Indian Journal of Weed Science **44**(2): 110–114, 2012

Weed dynamics, nutrient removal and yield of wheat as influenced by weed management practices under valley conditions of Uttarakhand

Sanjay Kumar*, Rohitashav Singh[1], Radhey Shyam[1] and V.K. Singh[1]
Krishi Vigyan Kendra, G.B. Pant University of Agriculture & Technology, Dhakrani, Deharadun, Uttarakhand 263 145

Received: 28 July 2011; Revised: 16 February 2012

ABSTRACT

A field experiment was conducted during *Rabi* seasons of 2006-07 and 2007-08 at Research Farm of GBPUA&T, Krishi Vigyan Kendra Dhakrani, Dehradun to study the effect of weed control practices on weed dyanamics, nutrient uptake and yield of wheat (*Triticum aestivum* (L.) emend. Fiori and Paol). Results revealed that application of clodinafop-propargyl + metsulfuron-methyl (60+4 g/ha) being on at par with clodinafop propargyl + 2,4-D (60+500 g/ha) reduced the weed population significantly over weedy check (97.2%) and other weed control treatments. Clodinafop-propargyl+ metsulfuron-methyl (60+4 g/ha) applied as post-emergence (35 DAS) recorded 14.3, 15.5, 23.7, 29.5, 45.9, 47.4 and 69.7 per cent more grain yield over pendimethalin, isoproturon + metsulfosulfuron-methyl, fenoxaprop-p-ethyl + metsulfuron-methyl, fenoxaprop-p-ethyl, isoproturon, clodinafop-propargyl and weedy check, respectively. The weeds removed the 28.7 kg of N, 13.4 kg P_2O_5 and 21.5 kg of K_2O/ha, and reduced the wheat grain yield by 78.8% as compare to weed free conditions. Application of clodinafop-propargyl + metsulfuron-methyl reduced the nutrients removal by weeds and increased its removal by wheat.

Key words: Herbicides, Nutrient uptake, Weed density, Weed dry matter, Wheat, Yield

Weed infestation is one of the most serious problems in wheat growing areas. Weed competition during the crop period results in more than 53% reduction in grain yield depending on the weed densities and type of weed flora. It has been proved that due to continuous use of isoproturon for the control of Phalaris minor the major weed of wheat has developed the resistance Researches revealed that wheat weeds especially *Phalaris. minor* has developed resistance. Herbicides like clodinafop-propargyl, fenoxaprop-p-ethyl and sulfosulfuron have been recommended as an alternative to isoproturon and metsulfuron-methyl to 2,4-D. Clodinafop-propargyl and fenoxaprop-p-ethyl have been very effective against *Phalaris minor* and *Avena fatua* (Banga and Yadav 2004, Mahajan *et al.* 2004) but ineffective against non grassy weeds. Use of these herbicides has resulted in proliferation of non grassy weeds like *Chenopodium album*, *Melilotus* spp. and *Fumaria parviflora* in wheat (Singh and Singh 2005). Metsulfuron-methyl and 2,4-D are being used commonly for the control of non grassy weeds in wheat. Therefore, it was felt necessary to screen out compatible/suitable herbicides combination for broad-spectrum weed control in wheat.

***Corresponding author:** sankumar91@rediffmail.com

[1]*Department of Agronomy, GBPUA&T, Pantnagar, Uttarakhand 263 145*

MATERIALS AND METHODS

The field experiment was conducted at the GBPUA&T, Krishi Vigyan Kendra, Dhakrani, Dehradun during *Rabi* seasons of 2006-07 and 2007-08. The soil was loamy sand in texture having pH 7.2, organic carbon 0.52%, available P 14.2 kg/ha and available K 168 kg/ha. Twelve treatments comprising pendimethalin at 1000 g/ha, isoproturon at 1000 g/ha, isoproturon + 2,4-D at 1000+500 g/ha, isoproturon + metsulfuron-methyl at 1000+4 g/ha, fenoxaprop-p-ethyl at 80 g/ha, fenoxaprop-p-ethyl + 2,4-D at 80+500 g/ha, fenoxaprop-p-ethyl + metsulfuron-methyl at 80+4 g/ha, clodinafop-propargyl at 60 g/ha, clodinafop-propargyl + 2,4-D at 60+500 g/ha and clodinafop-propargyl + metsulfuron-methyl at 60+4 g/ha along with weed free and weedy check were replicated thrice in a randomized block design. Wheat (*PBW-343*) was sown in row 22 cm apart during 2nd fortnight of November in both the years with the help of ferti-seed drill using 120 kg seed/ha. Crop was fertilized with 120: 60: 40 and 20 kg/ha of N, P_2O_5, K_2O and Zinc sulphate respectively. One third of N and full dose of P, K and Zn were applied as basal at the time of sowing. Remaining N was top dressed in 2 equal splits one after 1st irrigation and second at the time of maximum tillering stage ensuring appropriate moisture level in the field. The herbicides were

