Indian Journal of Weed Science **45**(1): 25–28, 2013

Integrated weed management in wheat with new molecules

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Received: 15 November 2012; Revised: 6 February 2013

ABSTRACT

A field experiment was carried out at Instructional Farm, Department of Agronomy, Junagadh Agricultural University, Junagadh (Gujarat) during *Rabi* of 2008-09 and 2009-10. The weed free treatment recorded significant improvement in yield attributes, *viz*. number of effective tillers, spikelets per spike and grain weight per plant, followed by pendimethalin 0.9 kg/ha as pre-emergence followed by one hand weeding at 35- 40 DAS. Integration of pendimethalin as pre-emergence with clodinafop, metsulfuron-methyl and 2,4-D amine salt as post-emergence with or without hand weeding proved effective in reducing weed density and dry weight of weeds. All the weed control treatments significantly influenced the grain and straw yield of wheat excluding unweeded control. The pre-emergence application of pendimethalin controlled monocot and dicot weeds, while clodinafop controlled monocot and metsulfuron-methyl controlled dicot weeds. Integrated weed management practices also produced increased nutrient uptake by crop and minimized nutrient due to weeds.

Key words: Growth, Herbicides, Nutrient uptake, Wheat, Yield

Wheat (*Triticum* spp.) is one of the most important grain crops which is grown in approximately 225 million ha world wide, about half of which is in developing countries. India is the second largest producer of wheat in the world contributing about 80.6 million tones of grains with productivity of 2.8 t/ha from the area of 28.4 million hectares (Anonymous 2013). Weed problem is one of the major barrier responsible for low productivity of wheat. The weeds in India cause about ₹16,500 million loss in terms of production (Joshi 2002). In agriculture, weeds causes more damage compared to insects, pests and diseases but due to hidden loss by weeds in crop production, it has not drawn much attention of agriculturists.

The use of herbicides have revolutionized weed control due to non-availability and high cot of labours. The integrated weed management approach is advantageous because one technique rarely achieve complete and effective control of all weeds during crop season and even a relatively few surviving weeds can produce sufficient number of seeds to perpetuate the species (Walia *et al.* 1997, Nayak 2006). Therefore, the present investigation was undertaken to provide appropriate options to farmers for effective weed management in wheat.

MATERIALS AND METHODS

An experiment was conducted during *Rabi* season of 2008 and 2009 at Junagadh Agricultural University, Junagadh (Gujarat, India). The soil of the experimental field was clay, low in available nitrogen and medium in available phosphorus and potash and slightly alkaline in reaction with pH 8.05 and EC 0.26/dsm. Total 12 treatments (T_1- pendimethalin 0.9 kg/ha as pre-emergence, T_2- Pendimethalin 0.9 kg/ha as pre-emergence + 1 HW at 40 DAS, T_3- metsulfuron-methyl 6 g/ha as post-emergence at 25-30 DAS, T_4- 2,4-D amine salt 0.75 kg/ha post-emergence at 25-30 DAS, T_5- clodinafop 60 g/ha as post-emergence at 25-30 DAS, T_6- pendimethalin 0.9 kg/ha as pre-emergence + metsulfuron-methyl 6 g/ha as post-emergence at 35-40 DAS, T_7- pendimethalin 0.9 kg/ha as pre-emergence + 2,4-D amine salt 0.75 kg/ha post-emergence at 25-30 DAS, T_8- pendimethalin 0.9 kg/ha pre-emergence + clodinafop 60 g/ha as post-emergence at 35-40 DAS, T_9- 1 HW at 20 DAS, T_{10}- 2 HW at 20 and 40 DAS, T_{11}- weed free and T_{12}- unweeded control) were assigned in randomized block design with three replications. The wheat variety '*GW- 366*' was sown at 22.5 cm row spacing at 120 kg seed/ha on November 17 and harvested on February 27. Pendimethalin was sprayed next DAS (days after sowing) and metsulfuron-methyl, 2,4-D amine salt and clodinafop were sprayed on 30 and 40 DAS at spray volume of 500 l/ha. Spraying was done by manually operated knapsack sprayer. The crop was grown with standard package of practices for the region. The weed index was calculated by following the formula given by Gill and Kumar (1969).The weed control efficiency was calculated by using the following formula (Mani *et al*. 1981).

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RESULTS AND DISCUSSION

Effect on growth and yield

Growth parameter like plant height affected significantly due to weed free conditions (Table 1) over unweeded control. Significantly higher number of effective tillers, spikelets per spike and grain weight per plant were recorded under weed free conditions over unweeded control which was closely followed by treatment pendimethalin 0.9 kg/ha as pre-emergence (T_1).

