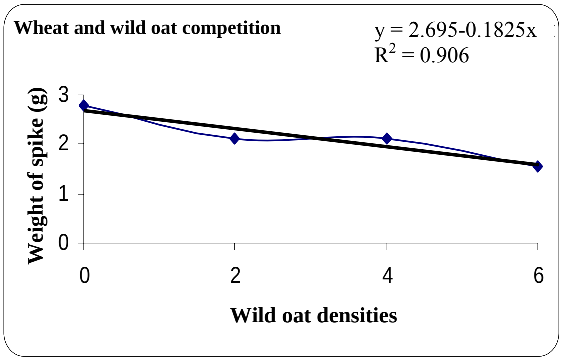

Fig. 3. Regression of weight of wheat spike under different densities of wild oats.

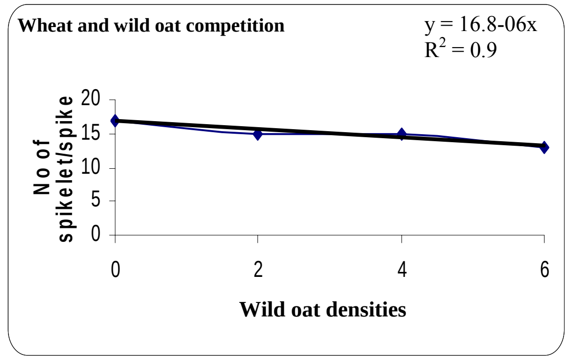

Fig. 4. Regression of No. of spikelets spike^{-1} with different densities of wild oats.

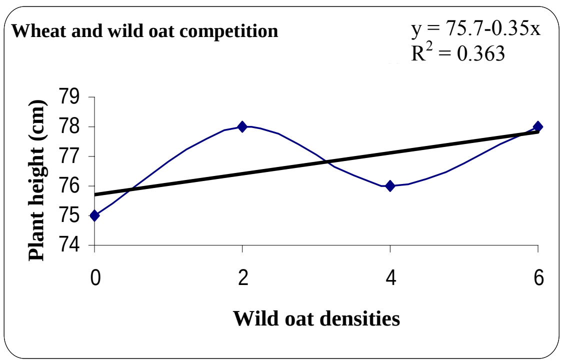

Fig. 5. Regression of plant height (cm) under different densities of wild oats.

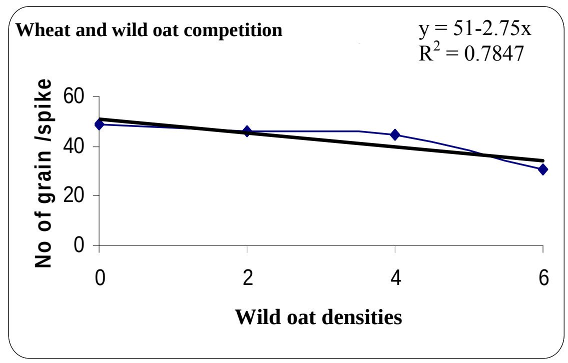

Fig. 6. Regression of number of grains spike^{-1} under different densities of wild oats.

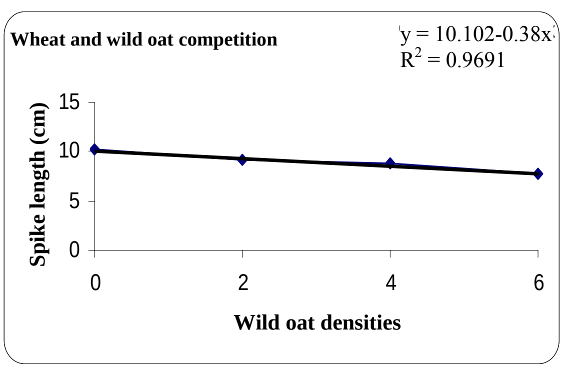

Fig. 7. Regression of spike length (cm) of wheat under different densities of wild oat.

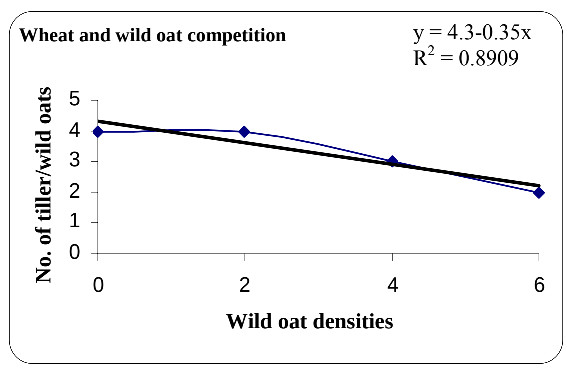

Fig. 8. Regression of number of tillers wild oat plant^{-1} under different densities of wheat.

