Pak. J. Weed Sci. Res., 18: 629-635, Special Issue, October, 2012

COMPETITIVE ABILITY OF WHEAT CULTIVARS AGAINST COMPLEX WEED FLORA IN ZERO-TILL PLANTING

Ramesh Kumar Singh[1] and Siya Ram

ABSTRACT

Continuous and indiscriminate use of herbicides may lead to many problems such as resistance in weeds, residue in crop and soil, pollution hazards, health hazards to non-target organisms. In wheat crop, farmers can select a competitive cultivar to smoother weeds. Two year field studies were conducted at agricultural research farm of Banaras Hindu University to evaluate competitive attributes of wheat cultivars against complex weed population in wheat grown under zero-till. Variety K8027 which had taller plant and higher leaf area index was found most competitive against weed when compared with other varieties viz.K9107, HUW234, HUW468 and NW1014. Tank mix application of isoproturon + 2,4-D sodium salt at 1.0 + 0.5 kg/ha as post-emergence treatment was most effective in suppressing of weeds in all the varieties.

Keywords: Cultivars, Competitive ability, Wheat, Weeds, Zero-till

INTRODUCTION

Rice-wheat (RW) is the most important cropping system for food security in South Asia. In India, it contributes 26% of total cereal production and 60% of total calorie intake. The area under rice-wheat system is static and the productivity and sustainability of the system is threatened because of the inefficiency of current production practices, shortage of resources, such as water and labour and socioeconomic changes (Ladha *et al., 2003*). In recent decade, wheat establishment method has shifted from conventional multi-till to reduced zero-till system. Zero tillage minimizes the loss on account of delayed sowing as it advances the wheat sowing by 10-15 days and also saves the time and cost involved in field preparation (Sen *et al.,* 2002). Weeds continue to be a serious threat to wheat productivity despite several decades of modern weed control practices realizing much of weed suppression through herbicides use. The development of herbicide-resistant weeds and weed population shifts continue to challenge the herbicide based weed management systems (Malik *et al*., 1998).

Modern wheat cultivars are nearly always evaluated for yields in weed free environments, so very little is known about their competitive interaction with weeds. The competitive ability of a crop

[1] Department of Agronomy, Institute of Agricultural Sciences Banaras Hindu University Varanasi, Uttar Pradesh-221005, INDIA
Corresponding author's email: rks1660bhu@gmail.com

against weeds can be measured in two ways: (a) the ability of the crop to maintain yield in the presence of weeds, and (b) the ability of the crops to suppress weeds and weed seed production. Several researchers (Blackshaw, 1994; Challaiah *et al.,* 1986; Bussan *et al.,* 1997; Wicks *et al.,* 2004) reported that use of taller cultivars reduce weed biomass and seed production more than shorter cultivars. Similarly other crop traits (flag leaf length and orientation, overall leaf area and canopy structure) have been identified to provide competitive advantage to crop over weeds (Lemerle *et al.,* 1996; Seavers and Wright, 1999). The objective of our research was to identify the traits associated with commonly grown wheat cultivars that confer competitiveness against complex weed flora in zero-till wheat.

MATERIALS AND METHODS

Two year field experiments were conducted at agricultural research farm of Banaras Hindu University, Varanasi, India during 2002-03 and 2003-04 winter seasons in sandy clay loam soil to evaluate the effect of five wheat cultivars and five weed control treatments on wheat yield and related weeds. Five wheat cultivars were K9107, HUW234, HUW468, NW1014and K8027, while the weed control treatments were sulfosufuron @ 25 g a.i./ha, metribuzin @ 210 g a.i./ha, isoproturon 750 g a.i. + 2,4-D sodium salt 500 g a.i./ha (tank mix), weed free and unweeded check. The experimental design was a split plot design with four replication, cultivars were arranged in main plots and weed control treatments were assigned to sub-plots. All the herbicides were applied as post-emergence at 30 days after sowing (DAS) using spray volume of 500 l/ha by foot sprayer fitted with flat fan nozzle.

Wheat cultivars were sown at row space of 20 cm by opening slits with zero-till drill machine using a constant seed rate of 100 kg/ha. The crop received an uniform rate of 40 kg N, 60 kg P_2O_5 and 60 kg K_2O /ha at sowing and 80 kg N/ha after first irrigation. The crop was given three irrigations at 21, 75 and 90 DAS during both the years. Weeds were counted 60 days after sowing from quadrate (0.5 x 0.5 m) randomly placed at four places in each plot. Dry weight of weeds was recorded after complete drying at 70º C for 48 hours in hot air oven. At harvest, a plant sample of one square meter from each plot was taken to determine number of ear head, number of grain/ear head and 1000 grains weight. Grain yield per plot was recorded by harvesting net plot area of each treatment. For comparison between means, L.S.D. test at 5% level was used.

