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Herbicide combinations for control of complex weed flora in wheat

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Abstract

A field experiment was conducted during 2019-20 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 750 g/ha, metribuzin 210 g/ha, post-emergence application of sulfosulfuron 25 g/ha, clodinafop 60 g/ha, pendimethalin + metribuzin (1000+175 g/ha), pendimethalin fb sulfosulfuron (1000 fb 18 g/ha), sulfosulfuron + metsulfuron-methyl (30+2 g/ha), pinoxaden + metsulfuron-methyl (60+4 g/ha), mesosulfuron + iodosulfuron-methyl (12+2.4 g/ha) and clodinafop + metsulfuron-methyl (60+4 g/ha) along with two hand weeding at 30 & 60 DAS and weedy check, were tested in randomized block design with three replications. Two hand weeding recorded significantly reduced weed density and weed dry matter at 65 DAS with WCE of 96.22% and was similar to use of pendimethalin fb sulfosulfuron. This herbicide combination resulted in maximum plant height (100.98cm), number of effective spikes/m² (283.56), number of grains/spike (61.92), test weight (39.41g), grain yield (4.26 t/ha), net return (Rs. 38936/ha) and B:C ratio (2.01) compared to other herbicide applications.

Keywords: Chemical control, hand weeding, herbicide combination, weed control efficiency, wheat

Introduction

Wheat (*Triticum aestivum* L.) is widely grown as winter cereal and is the backbone of food security in India. During last four decades, wheat production and productivity have increased almost six times and it alone contributed about one-third of the total food grain production of India. It is grown in about 31.0 million ha area with production and productivity of 88.9 million tonnes and 2.87 t/ha, respectively (DES, 2015) [6]. Though the production and productivity of wheat have increased in the country during the last five years, but production and productivity levels are still low in Bihar as compared to other wheat growing states. There are many factors which affect the wheat yield, but weed infestation is one of the most serious causes of low yields of wheat. The reduction in yields is mainly due to severe competition between weeds and crop plants for moisture, nutrient, light and space (Cudney *et al.* 2001) [5]. Severe competition of grassy weeds like *Phalaris minor* caused 30-80% reduction in grain yield of wheat (Brar and Walia 2008) [3]. The studies of Angiras *et al.* (2008) [2] and Kumar *et al.* (2011) [7] revealed that if the weeds are not controlled at the critical stages of crop growth, they may cause reduction in yield up to 66%. Therefore, effective weed management is necessary to produce optimum yields. Among different weed management practices chemical weed control is mostly preferred because of less labour involvement and no mechanical damage to the crop that happens during manual weeding (Marwat *et al.* 2008) [8]. Hand weeding though considered being the most effective weed management method but it is never an economical weed control method (Akhtar *et al.* 2000) [1]. Though the chemical method is being discouraged worldwide, its immediate effect and economic returns cannot be ignored totally by the farmers of countries like India. Therefore, the present experiment was carried out to evaluate the efficacy of pre and post-emergence herbicides and their combination to tackle the ever increasing problem of complex weed flora and productivity as well as profitability in wheat production.

Materials and methods

To study the effect of herbicides on weed dynamics and productivity of wheat under Bihar situation, a field experiment was carried out at BAU farm, Sabour, Bihar, India. The soil of the experimental plot was sandy loam having pH 7.8, organic carbon 0.54%, low in available Nitrogen (179.46 kg/ha), Phosphorus (29.3 kg P₂O₅/ha) and Potassium (194.5 kg K₂O/ha). The wheat variety 'HD2967' was sown on November 24, 2019 in 5.0 x 4.0 m plots with seed rate 100 kg/ha by seed drill machine in rows 20.0 cm apart. The crop was raised with all recommended package of practices except the herbicidal treatments. The experiment was laid

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out in a randomized block design, replicated three times, and consisted of 12 treatments including four treatment as pendimethalin 750 g/ha, metribuzin 210 g/ha as pre-emergence (PE); sulfosulfuron 25 g/ha, clodinafop 60 g/ha as post-emergence (PoE) used individually and six of different herbicidal combinations as pendimethalin + metribuzin (1000+175)g/ha (PoE), pendimethalin fb sulfosulfuron (1000 fb 18)g/ha (PE fb PoE), sulfosulfuron + Metsulfuron-methyl (30+2)g/ha (PoE), pinoxaden + metsulfuron-methyl (60+4)g/ha (PoE), mesosulfuron + iodosulfuron-methyl (12+2.4)g/ha (PoE) and clodinafop + metsulfuron-methyl (60+4)g/ha (PoE) along with two hand weedings at 30 & 60 DAS and weedy check. The recommended dose of fertilizers i.e. 150-60-40 kg N- P₂O₅- K₂O/ha was applied. Half dose of Nitrogen and full dose of Phosphorus and Potassium were applied as basal and remaining dose of Nitrogen was applied in two equal splits at active tillering and spikes initiation stages respectively in all plots. Herbicides were applied with the help of Knapsack sprayer fitted with flat fan nozzle. Observations on weed density and dry matter of weeds were recorded from 1.0 m² quadrat in each plot to determine weed density and dry weight of weeds at 65 DAS. Yield attributes and grain yield was recorded at harvest which was statistically analysed.

