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RESEARCH ARTICLE

Management of complex weed flora in wheat by herbicide combinations

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ABSTRACT

A field experiment was conducted during 2014-15 and 2015-16 to evaluate the efficacy of pre- and post-emergence herbicides and their combination against complex weed flora in wheat. Twelve treatments consisted with ten herbicidal treatments, pre-emergence application of pendimethalin 0.75 kg/ha, metribuzin 0.21 kg/ha, post-emergence application of sulfosulfuron 0.025 kg/ha, clodinafop 0.06 kg/ha, pendimethalin + metribuzin (1 + 0.175 kg/ha), pendimethalin *fb* sulfosulfuron (1 *fb* 0.018 kg/ha), sulfosulfuron + metsulfuron-methyl (0.03 + 0.002 kg/ha), pinoxaden + metsulfuron-methyl (0.06 + 0.004 kg/ha), mesosulfuron + iodosulfuron-methyl (0.012 + 0.0024 kg/ha), clodinafop + metsulfuron-methyl (0.06 + 0.004 kg/ha), two hand weeding at 30 and 60 days after sowing (DAS) and weedy check, were tested in randomized block design with three replications. Two hand weeding at 30 and 60 DAS recorded significantly reduced weed density and weed dry matter at 60 DAS with weed control efficiency of 85.26% and 84.14%, respectively. However, application of sulfosulfuron + metsulfuron resulted in maximum grain yield of 4.58 and 4.54 t/ha, net return of ₹ 51396 and 51136/ha and B:C ratio of 3.26 and 3.24, respectively in both the years compared to other herbicide applications. Thus, it may be concluded that for higher productivity and weed control, application of sulfosulfuron + metsulfuron (0.03 + 0.002 kg/ha) was found to be the best practice among the various herbicidal combinations.

Keywords: Economics, Sulfosulfuron + metsulfuron, Weed control efficiency, Wheat, Yield

INTRODUCTION

Wheat (*Triticum aestivum* L.) is widely grown as winter cereal and is the backbone of food security in India. Many factors affect the yield, weed infestation is one of the major causes of reduced yield. Weeds compete with crop species for water, nutrients and light leading to stunted plant growth and reduction in crop yield (Cudney *et al*. 2001). Therefore, suitable weed management practices are vital to produce optimum yields. Among different weed management practices, chemical weed control is preferred (Chaudhari *et al.* 2017) due to less labour availability. Though the chemical method is being discouraged worldwide, farmers in countries like India cannot ignore its immediate effect and economic returns. The application of herbicide is more effective as the weeds even within the rows are killed which escape, because of morphological similarity to wheat. The tank mixture of combination of isoproturon and 2,4-D have been recommended for complex weed flora in wheat but this combination has been effective in the situation where isoproturon was effective against *Phalaris minor* (Alhammad *et al*. 2023). This mixture was not so effective against complex weed flora dominated by other weeds (Patel *et al*. 2017). Under such situations, a proper combination of clodinafop with some broad-spectrum herbicides like sulfosulfuron and metribuzin was needed (Meena *et al.* 2019). Hence, the present experiment was carried out to evaluate the efficacy of pre- and post-emergence herbicides and their combination against diverse weed flora, productivity as well as profitability of wheat.

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MATERIALS AND METHODS

A field experiment was conducted in research farm of Dr. Rajendra Prasad Central Agricultural University, Pusa, during winter season of 2014-15 and 2015-16 to find out the effect of herbicides on weed dynamics and productivity of wheat. The treatments consisted of ten herbicidal treatments, pre-emergence application of pendimethalin 0.75 kg/ha, metribuzin 0.21 kg/ha, post-emergence application of sulfosulfuron 0.025 kg/ha, clodinafop 0.06 kg/ha, pendimethalin + metribuzin (1 + 0.175 kg/ha), pendimethalin followed by (*fb*) sulfosulfuron (1 *fb* 0.018 kg/ha), sulfosulfuron + metsulfuron-methyl (0.03 + 0.002 kg/ha), pinoxaden + metsulfuron-methyl (0.06 + 0.004 kg/ha), mesosulfuron + iodosulfuron-methyl (0.012 + 0.0024 kg/ha), clodinafop + metsulfuron-methyl (0.06 + 0.004 kg/ha), two hand weeding at 30 and 60 DAS and weedy check. The experiment was laid out in a randomized block design with three replications. The experimental soil was low in nitrogen (271 kg/ha) and