applied as post-emergence at 35 days after sowing (DAS) using 500 litres water with knapsack sprayer fitted with flat-fan nozzle. However, pendimethalin was applied as pre-emergence at 01 DAS. The crop was raised under irrigated condition with recommended package of practices. Density, dry matter and NPK uptake by weeds were recorded at 60 DAS. The data so obtained were transformed using square root transformation prior to analysis, wherever needed.

RESULTS AND DISCUSSION

Weed flora

The weed flora observed in the experimental plots included *Chenopodium album* L., *Fumeria parviflora* Lam. *Melilotus indica* L. and *Anagallis arvensis* L. among broad leaf weeds; and *Phalaris minor* (L) Retz. and *Avena fatua* L. among annual grasses besides *Cyperus spp*. among sedges. *Phalaris minor* was the dominant (41.3%) among grassy whereas, *Fumeria parviflora* (10.0%) under non grassy weeds.

Weed population and dry matter

The weed control treatments significantly reduced the density and dry biomass of weeds than weedy check (Table 1). Tank mixture of clodinafop-propargyl + metsulfuron-methyl (60+4 g/ha) and clodinafop-propargyl + 2,4-D (60+500 g/ha) proved most effective herbicide combination against both broad-leaved weeds and grasses.

Table 1. Effect of weed management treatments on weed density and weed dry matter in wheat (mean of 2 years)

Treatment	Dose (g/ha)	Application stage (DAS)	*Phalaris minor*	*Avena fatua*	*Chenopodium album*	*Fumaria parviflora*	Others	Total
Weed density (no./m²)								
Weedy	-	-	6.73 (45)	2.73 (7)	3.08(9)	3.24(10)	5.77(38)	11.2(109)
Weed free	-	-	0.70 (0)	0.70(0)	0.70(0)	0.70(0)	0.70(0)	0.70(0)
Pendimethalin	1000	1	3.38 (11)	0.70(0)	1.22(1)	2.34(5)	2.11(4)	4.60(21)
Isoproturon	1000	35	3.24 (10)	1.21(1)	1.58(2)	2.34(5)	3.65(13)	5.68(31)
Isoproturon+2,4-D	1000+500	35	3.08 (9)	1.58(2)	0.70(0)	0.70(0)	1.58(2)	3.67(13)
Isoproturon + metsulfuron-methyl	1000+4	35	3.38(11)	1.58(2)	1.22(1)	0.70(0)	2.73(7)	4.62(22)
Fenoxa prop-p-ethyl	80	35	3.24(10)	1.84(3)	1.84(3)	3.24(10)	5.30(27)	7.31(53)
Fenoxa prop-p-ethyl +2,4-D	80+500	35	3.38(11)	1.22(1)	1.22(1)	0.70(0)	1.58(2)	3.67(13)
Fenoxa prop-p-ethyl + metsulfuron- methyl	80+4	35	2.73(7)	1.55(2)	1.22(1)	0.70(0)	2.55(6)	3.24(10)
Clodinafop -propargyl	60	35	3.23(90)	1.55(2)	1.84(3)	2.34(5)	5.54(35)	7.41(54)
Clodinafop-propargyl + 2,4-D	60+500	35	2.91(8)	1.22(1)	0.70(0)	0.70(0)	0.70(0)	3.08(9)
Clodinafop-propargyl + metsulfuron methyl	60+4	35	2.55(6)	0.70(0)	0.70(0)	0.70(0)	0.70(0)	2.55(6)
LSD (P=0.05)			0.4	0.37	0.14	0.12	0.16	0.48
Weed dry matter (g/m²)								
Weedy	-	-	3.57(12.3)	3.71(13.2)	2.54(6.0)	4.03(15.8)	5.32 (28.6)	9.72(75.7)
Weed free	-	-	0.70(0)	0.70(0)	0.70(0)	0.70(0)	0.70(0)	0.70(0)
Pendimethalin	1000	1	3.10(8.5)	0.70 (0)	1.04(0.6)	2.88(7.8)	3.01 (8.7)	4.72(22.6)
Isoproturon	1000	35	2.22(4.5)	1.3 (1.2)	1.58(2.0)	3.20(9.8)	4.62(22.2)	6.31(39.7)
Isoproturon + 2,4-D	1000+500	35	3.10(8.5)	2.06 (2.8)	0.7(0)	0.70(0)	2.14(4.3)	3.98(15.6)
Isoproturon + metsulfuron methyl	1000+4	35	3.15(8.6)	1.86 (3.0)	1.22(1.0)	0.70(0)	3.95(15.2)	4.78(27.8)
Fenoxa prop-p-ethyl	80	35	1.96 (3.3)	2.18 (4.3)	2.34 (5.0)	4.21(15.0)	4.79(24.5)	5.58(34.1)
Fenoxa prop-p-ethyl +2,4-D	80+500	35	2.98 (8.4)	1.45 (1.6)	0.7(0)	0.70(0)	3.48(11.7)	4.67(21.7)
Fenoxa prop-p-ethyl + metsulfuron-methyl	80+4	35	3.50(11.8)	1.73 (2.5)	1.13(0.8)	0.70(0)	4.13 (16.8)	5.36(31.9)
Clodinafop-propargyl	60	35	1.91(2.3)	1.70 (2.4)	2.24(4.8)	3.72 (13.8)	5.63 (30.7)	7.41 (55.5)
Clodinafop-propargyl + 2,4-D	60+500	35	3.54 (12.1)	1.45 (1.6)	0.7(0)	0.70(0)	0.70(0)	3.70 (13.7)
Clodinafop-propargyl + metsulfuron methyl	60+4	35	3.5 (11.6)	0.70 (0)	0.7(0)	0.70(0)	0.70(0)	3.51 (11.6)
LSD (P=0.05)			0.34	0.25	0.18	0.18	0.22	0.33