Number of leaves wild oat tiller^{-1}: A strong dependence of wild oats leaves was established with the wheat density in the pots. Number of leaves wild oat tiller^{-1} of wild oats were the maximum at 0 wheat density and minimum at 6 wheat density (Fig. 9). Only 1.3 wheat plants on the average suppress number of leaves in wild oats to the tune of 10%, which is an enormous suppression due to wheat in mixture. The same inhibition in wheat by the wild oats density was recorded with 1.8 wild oats plants. The density relationship of wild oats with wheat exhibited a higher regression coefficient (Table 1). The management implications are very obvious that wheat is more detrimental to wild oats than the later to wheat. Hence, enhanced wheat seed rates will be a judicious approach to contain the adverse effects of wild oats. Our results are in conformity with the work of Cudney *et al.*, (1989), who reported that at higher density of wheat, number of leaves and tillers were greatly reduced in wild oats. The wheat in addition to physical competition also renders genotype dependent allelopathic damages to annual ryegrass (Wu *et al.*, 2005).

Table 1. Comparative account of wheat and wild oats competition for different characters of each species.

Parameters	Wheat			Wild oat		
	a (Intercept)	b(Regression coefficient)	10 % losses	a (Intercept)	b(Regression coefficient)	10% losses
Tiller plant^{-1}	5.0	-0.5	1.0	4.3	-0.35	1.22
No. of leaves	6.3	-0.35	1.80	6.5	-0.5	1.3
Weight of spike/ panicle	2.695	-0.182	1.48	6.5	-0.5	1.3
No. of spikelets/ spike or panicle	16.8	-0.60	2.80	8.7	-0.65	1.34
Plant height	75.7	-0.35	21.63	97.8	-0.1	97.8
No. of grains spike^{-1}	51	-2.75	1.85	-----	------	-----
Spike length	10.102	-0.384	2.63	-------	------	-----
Leaf area cm^{-2}	-	-	-	96.6	-6.75	1.43

Weight of wild oats pancile^{-1}(g): Weight of wild oats pancile^{-1} was also greatly affected by the different densities of wheat. Maximum weight of wild oat spike was recorded at 0 density of wheat or the wild oats monoculture and minimum at 6 wheat density (Fig. 10). Only 1.3 wheat plants on the average suppress weight of wild oats panicle by 10%, which is an enormous suppression due to wheat in mixture. The same inhibition in wheat by the wild oats density was recorded with 1.48 wild oats plants. The density relationship of wild oats with wheat exhibited a higher regression coefficient (Table 1). The management implications are very obvious that wheat is more detrimental to wild oats than the later to wheat. Hence, enhanced wheat seed rates will be a judicious approach to contain the adverse effects of wild oats.

Leaf area of wild oats (cm^2): Like other above parameters, wild oats leaf area also shows a linear relationship with wheat densities. As severe as 10% reduction in wild oats was deciphered with 1.43 wheat plants (Fig. 11). The finding has very encouraging bearing from the wild oats management perspective that drastic reduction in the wild oats leaf area could be harnessed with the increased seeding rates of wheat. The shading of wheat by wild oats is a worst type of competition, thus with the reduced wild leaf area the competition could be curtailed considerably. Our inferences are in accordance with the work of Tessema & Tanner , (1997) who reported that leaf area of wild oat plant decreased markedly as wheat seedling density increased. Tessema *et al*., (1996a; 1996b) also correlated the reduction in wheat yield with cultivar height when subjected to 4 wild oats densities.

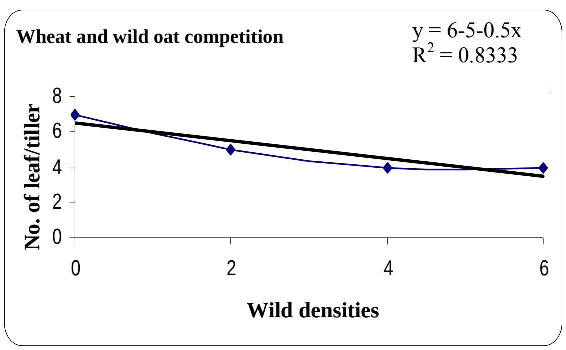

Fig. 9. Regression of number of leaves wild tiller^{-1} vs. different densities of wheat.

