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Assessment of pre-mix broad spectrum herbicides for weed management in wheat

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ABSTRACT

A field experiment was carried out during the *Rabi* season of 2014 and 2015 on sandy loam soil to test the bio-efficacy of pre-mix broad spectrum herbicides for weed management in wheat. Major dominant weed flora in the experimental plot were *Chenopodium murale* (54.1%), *Chenopodium album* (11.9%), *Phalaris minor* (10.4%) and *Melilotus alba* (9.6%). Application of pre-mix sulfosulfuron (75%) + metsulfuron-methyl (5%) 32 g/ha as post-emergence, clodinafop (15%) + metsulfuron-methyl (1.0%) 64 g/ha as post-emergenc (PoE), mesosulfuron (3%) + iodosulfuron-methyl sodium (0.6 %) 14.4 g/ha as PoE and hand weeding at 20 and 40 DAS remained at par with each other and significantly reduced the density and biomass of both monocot as well as dicot weeds and resulted in significantly more number of effective tillers and yield of grain and straw. However, mesosulfuron (3%) + iodosulfuron-methyl sodium (0.6 %) 14.4 g/ha PoE showed phytotoxic effect on plant.

Key words: Pre-mix herbicides, Weed dry weight, Weed flora, Wheat, Yield

Wheat is one of the most important food grain crop which is grown in approximately 225 million hectares worldwide and about half of which is in developing countries. India is the second largest producer of wheat in the world contributing about 80.6 million tons of grains with the productivity of 2.8 t/ha from the area of 28.4 million hectares (Anon, 2012). Weed infestation is one of the major barriers in realizing potential yield of wheat. Uncontrolled weeds are reported to cause up to 66% reduction in wheat grain yield (Angiras *et al*. 2008, Kumar *et al.* 2009 and Kumar *et al*. 2011) or even more depending upon the weed density, type of weed flora and duration of infestations. Chemical weed control is a preferred practice due to scarce and costly labour as well as lesser feasibility of mechanical or manual weeding. In order to optimize the weed control efficacy and minimize the application costs, use of pre-and post-emergence herbicides, as well as herbicide mixtures, has become the alternative. This strategy also represents an important tool to avoid problems related to herbicide resistance. Considering above fact, the present experiment was planned to assess the relative bio-efficacy of pre-mix herbicide molecule for broad spectrum weed control.

MATERIALS AND METHODS

The present experiment was conducted in two consecutive *Rabi* season of the year 2014 and 2015-16 in B.A. College of Agriculture, Anand Agricultural University, Anand (Gujarat). The soil was sandy loam in texture having low in total nitrogen (0.042 %) and medium in available phosphorus (69.10 kg/ha) and high in potassium (358 kg/ha). Ten weed management practices, *viz*. pendimethalin 500 g/ha as pre-emergence (PE), 2,4-D 750 g/ha as post-emergence (PoE), metsulfuron-methyl 4.0 g/ha as PoE, clodinafop-propargyl 60 g/ha as PoE, sulfosulfuron 25 g/ha as post-emergence, sulfosulfuron (75%) + metsulfuron-methyl (5%) (pre-mix) 32 g/ha as post-emergence, clodinafop (15%) + metsulfuron-methyl (1%) (pre-mix) 64 g/ha as post-emergence, mesosulfuron (3%) + iodosulfuron-methyl-sodium (0.6%) (pre-mix) 14.4 g/ha as post-emergence, hand weeding (HW) at 20 and 40 DAS and weedy check were studied in randomized block design with four replications. The wheat cv. '*GW-496*' was sown manually keeping the row distance of 22.5 cm with the seed rate of 120 kg/ha during 1st week of December during both the years. Entire quantity of phosphorous (40 kg/ha) and half dose of nitrogen (60 kg/ha) in the form of single super phosphate and urea, respectively were applied as basal. Remaining quantity of nitrogen was applied in two equal split. The herbicides were applied using knapsack sprayer fitted with flat fan nozzle with spray volume of 500 L/ha. The other package of practices was adopted to raise the crop as per the recommendations. After sowing, a light irrigation was given to the crop for uniform germination and next day the pre-emergence herbicides were applied. The crop was harvested on

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last week of March and first week of April during 2014-15 and 2015-16, respectively. The observations on number of weeds and dry matter of weeds were taken from randomly selected four spots by using 0.25 m^2 iron quadrate from net plot area. The weed data were subjected to square root transformation before analysis. Weed control efficiency was also calculated on the basis of dry matter production by weeds. Data on yield attributes and yield were determined at harvest. The data were statistically analyzed by using statistical procedures and comparisons were made at 5% level of significance.

RESULTS AND DISCUSSION

Weed flora

Major weed flora observed on weedy plot comprised of *Chenopodium murale*, *Chenopodium album*, *Phalaris minor*, *Melilotus alba*, *Avena fatua*, *Asphodelus tenuifolius* and *Setaria tomentosa*. In weedy plot, grassy weeds constituted about 21.3% while broad-leaf weeds accounted 78.7%, of the total weed population. Herbicide treatments showed differences in weed control during both the years of experimentation in wheat crop.