*Original values in parentheses

Among the herbicides application of clodinafop-propargyl + metsulfuron-methyl (60+4 g/ha) though statistically on par with clodinafop-propargyl + 2,4-D (60+500 g/ha) reduced the weed population significantly than weed check (97.2%), clodinafop-propargyl alone (88.0%), fenoxa prop-p-ethyl alone (83.0%), isoproturon alone (80.0%), isoproturon + metsulfuron-methyl (72.2%), pendimethalin (71.4%), isoproturon + 2,4-D (53.8%), fenoxaprop-p-ethyl + 2,4-D (53.8%) and fenoxaprop-p-ethyl + metsulfuron-methyl (40.0%) at 60 days after sowing stage. A similar trend was observed with all the applied herbicides with respect to reduction in dry weight of weeds. The reduction in weed population as well as dry matter may be due to the fact that clodinafop-propargyl along with 2,4-D and metsulfuron-methyl may have acted synergistically in broadening the efficacy against variety of weed flora. Similar results werer also obtained by Singh *et al.* (2003), Punia *et al.* (2004) and Bharat and Kachroo (2007).

Weed control efficiency

Maximum weed control efficiency of 84.7% was observed (Table 2) with the application of clodinafop-propargyl + metsulfuron-methyl (60+4 g/ha) followed by clodinafop-propargyl + 2,4-D (81.9%). The lowest weed control efficiency (26.7%) was recorded when clodinafop-propargyl (60g/ha) was applied alone. Higher weed control efficiency with clodinafop-propargyl + metsulfuron-methyl (60+4 g/ha) may be attributed to the better weed control resulting in lower dry weight of weeds.

Yield and weed index

Herbicide application had significant effect on wheat grain and straw yield (Table 2). The highest grain yield of wheat (4.72 t/ha) was recorded in weed free plot which might have resulted in increased nutrients, water, space and light supply to the wheat crop with zero crop-weed competition. This might have resulted in greater photosynthesis and translocation of photosynthates besides longer and stronger sink size as reflected by maximum values of yield attributes and finally the yield. Among the herbicides clodinafop-propargyl + metsulfuron-methyl (60+4 g/ha) applied as post-emergence produced 14.3, 15.5, 23.7, 29.5, 45.9, 47.4 and 69.7 per cent increased grain yield over pendimethalin, isoproturon + metsulfosulfuron-methyl, fenoxaprop-p-ethyl + metsulfosulfuron-methyl, fenoxaprop-p-ethyl, isoproturon, clodinafop-propargyl and weedy check, respectively. Pendimethalin (1000 g/ha) and isoproturon (1000 g/ha) alone or in combination with metsulfuron-methyl (4 g/ha), fenoxaprop-p-ethyl alone (80 g/ha) and in combination with metsulfuron-methyl (4 g/ha) and clodinafop-propargyl alone (60 g/ha) being on a par with each other,

Table 2. Effect of weed control treatments on wheat yield, weed control efficiency, weed index and economics

