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Weed management through tank mix and premix herbicides in wheat

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ABSTRACT

A field experiment was conducted during the *Rabi* (winter) season of 2014-15 and 2015-16 at Agricultural Research Station, Dharwad, Karnataka, India to evaluate the efficacy of tank mix herbicides and premix herbicides on weed control and its influence on productivity and profitability in irrigated wheat. Tank mix application of sulfosulfuron + metsulfuron 25 + 4 g/ha recorded significantly higher grain yield (4.31 t/ha) followed by clodinafop + metsulfuron 60 + 4 g/ha (4.15 t/ha) over weedy check. Biological yield was recorded significantly higher with clodinafop + metsulfuron 60 + 4 g/ha (12.21 t/ha) followed by sulfosulfuron + metsulfuron 25 + 4 g/ha (12.18 t/ha) over 2,4-D 2.5 kg/ha (10.68 t/ha) alone. The lower weed density, weed biomass and higher weed control efficiency was recorded with sulfosulfuron + metsulfuron 25 + 4 g/ha followed by clodinafop + metsulfuron 60 + 4 g/ha compared to weedy check. The more gross returns, net returns and benefit : cost ratio was obtained with sulfosulfuron + metsulfuron 25 + 4 g/ha over other weed management practices.

Key words: Crop growth, Herbicide mixture, Post-emergent, Tank mix, Weed management, Wheat

Weed infestation is one of the main biotic constraints in wheat production. Wheat is infested by diverse weed flora comprising of grasses and broad-leaved weeds. Nearly 50% of the wheat yield reduction is observed due to some dominant weed flora appearing at early stage and interfering the crop growth because of frequent irrigations. Manual weeding in wheat is cumbersome, laborious, time consuming and costly. Therefore, most of the wheat farmers depend on herbicides due to effective and easy application compared to manual weeding. Yaduraju and Das (2002) suggested that chemical herbicides play an important role for weed control in close spaced crops like wheat, barley where mechanical or manual weeding is difficult. Farmers use herbicides with similar mode of action. This leads to shift in weed flora and development of resistance against widely used herbicides. Pre-emergent herbicides are used for their effectiveness in initial stages, but their efficacy are lost within 15 DAS, which results in emergence of new flush of weeds. Post-emergent herbicides applied at 20-30 DAS may avoid this problem. Therefore, combination of herbicides in mixture will be an ideal means to increase the spectrum of weed control and also to prevent or delay the development of weed resistance in wheat. Hence, a study was undertaken to keep the weeds below threshold level and assess the effect of different herbicide mixtures on crop growth and yield performance of wheat.

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MATERIALS AND METHODS

A field experiment was conducted during *Rabi* (winter) season of 2014-15 and 2015-16 at Agricultural Research Station, University of Agricultural Sciences, Dharwad, Karnataka. The experiment was laid out in randomized complete block design with three replications on vertisols with pH of 8.1 and EC of 0.21 ds/m and available major nutrients of 325, 33.5 and 465 kg/ha NPK, respectively. Tank mix herbicides treatment consisted of sulfosulfuron + 2,4-D (25 g + 0.5 kg/ha); sulfosulfuron + metsulfuron (25 + 4 g/ha); clodinafop + 2,4-D (60 g + 0.5 kg/ha); clodinafop + metsulfuron (60 + 4 g/ha); metribuzin + 2,4-D (100 g + 0.5 kg/ha); metribuzin + metsulfuron (100 + 4 g/ha), while pre-mix herbicides were mesosulfuron + iodosulfuron (Atlantis) (12 + 2.4 g/ha) and fenoxaprop–p-ethyl + metribuzin (Accord plus) 100 + 175 g/ha, recommended 2,4-D 2.0 kg/ha, intercultivation + hand weeding and weedy check. Recommended doses of nitrogen, phosphorus, potassium were given in the form of urea, diammonium phosphate and murate of potash. Half of the recommended dose of N (100 kg/ha) and full dose of P_20_5 (75 kg/ha) and K_20 (50 kg/ha) were applied as basal and the remaining nitrogen was applied after 30 DAS. The variety '*UAS 304*' was sown with a spacing of 20 cm with seed rate of 150 kg/ha on 9 and 12 November 2014 and 2015 during the first and second year of experimentation. Irrigations were provided at fortnightly intervals. All the herbicides were applied at 20 - 25 days after sowing with the help of knapsack sprayer fitted with a flat–fan nozzle with a spray volume of 500 litres/ha. The weed free plot was maintained by repeated manual weeding. Inter-cultivation was done with hand operated wooden hoe at 20 - 25 DAS and weeding was done at 40 - 45 DAS. The crop was harvested on 22 and 25 March during 2015 and 2016, respectively. The weed density and weed biomass were recorded at 60 DAS with the help of 1 m^2 quadrate and data on weed parameters were subjected to square root transformation before statistical analysis. All the data obtained were statistically analyzed using the F-test procedure as given by Gomez and Gomez (1984). Least significant difference (LSD) values at P=0.05 were used to determine the significance of difference between means.