Effect on weeds

Among the different herbicidal treatments, complete control of monocot and dicot weeds were achieved under pre-mix broad spectrum application of sulfosulfuron (75%) + metsulfuron-methyl (5%) 32 g/ha as post-emergence, clodinafop (15%) + metsulfuron-methyl (1%) 64 g/ha as post-emergence and mesosulfuron (3%) + iodosulfuron (0.6%) 14.4 g/ha as post-emergence at harvest (**Table 1**). Malik *et al.* (2013) observed that clodinafop + metsulfuron-methyl proved very effective against complex weed flora and the control of grassy and broad-leaved weeds to the extent of 95%. Alone application of sulfosulfuron 25 g/ha as post-emergence also provides 100% control of both monocot and dicot weed during 2014-15. Further, post-emergence application of 2,4-D 750 g/ha and metsulfuron-methyl 4.0 g/ha alone effectively control all the dicot weeds. In general, pre-mixed herbicidal mixture was found effective in reducing both monocot and dicot weeds as compared to sole application of 2,4-D, metsulfuron- methyl, pendmethalin, clodinafop-propargyl and sulfosulfuron. Poor control of broad-leaf weeds with the application of clodinafop-propargyl in wheat was also observed by Kaur *et al.* (2015).

Effect on crop

Non-significant differences were observed in plant height recorded at harvest during 2014-15, while it was significant in 2015-16 due to different herbicidal treatments (**Table 2**). Significantly lowest plant height of 78.5 cm was recorded in mesosulfuron (3%) + iodosulfuron (0.6%) 14.4 g/ha

Table 1. Weed density and dry biomass recorded at harvest as influenced by weed management practices in wheat

Treatment	Monocot weed count (no./m^2)		Dicot weed count (no./m^2)		Monocot weed dry biomass (g/m^2)		Dicot weed dry biomass (g/m^2)	
	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16
Pendimethalin 500 g/ha as PE	4.12^{c} (16.0)	4.35^{d} (18.0)	1.0^{d} (0.0)	3.31^{c} (10.0)	19.9^{a} (395.1)	16.0^{b} (255.1)	1.0^{c} (0.0)	3.91^{e} (14.4)
2,4-D 750 g/ha as post-emergence	4.42^{bc} (18.7)	5.09^{c} (25.0)	1.0^{d} (0.0)	1.0^{d} (0.0)	19.3^{a} (371.5)	15.4^{b} (237.5)	1.0^{c} (0.0)	1.0^{f} (0.0)
Metsulfuron-methyl 4.0 g/ha as PoE	4.70^{b} (21.3)	5.80^{b} (32.7)	1.0^{d} (0.0)	1.0^{d} (0.0)	20.2^{a} (408.2)	15.7^{b} (247.2)	1.0^{c} (0.0)	1.0^{f} (0.0)
Clodinafop-propargyl 60 g/ha as PoE	1.00^{d} (0.0)	2.30^{f} (4.3)	8.26^{b} (67.3)	9.83^{a} (95.7)	1.00^{c} (0.0)	3.01^{d} (8.1)	6.42^{a} (40.3)	16.6^{a} (274)
Sulfosulfuron 25 g/ha as PoE	1.00^{d} (0.0)	2.64^{e} (6.0)	1.0^{d} (0.0)	3.55^{c} (11.7)	1.00^{c} (0.0)	2.32^{d} (4.4)	1.00^{c} (0.0)	5.24^{d} (26.0)
Sulfosulfuron (75%) + metsulfuron- methyl (5%) WG 32 g/ha as PoE	1.0^{d} (0.0)	1.0^{g} (0.0)	1.0^{d} (0.0)	1.0^{d} (0.0)	1.0^{c} (0.0)	1.0^{e} (0.0)	1.0^{c} (0.0)	1.0^{f} (0.0)
Clodinafop (15%) + metsulfuron- methyl (1%) WP 64 g/ha as PoE	1.0^{d} (0.0)	1.0^{g} (0.0)	1.00^{d} (0.0)	1.0^{d} (0.0)	1.0^{c} (0.0)	1.0^{e} (0.0)	1.0^{c} (0.0)	1.0^{f} (0.0)
Mesosulfuron (3%) + iodosulfuron (0.6%) WDG 14.4 g/ha as PoE	1.0^{d} (0.0)	1.0^{g} (0.0)	1.00^{d} (0.0)	1.0^{d} (0.0)	1.0^{c} (0.0)	1.0^{e} (0.0)	1.0^{c} (0.0)	1.0^{f} (0.0)
Hand weeding 20 and 40 DAS	4.12^{c} (16.0)	4.20^{d} (16.7)	2.37^{c} (4.7)	3.51^{c} (11.3)	3.31^{b} (10.0)	7.82^{c} (60.4)	2.82^{b} (7.0)	7.12^{c} (49.0)
Weedy check	5.38^{a} (28.0)	6.56^{a} (42.0)	9.05^{a} (81.0)	5.35^{b} (27.7)	19.4^{a} (376.2)	17.6^{a} (308.8)	6.52^{a} (41.6)	11.3^{b} (127)
LSD (p=0.05)	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.