RESULTS AND DISCUSSION

Effect of Treatments on Weeds

The dominant weeds in the unweeded plot at 60 days after wheat sowing were *Phalaris minor* Retz., *Cyperus rotundus* L., *Rumex dentatus* L., *Anagallis arvensis* L.,*Chenopodium album* L.,and *Melilotus indica*(L.) All and *Cynodon dactylon* (L.) Pers. Wheat cultivars caused mark variation in relative dominance of weeds in weedy check plots (Table 1). Cultivars NW 1014, HUW 234 and HUW 468 had higher relative density of *P. minor, R. dentatus* and *C. rotundus*. Whereas, *C.rotundus* was dominant weed in K9107 and K8027. Concerning the effect of weed control treatments on weeds, data in Table 1 indicated that tank mix application of isoproturon + 2,4-D at post-emergence reduced population of both grass and broadleaf weeds, but none of the herbicide treatment was effective in controlling *C.rotundus* . Herbicide sulfosulfuron was most effective against *P.minor* and metribuzin was least effective against the weeds.

Table-1. Effect of wheat cultivars and weed control treatments on relative composition (%) of weeds at 60 days from sowing.

Treatments	*P. minor*	*C. dactylon*	*C. rotundus*	*R. denticulate*	*A. arvensis*	*C. album*	*M. indica*
HUW 234	9.70	8.3	10.8	23.9	17.5	9.6	6.6
HUW 468	8.0	7.3	10.1	19.4	16.0	7.9	5.8
K 9107	7.2	6.6	9.5	17.3	14.7	7.7	4.9
K 8027	6.1	5.4	8.4	15.2	12.5	7.6	4.3
NW 1014	10.0	9.3	12.3	26.0	20.5	10.1	7.5
Unweeded	18.8	10.2	14.4	33.4	5.3	14.9	0.5
Sulfosulfuron	6.2	12.8	14.3	28.7	23.3	8.9	7.2
Metribuzin	9.2	10.9	10.9	20.6	21.8	9.2	6.8
Isoproturon+ 2,4-D	7.9	10.1	11.1	14.8	18.3	8.1	6.2

Results in Table 2 revealed that different cultivars and weed control treatments significantly influenced density of different weed species at 60 days after wheat sowing. Cultivar K8027 was significantly most suppressive to different weed species, while NW 1014 was least effective in controlling weeds. Application of sulfosulfuron was significantly superior to metribuzin and isoproturon+2,4-D in reducing density of P.minor, whereas, the population of broad leaf weeds and C. rotundus was minimum in isoproturon + 2,4-D traeatment. The lowest dry weight of weeds was recorded in cultivar K8027 and greatest in NW 1014. Data in Table 2 indicated that weeds dry weight was significantly less in herbicide mixture of isoproturon + 2,4-D when compared with individual herbicide sulfosulfuron and metribuzin.

Table-2. Effect of wheat cultivars and weed control treatments on weeds density (No. m^{-2}) and weeds dry weight at 60 days after sowing.

Treatment	*P. minor*		Broad leaf weeds		*C. rotundus*		Weeds dry weight (g/m^2)	
	2002-03	2003-04	2002-03	2003-04	2002-03	2003-04	2002-03	2003-04
HUW 234	7.20	5.70	16.50	15.30	4.33	3.30	34.90	31.10
HUW 468	6.70	4.20	17.80	15.90	4.38	3.34	35.70	32.70
K 9107	6.40	3.60	15.80	13.90	4.10	3.00	33.30	29.50
K 8027	6.20	5.10	15.20	12.90	3.90	2.80	31.70	28.60
NW 1014	7.50	6.30	19.20	18.10	4.60	3.50	36.90	34.30
LSD (P=0.05)	0.44	0.42	1.70	1.62	0.23	0.22	2.42	2.30
Weed control treatments								
Un weeded	17.28	15.30	33.40	30.70	10.30	7.10	73.90	68.30
Weed Free	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sulfosulfuron	4.70	3.80	18.90	16.90	4.10	3.60	34.60	30.90
Metribuzin	6.5	5.20	17.40	15.50	3.80	2.90	33.40	29.80
Isoproturon + 2,4-D	5.5	4.30	14.70	12.90	3.20	2.50	30.60	27.20
LSD (P=0.05)	0.34	0.32	0.95	0.90	0.12	0.11	2.12	2.01

Effect of Treatments on Growth of Crop

The data on plant height, tiller number/meter row, leaf area index and crop dry weight revealed that cultivar K8027 had significantly higher values of these parameters than other cultivars of wheat (Table-3). Tank mix application of isoproturon+2,4-D recorded significantly taller plants, more number of tillers, higher leaf area index and greater dry matter accumulation by crop than individual treatment of sulfosulfuron and metribuzin.