RESULTS AND DISCUSSION

Weed control

Weeds of experimental plots were *Chenopodium* sp., *Anagallis arvensis, Melilotus* sp., *Phyllanthus niruri, Ageratum conyzoides, Oxalis corniculata, Echinochloa colonum, Convolvulus arvensis, Amaranthus viridis, Portulaca oleraceae, Cynodon dactylon, Sida cordifolia* and *Digitaria sanguinalis.*

All weed control treatments recorded significantly lower weed density than weedy check (Table 1). Among the herbicide treatments, application of tank mix herbicide sulfosulfuron + metsulfuron 25 + 4 g/ha exerted the maximum herbicide effect and caused the highest reduction in total weed density and total biomass which however, was statistically at par with clodinafop + metsulfuron 60 + 4 g/ha and metribuzin + metsulfuron 100 + 4 g/ha. This might be due to the fact that combined application of two herbicides known for controlling grassy and broad-leaf weeds provided effective control of all the weeds to achieve higher level of weed control. These results confirm the findings of Singh *et al.* (1998) and Pal *et al.* (2016). Higher weed control efficiency was noticed with sulfosulfuron + metsulfuron 25 + 4 g/ha (81.6%) followed by clodinafop + metsulfuron 60 + 4 g/ha (79.2%), metribuzin + metsulfuron 100 + 4 g/ha and mesosulfuron + iodosulfuron 12 + 2.4 g/ha (77.3%) over other weed control treatments.(Singh *et al.* 2003).

Crop growth

The higher plant height, more number of tillers and dry matter accumulation was observed with the treatment on sulfosulfuron + metsulfuron (25 + 4 g/ha) and recorded significantly higher with 2,4-D alone (Table 1). This was in conformity with the findings by Singh *et al.* (1997).

Yield and yield parameters and economics

Application of tank mix herbicide sulfosulfuron + metsulfuron (25 + 4 g/ha) recorded significantly higher spike/m^2 (251.8) compared to 2,4-D alone and found at par with clodinafop + metsulfuron (60 + 4 g/ha) and metribuzin + metsulfuron (100 + 4 g/ha). The corresponding increase was also observed in grains/ear head and 1000-grain weight (Table 2). The improvement in yield characters through weed control could be ascribed to reduced density and dry weight of weeds and thus resulted in the least competition for moisture, space, nutrients, light *etc.* Significantly, higher 1000-seed weight was observed with tank mix herbicide sulfosulfuron + metsulfuron (25 +4 g/ha) as compared to mesosulfuron + iodosulfuron (12 + 2.4 g/ha), fenoxaprop–p-ethyl + metribuzin (100 + 175 g/ha) and 2,4-D alone (Bharat *et al.* 2012, Chaudry *et al.* 2013). Tank mix herbicide

Table 1. Density, biomass and weed control efficiency of various post-emergent herbicides at 60 DAS (pooled data of two years)

Treatment	Weed density/m^2			Weed biomass g / m^2			Weed control efficiency (%)
	Monocot	Dicot	Total	Monocot	Dicot	Total	
Sulfosulfuron + 2, 4- D (25 + 0.5 kg/ha)	2.75 (7.00)	3.38 (11.00)	4.25 (18.00)	2.44 (5.00)	2.93 (8.00)	3.70 (13.00)	65.43
Sulfosulfuron + metsulfuron (25 + 4 g/ha)	1.91 (3.00)	2.69 (6.00)	3.14 (9.00)	1.50 (1.00)	2.30 (4.00)	2.57 (5.00)	81.62
Clodinafop + 2, 4- D (60 g + 0.5 kg/ha)	3.07 (9.00)	3.73 (13.0)	4.74 (22.00)	2.83 (7.00)	2.86 (7.00)	4.05 (14.00)	79.72
Clodinafop + metsulfuron (60 + 4 g/ha)	2.02 (3.00)	2.81 (7.00)	3.32 (10.00)	1.70 (2.00)	2.32 (5.00)	2.70 (7.00)	79.72
Metribuzin + 2, 4- D (100 g + 0.5 kg/ha)	3.08 (9.00)	3.40 (11.00)	4.48 (20.00)	2.54 (6.00)	2.91 (8.00)	3.74 (14.00)	61.52
Metribuzin + metsulfuron (100 + 4 g/ha)	2.09 (4.00)	2.80 (7.00)	3.38 (11.00)	1.81 (2.00)	2.36 (5.00	2.82 (7. 00)	78.91
Mesosulfuron + iodosulfuron (12 + 2.4 g/ha)	2.17 (4.00)	2.88 (8.00)	3.50 (12.00)	2.03 (3.00)	2.46 (5.00)	3.04 (8.00)	77.11
Fenoxaprop-p-ethyl + metribuzin (100 + 175 g/ha)	2.37 (5.00)	3.08 (9.00)	3.74 (14.00)	2.19 (4.00)	2.67 (6.00)	3.31 (10.00)	73.33
Recommended (2,4-D 2.0 kg/ha)	2.27 (4.00	3.00 (8.00)	3.62 (12.00)	2.06 (3.00)	2.55 (6.00)	3.13 (9.00	75.36
Intercultivation + hand weeding	2.44 (5.00)	3.31 (10.00)	3.99 (15.00)	2.29 (4.00	2.83 (7.00)	3.51 (11.00)	69.71
Weedy check	4.65 (10.00)	5.48 (21.00)	5.15 (31.00)	3.46 (8.00)	3.72 (10.00)	4.33 (18.00)	0.00
LSD (P=0.05)	0.29	0.39	0.24	0.22	0.52	0.35	5.13