Results and discussion

Effect on yield and yield attributed characters of crop

The data presented in table 1 revealed that the yield attributing traits, viz. plant heights, number of effective spikes/m², number of grains/spike, test weight including grain yield were affected significantly due to weed control treatments. These attributes attained the poorest values under weedy check plots. The higher yield and yield attributes were owing to superior weed control both in terms of reduction in density and biomass of weeds. Chaudhry *et al.* (2008) [4] also found that the grain yield of wheat was significantly increased by use of different chemicals for weed control as compared with weedy check. Two hand weedings at 30 & 60 DAS resulted in maximum plant height (101.32 cm), number of effective spikes/m² (287.77), number of grains/spike (63.32), test weight (39.76g) and grain yield (4.49 t/ha). Among herbicidal treatments, maximum plant height (100.98cm), number of effective spikes/m² (283.56), number of grains/spike (61.92), test weight (39.41g) and grain yield (4.26 t/ha) were obtained with the use of pendimethalin as pre-emergence fb post-emergence application of sulfosulfuron (1000 fb 18 g/ha) followed by use of mesosulfuron + iodosulfuron-methyl (12+2.4 g/ha) and clodinafop + metsulfuron-methyl (60+4 g/ha).

Table 1: Effects of weed management practices on yield attributes and yield in Wheat.

Herbicides	Plant height (cm)	Effective spike /m ²	No. of grains/spike	Test weight (g)	Yield (t/ha)
T1 Pendimethalin 750 g/ha as PE	95.97	260.49	56.57	36.09	3.19
T2 Metribuzin 210 g/ha as PE	95.69	257.52	56.14	35.68	2.95
T3 Sulfosulfuron 25 g/ha as PoE	96.56	263.32	57.16	36.82	3.38
T4 Clodinafop 60 g/ha as PoE	97.94	267.70	58.35	37.54	3.58
T5 Pendimethalin +Metribuzin (1000+175 g/ha) as PE	98.25	264.65	58.24	37.10	3.43
T6 Pendimethalin fb sulfosulfuron (1000 fb 18 g/ha) as PE fb PoE	100.98	283.56	61.92	39.41	4.26
T7 Sulfosulfuron +Metsulfuron-methyl (RM) (30+20 g/ha) as PoE	98.69	272.89	59.36	38.22	3.75
T8 Pinoxaden+Metsulfuron-methyl (Premix) (60+4 g/ha) as PoE	99.38	270.34	59.25	37.78	3.61
T9 Mesosulfuron+Iodosulfuron-methyl (RM) (12+2.4 g/ha) as PoE	100.56	278.71	61.81	38.84	4.17
T10 Clodinafop + Metsulfuron-methyl (RM) (60 + 4 g/ha) as PoE	100.02	276.45	59.54	38.45	3.93
T11 Two hand weedings (30 & 60 DAS)	101.32	287.77	63.32	39.76	4.49
T12 Un-weeded control	94.26	234.84	44.64	35.12	2.52
S. Em±	5.70	10.04	1.78	1.59	0.14
CD (P=0.05)	NS	27.33	5.62	NS	0.47

Effect on weeds

Wheat field was infested with both grassy and broadleaved weeds. However, the flora was dominated by grassy weeds (*Phalaris minor*, *Cynodon dactylon*, *Avena fatua* and *Polygonum plebium*). The density and dry mater of weeds decreased significantly due to all treatments as compared to un-weeded control plot (density 9.25 m⁻² and dry mater 7.53 g/m²) at 65 DAS. (Table 2). The lowest weed density (2.42 m⁻²) and weed dry weight (1.62 g/m²) was recorded in cultural method of weed control where two hand weeding were done at 30 and 60 DAS. The highest weed control efficiency of

96.22% was recorded with two hand weedings at 30 and 60 DAS. It was followed by the herbicide combinations of pendimethalin as pre-emergence fb post-emergence application of sulfosulfuron (81.21%) and mesosulfuron + iodosulfuron-methyl (79.93%). Alone application of herbicidal treatments did not show any efficient weed control. Among all herbicidal treatments herbicide combination of pendimethalin fb sulfosulfuron also showed lowest weed index (5.02%) followed by mesosulfuron+ iodosulfuron-methyl (7.04%). Alone application of Metribuzin 210 g/ha as PE showed highest weed index (34.15%).