Treatment	Dose (g/ha)	Yield (t/ha)				Pooled yield (t/ha)		WCE (%)	WI (%)	Net returns (₹/ha)	B:C ratio
		2006-07		2007-08							
		Grain	Straw	Grain	Straw	Grain	Straw				
Weedy	-	2.16	3.10	3.12	3.90	2.64	3.50	-	44.1	11,440	1.64
Weed free	-	4.11	5.42	5.33	6.86	4.72	6.14	-	-	27,800	2.13
Pendimethalin	1000	3.24	4.56	4.60	5.72	3.92	5.14	70.1	16.9	23,600	2.18
Isoproturon	1000	2.98	3.66	3.16	4.46	3.07	4.06	47.6	35.0	15,215	1.80
Isoproturon+2,4-D	1000+500	3.98	5.07	4.44	5.75	4.21	5.41	79.4	10.8	27,105	2.39
Isoproturon+metsulfuron-methyl	1000+4	3.24	4.64	4.52	5.44	3.88	5.04	63.3	17.8	23,560	2.21
Fenoxaprop-p-ethyl	80	3.09	4.02	3.83	4.86	3.46	4.44	55.0	26.7	18,790	1.96
Fenoxaprop-p-ethyl +2,4-D	80+500	4.01	5.07	4.31	6.57	4.16	5.82	71.3	11.9	27,200	2.37
Fenoxaprop-p-ethyl +metsulfuron methyl	80+4	3.21	4.66	4.03	5.54	3.62	5.10	57.9	23.3	21,470	2.10
Clodinafoppropargyl	60	2.98	4.06	3.1	4.42	3.04	4.24	26.7	35.6	15,020	1.78
Clodinafop propargyl + 2,4-D	60+500	4.06	5.13	4.48	5.99	4.27	5.56	81.9	9.5	27,915	2.43
Clodinafoppropargyl + metsulfuron-methyl	60+4	4.13	5.37	4.83	6.39	4.48	5.88	84.7	5.1	30,340	2.56
LSD (P=0.05)		0.38	0.32	0.52	0.42	0.52	0.40	-	-		

Table 3. Effect of weed control treatments on nutrient removal by wheat and associated weeds

Treatment	Dose (g/ha)	Nutrient removal by wheat (kg/ha)			Nutrient removal by weeds* (kg/ha)		
		N	P	K	N	P	K
Weedy	-	98.4	15.8	95.6	5.40(28.7)	3.77(13.4)	4.62(21.5)
Weed free	-	114.7	23.7	118.2	0.70(00.0)	0.70(0.0)	0.70(00.0)
Pendimethalin	1000	108	19.8	109.8	4.01(15.6)	2.87(7.8)	3.64(12.8)
Isoproturon	1000	104.6	17.8	107.5	4.43(19.2)	3.11(9.2)	3.78(13.8)
Isoproturon + 2,4-D	1000+500	110.8	20.9	115.7	3.63(12.4)	2.86(7.7)	3.33(10.6)
Isoproturon + metsulfuron-methyl	1000+4	106.7	19.2	111.3	4.22(17.4)	3.08(9.0)	3.66(12.6)
Fenoxaprop-p-ethyl	80	104.9	19.3	107.4	4.32(18.2)	3.21(9.8)	3.75(13.6)
Fenoxaprop-p-ethyl +2,4-D	80+500	109.6	20.4	115.2	3.68(12.8)	3.02(8.7)	3.58(12.3)
Fenoxapropp-ethyl + metsulfuron-methyl	80+4	105.3	19.5	108	4.30(17.8)	3.14(9.4)	3.66(12.9)
Clodinafop-propargyl	60	102.3	17.5	106.3	4.60(20.4)	3.18(9.6)	3.88(14.6)
Clodinafop-propargyl +2,4-D	60+500	112.6	21.3	116.3	3.46(11.5)	2.77(7.2)	3.48(11.6)
Clodinafop-propargyl + metsulfuron-methyl	60+4	112.1	21.6	116.7	3.40(10.8)	2.82(7.4)	3.27(10.2)
LSD (P=0.05)		5.0	2.0	5.3	0.3	0.28	0.3

*Original values in parentheses

increased the yield of wheat significantly as compared with weedy check. However, herbicide combinations of isoproturon + 2,4-D (1000+500 g/ha), clodinafop-propargyl + 2,4-D (60+500 g/ha), fenoxaprop-p-ethyl + 2,4-D (80+500g/ha) and clodinafop-propargyl + metsulfuron-methyl (60+4 g/ha) yielded similar to that of weed free condition. The similar results have also been reported by Punia *et al.* (2004). The lowest weed index (5.1%) was observed in clodinafop-propargyl + metsulfuron-methyl (60+4 g/ha) followed by clodinafop-propargyl + 2,4-D (9.5%).