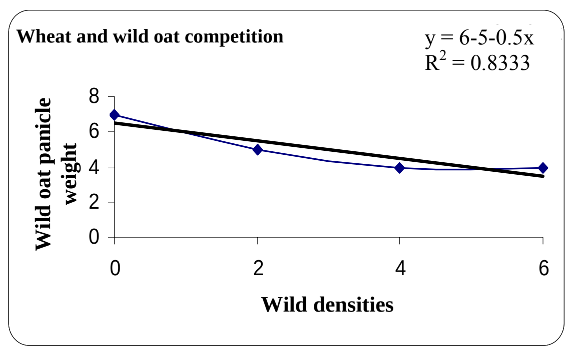

Fig. 10. Regression of weight of wild oat panicle under different densities of wheat.

Wild oat height (cm): Wild oats height is the strongest determinant in interspecific competition of wheat and wild oats (Fig. 12). Since the introduction of short statured cultivars with the inception of Dr. Norman Borlaug's green revolution the taller weeds like wild oats, Italian ryegrass and barley have leverage over wheat. Thus, the wheat density based reduction oats height must be exploited in wheat husbandry as part of integrated weed management. However, our data exhibit a very poor relationship of oats height vs. the wheat density. Perhaps the oats height is governed strongly genotypically and it is least influenced by the environment.

Spikelets panicle^{-1} of wild oat: The Fig. 13 shows that spikelets of wild panicle^{-1} linearly decrease when wheat density increases. Maximum spikelets were recorded in 0 density and minimum at 6 density of wheat. As high as 97% coefficient of determination depicts a very strong association of number of wild spikelets with the wheat density. Only 1.34 estimated wheat can induce 10% reduction in wild oats spikelets panicle^{-1}. It is thus, recommended that spikelets development and ultimately the seed setting in wild oats may be curbed with higher planting densities of wheat. Wild oats deposit its seeds into seed bank via shattering before harvesting of wheat. Thus, the lower spikelets are a boon to be used in IWM of wild oats by using higher wheat rates. Our research has a great similarity with Qingwu, (2001) who reported that wheat seeding rate from 175 to 280 plants m^{-2} reduced the number of panicles by 10% in wild oats.

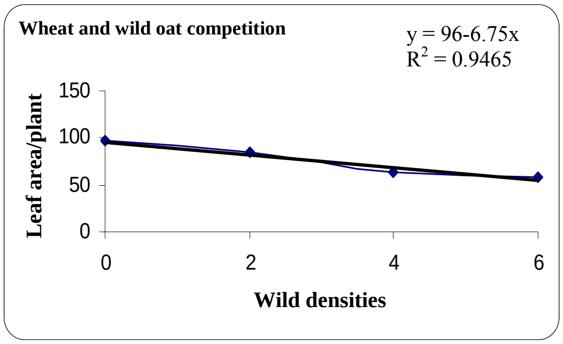

Fig. 11. Regression of leaf area of wild oats (cm^2) vs. different densities of wheat.

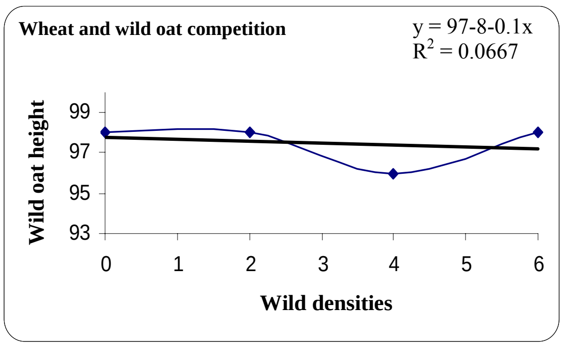

Fig. 12. Regression of wild oat height vs. under different densities of wheat.