Effect of Treatments on Grain Yield and Yield Attributes

The data pertaining to yield contributing characters viz. head/m2, grains/head and 1000, grains weight (Table-4) indicated that cultivar K8027 had significantly greater number of heads/m2, number of grains/heads and 1000-grain weight than HUW234,HUW 468 and NW1014 (Table-4).

Amongst weed control treatments, herbicide mixture of isoproturon + 2,4-D recorded significantly maximum number of heads, grains/head and 1000-grain weight of crop than individual application of herbicide sulfosulfuron and metribuzin. It is evident from the data in Table 4 that cultivars K8027 produced numerically higher grain yield than K9107 and HUW 234, but was significantly superior to HUW468 and NW1014 while NW1014 had minimum grain yield. The herbicide treatment isoproturon + 2,4-D recorded significantly higher grain yield than sulfosulfuron or metribuzin (Table 4). However, both the herbicides produced significantly higher grain yield than unweeded treatment.

Table-3. Effect of wheat cultivars and weed control treatments on growth parameters of wheat at 60 days from sowing.

Treatment	Plant height (cm)		No. of tillers per running meter		Late area index		Crop Dry Weight (g/m2)	
	60 DAS		60 DAS		60 DAS		60DAS	
	2002-03	2003-04	2002-03	2003-04	2002-03	2003-04	2002-03	2003-04
HUW 234	59.22	62.39	69.58	71.53	3.15	3.46	364.7	411.2
HUW 468	55.23	58.11	67.11	68.81	3.08	3.39	354.9	400.4
K 9107	63.62	67.03	72.08	74.29	3.22	3.54	372.2	419.4
K 8027	66.70	70.33	74.09	76.49	3.39	3.73	388.9	437.8
NW 1014	53.79	55.52	63.94	65.30	3.05	3.35	345.6	390.1
LSD (P=0.05)	5.40	5.93	4.29	4.79	0.19	0.21	22.4	34.8
Weed control treatments								
Un weeded	50.73	52.65	64.67	66.32	2.90	3.19	342.1	386.2
Weed Free	67.94	71.76	73.63	75.17	3.39	3.72	389.7	438.7
Sulfosulfuron	56.56	59.26	67.09	68.99	3.09	3.40	353.4	398.7
Metribuzin	58.99	61.92	69.36	71.49	3.19	3.51	366.7	413.4
Isoproturon + 2,4-D	64.34	67.81	72.05	74.45	3.32	3.65	374.4	421.8
LSD (P=0.05)	3.90	4.29	3.68	3.96	0.14	0.16	14.1	15.5

Table-4. Yield and yield attributes of wheat crop as affected by cultivars and weed control treatments.

Treatment	Ear head/ m^2		Grains/ ear head		1000, grains weight(g)		Grain yield (Kg/ha)	
	2002-03	2003-04	2002-03	2003-04	2002-03	2003-04	2002-03	2003-04
HUW 234	270.70	287.60	43.44	43.90	40.10	40.90	3176	3548
HUW 468	256.30	278.86	42.80	43.30	38.30	39.02	2865	3220
K 9107	275.90	294.40	44.50	46.90	43.30	44.10	3281	3658
K 8027	278.10	305.10	47.50	47.90	44.80	45.70	3352	3733
NW 1014	245.10	272.36	42.20	42.60	37.10	37.90	2738	3085
LSD (P=0.05)	19.87	20.56	3.70	3.73	2.70	2.64	233	239
Weed control treatments								
Un weeded	243.20	264.20	38.80	39.10	38.66	39.44	1849	2149
Weed Free	276.90	307.60	48.20	48.70	42.40	43.30	3823	4229
Sulfosulfuron	261.10	284.70	43.70	44.10	40.10	40.80	2966	3326
Metribuzin	270.10	279.30	45.10	45.50	40.50	41.30	3229	3604
Isoproturon + 2,4-D	274.90	301.60	46.60	47.10	41.96	42.80	3545	3937
LSD (P=0.05)	10.93	14.26	2.90	2.87	2.06	2.08	124	133