Data subjected to ($\sqrt{x+0.5}$) transformation, and figures in parentheses are original values

Table 2. Crop growth, yield and yield attributes and economics of wheat as influenced by various post-emergent herbicides (pooled data of two years)

Treatment	Plant height (cm) at harvest	Tillers (no./m) at harvest	DMA (g/m) at harvest	Spikes/ m^2	Grains/ spike	Test weight (g)	Grain yield (t/ha)	Biomass yield (t/ha)	Gross returns (x 10^3 `/ha)	Net returns (x 10^3 `/ha)	Benefit: cost ratio
Sulfosulfuron + 2, 4- D (25 + 0.5 kg/ha)	88.80	90.50	123.80	243.82	42.32	41.43	3.99	12.03	87.7	44.4	2.03
Sulfosulfuron + metsulfuron (25 + 4 g/ha)	89.40	99.50	128.50	251.81	43.73	42.37	4.31	12.18	94.8	51.4	2.19
Clodinafop + 2, 4- D (60 g + 0.5 kg/ha)	81.90	77.93	112.50	228.64	36.64	37.04	3.41	9.74	74.9	31.6	1.73
Clodinafop + metsulfuron (60 + 4 g/ha)	89.30	93.20	127.40	249.18	42.72	41.25	4.15	12.21	91.2	47.8	2.11
Metribuzin + 2, 4- D (100 g + 0.5 kg/ha)	82.60	86.70	110.50	236.12	39.52	38.45	3.68	10.00	81.0	38.4	1.90
Metribuzin + metsulfuron (100 + 4 g/ha)	88.50	91.57	120.60	249.87	41.86	40.48	3.90	11.28	85.8	43.0	2.00
Mesosulfuron + iodosulfuron (12 + 2.4 g/ha)	84.60	89.30	118.20	240.23	40.73	40.21	3.82	11.01	84.0	40.5	1.93
Fenoxaprop-p-ethyl + metribuzin (100 + 175 g/ha)	83.10	82.40	114.85	236.47	40.63	38.44	3.76	10.47	82.7	38.8	1.89
Recommended (2,4-D 2.0 kg/ha)	83.00	84.80	116.50	237.63	41	38.53	3.79	10.68	83.4	40.2	1.93
Intercultivation + hand weeding	80.00	80.40	114.50	230.61	38.3	38.27	3.51	9.96	77.1	31.6	1.70
Weedy check	73.20	74.50	95.50	227.07	36.09	36.09	2.70	8.09	59.4	17.2	1.41
LSD (P=0.05)	8.32	13.79	9.79	19.23	2.89	1.52	0.40	1.26	9.64	9.76	0.23

application provided weed free environment to crop and excellent yield characteristics as compared to 2,4-D alone. Application of tank mix herbicide sulfosulfuron + metsulfuron (25 + 4 g/ha) recorded significantly higher grain yield (4.31 t/ha) over 2,4-D alone and found at par with clodinafop + metsulfuron 60 + 4 g/ha (4.15 t/ha) and sulfosulfuron + 2,4-D 25 g + 0.5 kg/ha (3.99 t/ha). Clodinafop + metsulfuron 60 + 4 g/ha recorded significantly higher biomass yield (12.2 t/ha) followed by sulfosulfuron + metsulfuron 25 + 4 g/ha (12.2 t/ha) and sulfosulfuron + 2,4-D 25 g + 0.5 kg/ha (12.03 t/ha) over 2,4-D alone. Reduction in crop weed competition under weed control treatments led to enchanced crop growth and finally biomass yield. Our results support the findings of Pisal and Sagarka (2013) and Pandey *et al.* (2006). All the weed control treatments fetched significantly more gross returns, net returns and benefit : cost ratio over weedy check, which might be due to more grain yield registered in these treatments. Application of tank mix herbicide sulfosulfuron + metsulfuron 25 + 4 g/ha recorded significantly higher benefit : cost ratio (2.19) over 2,4-D alone and at par with clodinafop + metsulfuron 60 + 4 g/ha, metribuzin + metsulfuron 100 + 4 g/ha (2.00) and sulfosulfuron + 2,4-D 25 g + 0.5 kg/ha (2.03).

It was concluded that tank mix herbicide sulfosulfuron + metsulfuron 25 + 4 g/ha is advisable for reducing the weed pressure and obtaining the higher grain yield of wheat.

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