medium in phosphorus (17.89 kg/ha) and potassium (142.3 kg/ha). Recommended dose of fertilizer 120:60:40 kg N, P and K/ha, respectively, was applied through urea, di-ammonium phosphate and muriate of potash. Half of the nitrogen, full dose of phosphorus and potassium were applied before sowing. Remaining half of nitrogen was applied in two equal splits at crown root initiation and maximum tillering stages of crop. Crop was sown at spacing of 20 cm on 21st November 2014 and 04th December 2015, and harvested on 22nd April 2015 and 26th April 2016, respectively. The weed density was recorded 60 DAS using a quadrat of 0.25 square meter (0.5 × 0.5 m), and data obtained were expressed as density (number/m^2). The percent composition of weed flora was estimated from weedy check plot. To record weed biomass weeds were cut at ground level, washed with tap water, sun-dried in hot air oven at 70 °C for 48 hrs and then weighed. For the statistical analysis weed density and biomass were converted to 1 m^2 and imposed square root transformation by using formula $(\sqrt{x + 0.5})$ before analysis to normalize their distribution. Economic analysis was carried out by including all the variable costs (rhizome, manure, chemicals, labour, mulch materials) and their respective units used during the experiment. The prevalent market price of the produce was considered to calculate gross and net return and finally benefit–cost ratio was calculated. Statistical analysis was done by adopting appropriate method of Analysis of Variance (Gomez and Gomez 1984) and mean comparisons were performed based on the least significant difference (LSD) at 0.05 probability.

RESULTS AND DISCUSSION

The dominant weed species observed in the experimental field were *Avena fatua, Cynodon dactylon, Phalaris minor, Cyperus rotundus, Anagallis arvensis, Chenopodium album, Cirsium arvense, Convolvulus arvensis, Eclipta alba, Fumaria parviflora, Lathyrus aphaca, Launia pinnatifida, Melilotus alba, Physalis minima, Rumex dentatus* and *Vicia hirsute.*

Weed density, dry matter and weed control efficiency

Two hand weeding at 30 and 60 DAS in wheat crop recorded significantly reduced weed density as well as weed dry matter (**Table 1**) and was at par with post-emergence application of sulfosulfuron + metsulfuron (0.03 + 0.002 kg/ha) and clodinafop + metsulfuron (0.06 + 0.004 kg/ha) during 2014-15 and 2015-16. Consequently, two hand weeding recorded maximum weed control efficiency (85.26, 84.14%) followed by post-emergence application of sulfosulfuron + metsulfuron (0.03 + 0.002 kg/ha) (75.62, 75.19%) respectively during both of the years. In general, significant reduction in weed dry weight with sulfosulfuron + metsulfuron application of might be due to more effectiveness in controlling broad spectrum weeds than others. Hence, pre-mix formulations of herbicide effectively manage the both group of weeds *i.e.* narrow and broadleaf due to their higher efficacy as compared to sole application of herbicide. This herbicide mixture works by interfering with the acetolactate synthase enzyme in plants, which prevents the development of essential amino acids such as isoleucine, leucine, and valine. It slows cell division and growth which results in drying of weeds and ultimately death of weed (Choudhary *et al.* 2021). Malekian *et al.* (2013) have also reported lower weed dry matter production and increase in weed control efficiency with use of herbicides in wheat.

Yield and economics

The weed control treatments resulted significant increase in grain yield as compared to unweeded

Table 1. Effect of weed control methods on weed dynamics in wheat

Treatment	Weed density/m^2 at 60 DAS		Weed biomass (g/m^2) at 60 DAS		Weed control efficiency (%)		Grain yield (t/ha)	
	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16
Pendimethalin 0.75 kg/ha	37	38	18.89	18.76	47.85	47.94	3.86	3.82
Sulfosulfuron 0.025 kg/ha	32	31	16.45	16.15	54.58	50.99	3.96	3.99
Metribuzin 0.21 kg/ha	40	39	19.27	19.12	46.80	46.94	3.82	3.80
Clodinafop 0.06 kg/ha	35	34.5	17.66	17.25	51.24	52.15	3.92	3.94
Pendimethalin + metribuzin (1 + 0.175 kg/ha)	30	29.5	14.82	14.30	59.08	60.32	4.05	4.08
Pendimethalin *fb* sulfosulfuron (1+ 0.018 kg/ha)	22	22.5	10.48	10.59	71.07	70.63	4.42	4.41
Sulfosulfuron + metsulfuron (0.03 + 0.002 kg/ha)	19	18.5	8.83	8.94	75.62	75.19	4.58	4.54
Pinoxaden+ metsulfuron (0.06 + 0.004 kg/ha)	22	22.5	10.73	10.92	70.38	69.69	4.37	4.39
Mesosulfuron + iodosulfuron (0.012 + 0.0024 kg/ha)	23	24	11.26	11.49	69.19	68.25	4.29	4.33
Clodinafop + metsulfuron (0.06 + 0.004 kg/ha)	21	21.5	10.25	10.04	71.7	72.14	4.44	4.45
2 hand weeding at 30 and 60 DAS	12	11	5.34	5.72	85.26	84.14	4.77	4.76
Un-weeded control	64	63	36.22	36.04	-	-	3.23	3.20
LSD (p=0.05)	3.89	4.38	2.35	2.64	-	-	0.28	0.30