Table 2: Effects of weed management practices on weed flora, WCE% WI% in wheat.

Herbicides	Weed density/m ² (65 DAS)	Weed biomass (g/m ²) (65 DAS)	WCE (%) (65 DAS)	WI (%)
T1 Pendimethalin 750 g/ha as PE	31.95(5.70)	20.96(4.63)	62.67	28.98
T2 Metribuzin 210 g/ha as PE	32.02(5.70)	21.35(4.67)	61.98	34.15
T3 Sulfosulfuron 25 g/ha as PoE	31.19(5.63)	20.22(4.55)	63.99	24.73
T4 Clodinafop 60 g/ha as PoE	27.82(5.32)	18.77(4.39)	66.57	20.09
T5 Pendimethalin +Metribuzin (1000+175 g/ha) as PE	26.36(5.18)	18.34(4.34)	67.34	23.56
T6 Pendimethalin fb sulfosulfuron (1000 fb 18 g/ha) as PE fb PoE	16.13(4.08)	10.55(3.32)	81.21	5.02
T7 Sulfosulfuron +Metsulfuron-methyl (RM) (30+20 g/ha) as PoE	24.98(5.05)	16.48(4.12)	70.65	16.38
T8 Pinoxaden+Metsulfuron-methyl (Premix) (60+4 g/ha) as PoE	24.85(5.03)	16.36(4.11)	70.86	19.56

T9	Mesosulfuron+Iodosulfuron-methyl (RM) (12+2.4 g/ha) as PoE	17.14(4.20)	11.27(3.43)	79.93	7.04
T10	Clodinafop + Metsulfuron-methyl (RM) (60 + 4 g/ha) as PoE	21.74(4.72)	14.31(3.85)	74.51	12.43
T11	Two hand weedings (30 & 60 DAS)	5.36(2.42)	2.12 (1.62)	96.22	-
T12	Un-weeded control	85(9.25)	56.15(7.53)	-	43.87
	S. Em±	1.54	1.78	-	-
	CD (P=0.05)	4.62	4.16	-	-

Data subjected to sq.root ($\sqrt{x+0.5}$) transformation. Figure in parentheses are Transformed value.

Economics

All the weed control treatments were significantly superior over un-weeded control plot in terms of monetary returns (Table 3). The highest gross return and net return (Rs.81426/ha and Rs.39526/ha) were fetched under two hand weeding performed at 30 and 60 DAS, and also maximum cost of cultivation (Rs.41900/ha) was recorded due to extra

labour cost. While among herbicide applications, pendimethalin as pre-emergence fb post-emergence application of sulfosulfuron recorded maximum gross and net return which was due to minimum yield loss percentage, and also recorded maximum B:C ratio (2.01) among all the treatments. Alone application of metribuzin 210 g/ha recorded minimum gross return, net return and B:C ratio.

Table 3: Effects of weed management practices on cost of cultivation, gross return, net return and benefit: cost ratio in wheat.

	Herbicides	Cost of cultivation (Rs./ha)	Gross return (Rs./ha)	Net return (Rs./ha)	B:C ratio
T1	Pendimethalin 750 g/ha as PE	37500	57832	20332	1.54
T2	Metribuzin 210 g/ha as PE	37000	53619	16619	1.45
T3	Sulfosulfuron 25 g/ha as PoE	37600	61290	23690	1.63
T4	Clodinafop 60 g/ha as PoE	37600	65067	27467	1.73
T5	Pendimethalin +Metribuzin (1000+175 g/ha) as PE	37650	62240	24590	1.65
T6	Pendimethalin fb sulfosulfuron (1000 fb 18 g/ha) as PE fb PoE	38400	77336	38936	2.01
T7	Sulfosulfuron +Metsulfuron-methyl (RM) (30+20 g/ha) as PoE	38000	68089	30089	1.79
T8	Pinoxaden+Metsulfuron-methyl (Premix) (60+4 g/ha) as PoE	37300	65496	28196	1.76
T9	Mesosulfuron+Iodosulfuron-methyl (RM) (12+2.4 g/ha) as PoE	38600	75691	37091	1.96
T10	Clodinafop + Metsulfuron-methyl (RM) (60 + 4 g/ha) as PoE	37900	71308	33408	1.88
T11	Two hand weedings (30 & 60 DAS)	41900	81426	39526	1.94
T12	Un-weeded control	35400	45707	10307	1.29
	S. Em±	-	3112	2017	0.10
	CD (P=0.05)	-	9107	6109	0.26

Conclusion

It has been concluded that application of, pendimethalin as pre-emergence fb post-emergence application of sulfosulfuron (1000 fb 18 g/ha) was as good as two hand weedings performed in wheat at 30 and 60 DAS for better weed control, higher crop yields and benefits.

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