DISCUSSION

The different characteristics of a good competitive cultivars are that it must have rapid germination, initial quick growth, tillerring capacity and leaf area (Lemerle *et al*., 1996; Challaiah *et al.,* 1983). The difference in the ability of cultivars K8027 to suppress weed growth more than other might be due to taller plants, high leaf area index,and light interception tillering capacity and vegetative growth habit (Seavers and Wright 1999; Dhima *et al*. 2008). Presence of these attributes in cultivar K8027 conferred better competitiveness against most weeds infested the crop than cultivars with shorter plants, less tillers and leaf area index. An effective herbicide is one that control complex weed community. The herbicide mixture of isoproturon + 2, 4-D had ability to control dominant grass as well as broadleaf weeds, while sulfosulfuron and metribuzin could control only grass weeds. The lower weed growth in isoproturon + 2,4-D treatment was due to broad spectrum weed control than other herbicides. The significant differences in growth attributes of cultivars can be attributed to their genetic makeup. Coleman and Gill (2002) also reported significant genetic correlations for grain yield, grain yield loss and ryegrass dry matter with agronomic and morphological traits on the wheat lines.

The variation in yield and yield attributes of cultivars can be attributed to their differential weed suppression ability that led to dry matter accumulation and its translocation for the formation of yield attributes. Cultivar K8027 which had taller plants, more tillers and leaf area index also accumulated higher dry matter that was finally used for production of agronomic characters determining crop yield.

REFERENCES CITED

Blackshaw, R.E. 1994. Differential competitive ability of winter wheat cultivars against downy brome. Agronomy Journals, 86: 649-654.

Bussan, A.J., O.C. Burnside, J.H. Orf, E.A. Ristau and K.J. Puettmann. 1997. Field evaluation of soybean (*Glycine max*) genotype for weed competitiveness. Weed Sci. 45: 31-37.

Challaiah, R.E., O.C. Burnside, G.A. Wicks, V.A. Johnson. 1986. Competition between winter wheat (*Triticum aestivum*) cultivars and downy brome (*Bromus tectorum*). Weed Sci., 34: 689-693.

Coleman, R. K. and G. S. Gill. 2002. Identifying traits conferring weed competitiveness in wheat in Australia. In Proc.of International workshop on herbicide resistance management and zero tillage in rice wheat cropping system. CCS Haryana Agricultural University, Hisar, India, March 4-6, pp.41-46.

Dhima,K., I Vasilakoglou, A. Lithourgidis, E. Mecolari, R. Keco, X. Agolli and Eleftherhorinos 2008. Phytotoxicity of 10 winter barley varieties and their competitive ability against common poppy and ivy-leaved apeedwell. *Experrimental Agric*., 44: 385-397.

Ladha, J.K., H. Pathak, A.T. Padre, D. Dawe, R.K. Gupta. 2003. Productivity trends in intensive rice- wheat cropping system in Asia. In: Ladha, J.K., et. Al (Eds.) Improving the Productivity and Sustainability of Rice-wheat Systems: Issues and Impacts. ASA Spec. Publ. 65, ASA, CSSA and SSSA, Madison, WI, P 45-76.

Lamerle, D., B. Verbeek and S.N. Coombe. 1995. Losses in grain yield in winter crops from *Lolium rigidium L.* competition against weeds. Weed Res. 35: 500-509.

Malik R.K., G . Gill and PR. Hobbs (Eds.) 1998. Herbicide Resistance- A major issue for sustaining wheat productivity in Rice wheat cropping system in the Indo- Gangetic Plains. Rice- Wheat Consortium Paper Series 3. New Delhi, India.

Seavers, G.P. and K.J. Wright. 1999. Crop canopy development and structure influence weed suppression. Weed Res. 39: 319-328.

Sen, A., S. N. Sharma, R.K. Singh, and M.D. Pandey. 2002. Effect of different tillage system on performance of wheat. In: Proc. of International workshop on herbicide resistance management and zero tillage in rice wheat cropping system. CCS Haryana Agricultural University, Hisar, India, March 4-6, pp. 115-116.

Wicks, G.A., P.T. Nordquist, P.s. Baenziger, R.N. Klein, R.H. Hammons and J.E. Watking, 2004. Winter wheat cultivar characteristics affect annual weed suppression. Weed Technol. 18: 988-998.