Table 2. Effect of weed control methods on economics of wheat

Treatment	Gross return (₹/ha)		Net Return (₹/ha)		B:C ratio	
	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16
Pendimethalin 0.75 kg/ha	62444	61914	39464	38934	2.72	2.69
Sulfosulfuron 0.025 kg/ha	64273	64801	41090	41618	2.77	2.80
Metribuzin 0.21 kg/ha	61733	61592	38817	38676	2.69	2.69
Clodinafop 0.06 kg/ha	63515	63664	40145	40294	2.72	2.72
Pendimethalin + metribuzin (1 + 0.175 kg/ha)	65567	65868	41937	42238	2.78	2.79
Pendimethalin *fb* sulfosulfuron (1+ 0.018 kg/ha)	71651	71604	47891	47844	3.02	3.01
Sulfosulfuron + metsulfuron (0.03 + 0.002 kg/ha)	74191	73931	51396	51136	3.26	3.24
Pinoxaden+ metsulfuron (0.06 + 0.004 kg/ha)	70738	71128	43148	43538	2.56	2.58
Mesosulfuron + iodosulfuron (0.012 + 0.0024 kg/ha)	69690	70184	46750	47244	3.04	3.06
Clodinafop + metsulfuron (0.06 + 0.004 kg/ha)	71827	72103	48932	49208	3.14	3.15
2 hand weeding at 30 and 60 DAS	77754	78247	43384	43877	2.26	2.28
Un-weeded control	52483	52247	30113	29877	2.35	2.34
LSD (p=0.05)	4567	4499	4567	4499	0.20	0.19

control (3.23, 3.20 t/ha). The highest grain yield of wheat (4.77 and 4.76 t/ha) was recorded by the treatment two hand weeding which remained at par with post-emergence application sulfosulfuron + metsulfuron (4.58 and 4.54 t/ha) during both of the years (**Table 1**). This exhibited an increase of grain yield 47.7 and 48.7 % over unweeded control. The higher yield might be due to effective weed control which kept the crop almost weed free during entire crop growth period that markedly reduced the competition for the moisture, space, nutrients, light leading to enhanced crop growth by utilizing greater moisture and nutrients from soil layers (Tiwari *et al*. 2015).

The results revealed that during the year 2014-15, sulfosulfuron + metsulfuron (0.03 + 0.002 kg/ha) and clodinafop + metsulfuron (0.06 + 0.004 kg/ha) recorded maximum B:C ratio value of 3.26 and 3.14 respectively. Whereas, during the year 2015-16 sulfosulfuron + metsulfuron (0.03 + 0.002 kg/ha), clodinafop + metsulfuron (0.06 + 0.004 kg/ha) and mesosulfuron + iodosulfuron (0.012 + 0.0024 kg/ha) was recorded maximum B:C ratio of 3.24, 3.15 and 3.06 respectively. Moreover, post-emergence application of sulfosulfuron + metsulfuron (0.03 + 0.002 kg/ha) recorded 18.47 and 16.54% higher net returns as compared to two hand weeding at 30 and 60 DAS (**Table 2**). In hand weeded plots the cost of cultivation increased remarkably due to higher labour wages. Different herbicidal treatments are favour on higher economical return because it cut down the application cost as well as labour requirement and it has been supported by Kushwaha and Singh (2000).

From the present study, it was concluded that post-emergence application of sulfosulfuron 0.03 kg/ha + metsulfuron 0.002 kg/ha was as good as two hand weeding at 30 and 60 DAS for higher productivity and profitability of wheat.

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