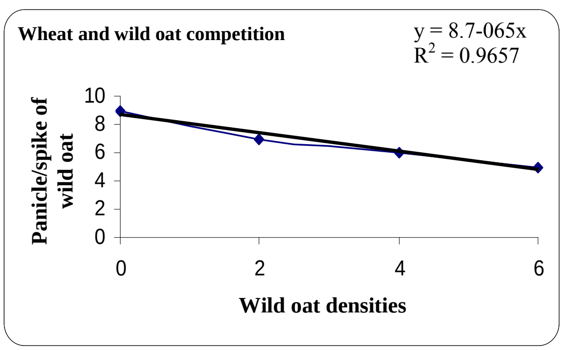

Fig. 13. Regression of spikelets panicle^{-1} of wild oats vs. different densities of wheat,

References

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

Carlson, H.L. and J.E. Hill.1985. Wild oat (*Avena fatua*) competition with spring wheat plant density effects. *Weed Sci*., 33: 176-181.

Cudney, D.W., L.S. Jordan, J.S. Holt and J.S. Reints. 1989. Competitive interactions of wheat (*Triticum aestivum*) and wild oat (*Avena fatua*) grown at different densities. *Weed Sci*., 37: 538-543.

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

Khan, I.A, G. Hassan and K.B. Marwat. 2008. Interaction of wild oats (*Avena fatua* L.) with spring wheat seeded at different rates. *Pak. J. Bot*., 40(3): 1163-1167.

Khan, I.A, G. Hassan, K.B. Marwat and I.A. Khattak. 2006. Yield and yield components of wheat affected by wild oats (*Aven fatua* L.) densities under irrigated conditions. *Herbologia*, 7(2): 31-39.

Khan, I.A, G. Hassan, K.B. Marwat, S.M.A. Shah and S.A. Khan. 2010. Interaction of wild oats (*Avena fatua* L.) with divergent wheat cultivars. *Pak. J. Bot*., 42(2): 1051-1056.

Korres, N.E and R.J Fround-Williams. 2002. Effect of winter wheat cultivars and seed rate on the biological characteristics of naturally occuring weed flora. *Weed Res*., 42(6): 417.

Martin, R.J., B.R. Cullis and D.W. Mc Namara. 1987. Predication of wheat yield losses due to competition by wild oats *(Avena* spp.*). Aust. J. Agric. Res*., 38: 487-499.

O' Donovan, J.T and M.P. Sharma. 1983. Wild oat, competition and crop losses. Proc. Wild Oat Symp., Regina, Canada: 27-42.

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.

Qingwu, X. 2001. Spring wheat seed size and seeding rate affect wild oat demographics. *Weed Sci*., 50: 312-320.

Radford, B.J., B.J. Wilson, O. Cartledge and F.B. Watkins. 1980. Effect of wheat seeding rate on wild competition. *Aust. J. Exp. Agric. and Animal Husb*., 20: 77-81.

Radosevich, S.R., J.S. Holt and C.M. Ghersa. 1996. *Weed Ecology Implications for Management*. 2nd ed. John Wiley, New York.

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

Taj, F.H., A. Khattak and T. Jan. 1986. Chemical weed control in wheat. *Sarhad J. Agric*., (2): 15-21.

Tessema T., D.G. Tanner and H. Mangistu. 1996b. Grass weed competition with bread wheat in Ethiopia.II. Prediction of grain yield loss by implication for economic weed control. *African Crop Sci. J*., 4: 411-421.

Tessema, T., D.G. Tanner and H. Mangistu. 1996a. Grass weed competition with bread wheat in Ethiopia.I. Effect on selected crop and weed vegetative parameters and yield components. *African Crop Sci. J*., 4: 399-409.

Tessema, T. and D.G. Tanner. 1997. Grass weed competition and calculated economic threshold densities in bread wheat in Ethiopia. *African Crop Sci. J*., 5:371-384.

Thill, D.C., J.T. O'Donovan and C.A. Mallory-Smith. 1994. Integrated weed management strategies for delaying herbicide resistance in wild oats. *Phytoprotection*, 75: 61-70.

Wilson, B.J. and N.C.B. Peters. 1982. Studies of competition between *Avena fatua* and spring wheat and barley. Influence of *Avena fatua* on yield of wheat and barley. *Weed Res*., 22: 143-148.

Wu, H., J. Partley, D. Lemerle, T. Haig and B. Verbeek. 1998. Differential allelopathic potential among wheat accessions to annual ryegrass. http://www.regional.org.au./au/asa/1998.

Young, F.L., A.G. Ogg, D.L. Young and R.I. Papendick. 1996. Weed management for crop production in the northwest wheat (*Triticum aestivum*) region. *Weed Sci*., 44(2): 429-436.

(Received for publication 17 March 2011)