Data subjected to $(\sqrt{x+1})$ transformation. Figures in parentheses are means of original values. Treatment means with the letters in common are not significant by Duncan's new multiple range test at 5% level of significance; PE: Pre-emergence; PoE - Post-emergence.

Table 2. Growth and yield attributes of wheat as influenced by different weed management practices

Treatment	Plant height (cm) at harvest		Effective tillers (no./m) at harvest		DMA (g/plant) at 60 DAS		Grain yield (t/ha)		Straw yield (t/ha)	
	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16
Pendimethalin 500 g/ha as PE	89.9	85.6^{a}	50.4^{b}	66.4^{c}	9.46	9.95	2.42^{b}	2.87^{c}	4.20^{b}	5.40^{c}
2,4-D 750 g/ha as PoE	89.6	86.5^{a}	48.0^{b}	63.3^{c}	8.89	10.8	2.69^{b}	2.27^{de}	4.87^{b}	5.10^{c}
Metsulfuron-methyl 4.0 g/ha as PoE	87.6	88.1^{a}	43.3^{b}	60.1^{c}	9.90	10.5	2.36^{b}	2.62^{cd}	4.67^{b}	5.21^{c}
Clodinafop-propargyl 60 g/ha as PoE	91.4	88.5^{a}	84.5^{a}	58.7^{c}	9.88	9.97	3.71^{b}	2.24^{e}	6.38^{a}	4.35^{d}
Sulfosulfuron 25 g/ha as PoE	90.3	85.8^{a}	97.1^{a}	84.6^{ab}	9.87	10.3	3.76^{a}	3.89^{b}	6.64^{a}	6.21^{b}
Sulfosulfuron (75%) + metsulfuron methyl (5%) WG 32 g/ha as PoE	91.3	85.9^{a}	99.5^{a}	97.8^{a}	9.88	10.5	4.27^{a}	4.38^{a}	6.89^{a}	6.68^{ab}
Clodinafop (15%) + metsulfuron-methyl (1%) WP 64 g/ha as PoE	91.0	87.9^{a}	92.9^{a}	98.1^{a}	9.45	10.7	4.35^{a}	4.55^{a}	6.89^{a}	6.88^{a}
Mesosulfuron (3%) + iodosulfuron (0.6%) WDG 14.4 g/ha as PoE	89.9	78.5^{b}	92.6^{a}	81.3^{b}	9.05	9.18	3.93^{a}	3.95^{b}	6.67^{a}	6.23^{ab}
Hand weeding at 20 40 DAS	92.8	85.3^{a}	83.3^{a}	88.0^{ab}	9.99	10.5	3.95^{a}	4.22^{ab}	6.71^{a}	6.51^{ab}
Weedy check	94.7	86.5^{a}	46.1^{b}	38.1^{d}	9.68	10.2	1.61^{c}	1.48^{f}	3.91^{b}	3.50^{e}
LSD (p=0.05)	NS	3.57	Sig.	Sig.	NS	NS	Sig.	Sig.	Sig.	Sig.

Letters in common are not significant by Duncan's new multiple range test at 5% level of significance

as post-emergence in 2015-16. The lowest plant height under mesosulfuron (3%) + iodosulfuron (0.6%) 14.4 g/ha was mainly due to their phototoxic effect on plant after their application. Number of effective tillers differed significantly due to different herbicidal treatment in both the years. All the pre-mixed herbicidal treatments and alone application of clodinafop-propargyl, sulfosulfuron as well as twice hand weeding treatment remained at par with each other but found significantly superior over rest of the treatments. The lowest number of tillers was recorded under weedy check treatment during both the years. Dry matter accumulation recorded at 60 DAS was found to be non-significant due to different weed management practices, though the marginally low dry matter accumulation/plant was recorded under pre-mix broad spectrum post-emergence application of mesosulfuron (3%) + iodosulfuron (0.6%) 14.4 g/ha due to their phytotoxic effect on plant at seven days after application.

Grain and straw yields were significantly affected by different herbicidal treatment wherein, all three pre-mixed herbicidal treatment, alone sulfosulfuron 25 g/ha as post-emergence and twice hand weeding treatment recorded significantly higher grain yield than pendimethalin 500 g/ha, 2,4-D 750 g/ha, metsulfuron-methyl 4.0 g/ha, clodinafop-propargyl 60 g/ha and weedy check during 2014-15. While post-emergence application of clodinafop (15%) + metsulfuron-methyl (1%) 64 g/ha, sulfosulfuron (75%) + metsulfuron-methyl (5%) 32 g/ha and twice hand weeding treatment recorded significantly higher grain yield as compared to rest of the treatments in 2015-16 except twice hand weeding, which was at par with treatment of sulfosulfuron 25 g/ha as PoE applied alone.

The present investigation conclusively inferred that application of clodinafop plus metsulfuron-methyl 64 g/ha or sulfosulfuron plus metsulfuron-methyl 32 g/ha as post-emergence application (25-30 DAS) or hand weeding at 20 and 40 days after sowing provided excellent control of mixed weed flora with better yield of wheat.

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