NPK depletion by weeds

Maximum removal of NPK by weeds was recorded in weedy check, due to higher dry matter of weeds which enabled them to absorb more nutrients. The minimum depletion of NPK was recorded with herbicide mixture of clodinafop-propargyl + metsulfuron-methyl due to efficient control of weeds (84.7%), which resulted in the lowest weed dry matter (Table 2). Herbicides, *viz.*, pendimethalin, isoproturon, isoproturon + 2,4-D, isoproturon + metsulfuron-methyl, fenoxaprop-p-ethyl , fenoxa prop-p-ethyl + 2,4-D, fenoxa prop-p-ethyl + metsulfuron-methyl, clodinafop-propargyl, clodinafop-propargyl + 2,4-D and clodinafop-propargyl + metsulfuron-methyl depleted 42.5, 33.6, 51.7, 38.7, 34.6, 46.8, 37.0, 30.0, 52.3 and 55.3 % less NPK over weedy check. Singh and Saha (2001) also reported lower nutrient depletion under herbicidal treatments as compared weedy check.

NPK uptake by crop

Significantly higher uptake of NPK by grains and straw of wheat was recorded in weed free conditions compared to the herbicidal treatments except clodinafop-propargyl + metsulfuron-methyl and clodinafop- propargyl + 2,4-D (Table 2) being 8.0, 11.6, 3.7, 8.2, 10.8, 4.6, 10.2 and 13.5 per cent higher over pendimethalin, isoproturon, isoproturon + 2,4-D, isoproturon + metsulfuron-methyl, fenoxaprop-p-ethyl, fenoxaprop-p-ethyl + 2,4-D, fenoxaprop-p-ethyl + metsulfuron-methyl and clodinafop-propargyl + metsulfuron-methyl, respectively. All the herbicidal treatments recorded significantly higher total nutrient uptakes than the weedy check. The lowest nutrient uptake by wheat grains and straw in weedy check seems to be due to the increase in weed dry matter accumulation. The results are similar to the finding of Pandey *et al.* 2001.

Economics

Maximum net returns were obtained with clodinafop-propargyl + metsulfuron-methyl (60 + 4 g/ha) applied at 35 DAS followed by clodinafop-propargyl + 2,4-D. The benefit : cost ratio was followed the trend same as net returns. The unweeded check recorded lowest net return and B:C ratio (Table 2).

It can be concluded that post-emergence application of clodinafop-propargyl + metsulfuron-methyl (60+4 g/ha) effectively reduced weed population and its dry weight and increased the grain yield of wheat.

REFERENCES

Banga RS and Ashok Yadav. 2004. Effect of fenoxaprop –p-ethyl and sulfosufuron alone and its tank mixture against complex flora of weeds. *Indian Journal of Weed Science* **36**: 163–165.

Bharat, R. and Dileep Kachroo. 2004. Bio efficacy of various herbicides and their mixture on weed and yield of wheat (*Triticum aestivum* L.) under subtropical agro-ecosystem. *Indian Journal of Ecology* **31**: 128–132.

Mahajan G, Barar LS and Sardana V. 2004. Efficacy of clodinafop against isoproturon resistant in *Phalaris minor* in relation to wheat cultivars and spacing. *Indian Journal of Weed Science* **36**: 166–170.

Pandey IB, Sharma SL, Tiwari S and Bharti V. 2001. Effect of tillage and weed management on grain yield and nutrients removal by wheat (*Triticum aestivum* L.) and weeds. *Indian Journal of Weed Science* **33**: 107–111.

Punia SS, Malik RK and Shoeren Parvinder. 2004. Bio efficacy of tank mix combination of fenoxaprop and clodinafop with broad leaf herbicides broad spectrum weed control in wheat (*Triticum aestivum* L.). *Indian Journal of Ecology* **31**: 128–132.

Singh G and Singh VP. 2005. Effect of affinity on wheat and associated weeds. *Indian Journal of Weed Science* **36**: 28–30.

Singh G, Singh VP, Singh Mahendra and Singh RK. 2003. Effect of doses and stages of application of sulfosulfuron on weeds and wheat yields. *Indian Journal of Weed Science* **30**: 176–178.

Singh SK and Saha GP. 2001. Productivity and profitability of wheat (*Triticum aestivum* L.) as influenced by cultural and chemical weed control. *Indian Journal of Agronomy* **46**(3): 475–479.