The maximum seed yield (4.40 t/ha) and straw yield (5.02 t/ha) were recorded under weed free conditions. The improved grain and straw yield under weed free treatment was closely followed by pendimethalin 0.9 kg/ha pre- emergence + 1 HW at 40 DAS (4.31 t/ha) which was statistically at par with pendimethalin 0.9 kg/ha as pre-emergence + metsulfuron-methyl 6 g/ha as post-emergence at 35- 40 DAS, pendimethalin 0.9 kg/ha as pre-emergence + 2,4-D amine salt 0.75 kg/ha as post-emergence at 35-40 DAS, pendimethalin 0.9 kg/ha pre-emergence + clodinafop 60 g/ha as post-emergence at 35-40 DAS and 2 HW at 20 and 40 DAS. The higher yields under these treatments could be ascribed to better control of weeds which favoured higher uptake of nutrients and water resulting optimum growth characters, *viz*. plant height, effective tillers, spikelets per spike, grain weight per plant and test weight. These growth and yield attributes evidently reflected in higher grain and straw yields under these treatments.

Significantly lowest grain and straw yields were recorded under unweeded control. These findings were in close conformity with Singh and Singh (2004) who reported highest grain yield with pendimethalin 0.9 kg/ha pre-emergence supplemented by one hand weeding. They observed maximum grain yield of wheat with post-emergence application of 2,4-D. Similarly, application of metsulfuron methyl at 3 to 5 g/ha and 2,4-D at 0.75 kg/ha recorded significantly higher grain and straw yields (Singh and Ali 2004, Maninder *et al.* 2007).

Effects on weeds

The predominant weed flora at experimental site were: *Brachiaria* spp. and *Echinochloa colona* among grasses; *Amaranthus viridis, Digera arvensis Chenopodium album* and *Euphorbia hirta* among dicot weeds; and *Cyperus rotundus* among sedges.

Among herbicides treatments, pre-emergence pendimethalin resulted efficient control of monocot and dicot weeds, whereas post-emergence application of clodinafop resulted excellent control of monocot weeds and post-emergence application of metsulfuron-methyl and 2,4-D amine salt controlled dicot weeds efficiently. However, integration of one hand weeding with pendimethalin 0.9 kg/ha pre-emergence, pendimethalin 0.9 kg/ha pre-emergence + clodinafop 60 g/ha as post-emergence at 35-40, pendimethalin 0.9 kg/ha as pre-emergence + metsulfuron-methyl 6 g/ha as post-emergence and pendimethalin 0.9 kg/ha as pre-emergence + 2,4-D amine

Table 1. Effect of different weed control treatments on growth and yield of wheat at harvest (pooled data of two years)

Treatment	Plant height at harvest (cm)	Tillers/m		Spikelets per spike	Grain weight/ plant (g)	Grain yield (t/ha)	Straw yield (t/ha)
		Effective	Non-effective				
Pendimethalin	75.00	45.87	4.53	14.60	1.82	3.72	4.38
Pendimethalin + 1 HW at 40 DAS	79.20	46.93	3.30	15.39	2.00	4.31	4.89
Metsulfuron-methyl	75.00	42.60	4.57	13.63	1.74	3.49	3.70
2,4-D amine salt	74.87	42.33	4.70	13.40	1.74	3.46	3.68
Clodinafop	74.83	44.63	4.43	13.83	1.73	3.52	3.89
Pendimethalin. + metsulfuron-methyl	76.00	46.40	3.40	15.00	1.96	4.07	4.65
Pendimethalin + 2,4-D amine salt	77.53	46.33	3.83	14.80	1.95	4.05	4.51
Pendimethalin + clodinafop	77.67	46.43	3.27	15.07	1.97	4.16	4.78
1 HW at 20 DAS	76.80	45.63	4.43	14.57	1.80	3.62	4.11
2 HW at 20 and 40 DAS	79.13	46.67	3.73	15.27	1.99	4.28	4.78
Weed free	80.70	47.07	2.23	15.57	2.03	4.40	5.02
Unweeded control	68.90	36.53	5.38	13.00	1.65	2.70	2.96
LSD (P=0.05)	5.89	5.94	0.59	1.63	0.22	0.64	0.72

salt 0.75 kg/ha post-emergence at 35-40 DAS proved more effective in reducing the weed density at harvest in comparison to herbicides applied alone. Pendimethalin 0.9 kg/ha pre-emergence + 1 HW at 40 DAS proved superior to rest of the treatments by recording minimum dry weight of weeds (Table 2) and remained at par with pendimethalin 0.9 kg/ha pre-emergence + clodinafop 60 g/ha as post-emergence at 35-40 DAS, 2 HW at 20 and 40 DAS, pendimethalin 0.9 kg/ha pre-emergence + metsulfuron-methyl 6 g/ha as post-emergence at 35-40 DAS and pendimethalin 0.9 kg/ha as pre-emergence + 2,4-D amine salt 0.75 kg/ha post-emergence at 35-40 DAS and gave higher weed control efficiencies of 90.7, 88.1, 87.9, 87.5 and 86.5%, respectively. Integrated treatments also recorded lower weed index as compared to sole herbicides, one hand weeding and unweeded control (Table 2). This might be due to the efficient control of weeds during initial stage by pre-emergence application and control of latter weeds through hand weeding. The lowest weed control efficiency was observed under unweeded control (T_{12}), because of better weed competition stress. Superiority of combination of metsulfuron-methyl with 2,4-D have been reported by Kurchania *et al*. (2000) and Nayak *et al*. (2003).

Table 2. Effect of different treatments on weed growth and weed control efficiency (pooled data of two years)

Treatment	Monocot weeds/m^2		Dicot weeds/m^2		Dry weight of weeds (kg/ha)	Weed index (%)	Weed control efficiency (%)
	60 DAS	At harvest	60 DAS	At harvest			
Pendimethalin	1.9 (3.3)	3.3 (10.3)	2.5 (6.0)	3.6 (12.3)	224.8	15.0	84.4
Pendimethalin + 1 HW at 40 DAS	2.0 (3.3)	1.8 (2.7)	2.7 (6.7)	2.4 (5.00)	133.7	1.3	90.7
Metsulfuron-methyl	4.7 (22.0)	6.0 (35.7)	1.8 (3.0)	2.7 (6.7)	424.6	20.0	70.6
2,4-D amine salt	4.7 (21.7)	6.1 (36.3)	1.7 (2.7)	2.6 (6.7)	446.4	20.5	69.1
Clodinafop	1.2 (1.0)	2.1 (4.0)	4.5 (20.0)	5.5 (29.3)	358.2	19.8	75.2
Pendimethalin + metsulfuron-methyl	1.7 (2.3)	3.0 (8.3)	2.5 (6.0)	1.8 (3.0)	180.6	7.0	87.5
Pendimethalin + 2,4-D amine salt	1.8 (2.7)	2.9 (8.3)	2.6 (6.3)	1.9 (3.3)	196.3	8.4	86.5
Pendimethalin + clodinafop	1.6 (2.0)	1.7 (2.3)	2.6 (6.3)	3.5 (12.0)	171.8	5.1	88.1
1 HW at 20 DAS	1.3 (1.3)	3.3 (10.3)	2.0 (3.3)	3.2 (10.0)	297.5	17.5	79.4
2 HW at 20 and 40 DAS	1.6 (2.0)	2.1 (4.0)	1.9 (3.3)	2.0 (3.7)	175.6	2.2	87.9
Weed-free	0.7 (0.0)	0.7 (0.0)	0.7 (0.0)	0.7 (0.0)	0.0	0.0	100.0
Unweeded control	5.1 (25.7)	6.2 (38.3)	5.4 (28.7)	6.2 (38.0)	1452.0	38.3	0.0
LSD (P=0.05)	0.51	0.61	0.66	0.54	69.8	-	-

$\sqrt{x + 0.5}$ transformation. Figures in parentheses are original values

Table 3. Influence of weed control treatments on N, P and K uptake by crop and weeds (pooled data of two years)

Treatment	Nutrient uptake by crop (kg/ha)			Nutrient uptake by weeds (kg/ha)		
	N	P	K	N	P	K
Pendimethalin	73.0	17.1	62.2	3.15	0.68	3.02
Pendimethalin + 1 HW at 40 DAS	84.1	18.7	66.4	1.74	0.37	1.85
Metsulfuron-methyl	62.3	15.4	58.1	6.84	1.35	5.10
2,4-D amine salt	58.2	15.0	56.1	7.11	1.22	5.60
Clodinafop	66.1	16.0	59.8	5.92	0.93	4.28
Pendimethalin + metsulfuron-methyl	79.0	18.1	65.0	2.61	0.49	2.27
Pendimethalin + 2,4-D amine salt	77.5	17.8	64.1	2.81	0.50	2.27
Pendimethalin + clodinafop	81.9	18.5	65.1	2.50	0.50	1.98
1 HW at 20 DAS	69.7	16.4	61.3	4.62	0.81	3.44
2 HW at 20 and 40 DAS	82.4	18.7	65.7	2.52	0.47	2.20
Weed-free	86.1	19.1	68.7	0.00	0.00	0.00
Unweeded control	49.9	11.3	40.0	24.43	4.38	20.67
LSD (P=0.05)	5.8	3.7	8.5	1.13	0.25	0.95

Nutrient uptake by crop and weeds

The weed free treatment recorded significantly highest uptake of N, P and K (Table 3) by crop (86.1, 19.1, 68.7/ kg) and lower N, P, K uptake by weeds which was closely followed by pendimethalin 0.9 kg/ha pre-emergence + 1 HW at 40 DAS and at par with treatments pendimethalin 0.9 kg/ha as pre-emergence + metsulfuron-methyl 6 g/ha as post-emergence at 35- 40 DAS (T_6), pendimethalin 0.9 kg/ha as pre-emergence + 2,4-D amine salt 0.75 kg/ha post-emergence at 35- 40 DAS (T_7), pendimethalin 0.9 kg/ha pre-emergence + clodinafop 60 g/ha as post-emergence at 35- 40 DAS (T_8) and 2 HW at 20 and 40 DAS (T_{10}). There were more loss of N, P, K by weeds from unweeded control plots. It can be explained in the light of the facts that these treatments controlled the weeds effectively, might have made more nutrients available to crop and consequently encouraged higher concentration of nutrients and more yield and thereby higher uptake of nutrients. These findings corroborated the reports of Jat *et al*. (2004) and Kanojia and Nepalia (2006).

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