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Weed Management through Tank Mix and Premix Herbicides in Late Sown Wheat (*Triticum aestivum* L.)

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A B S T R A C T

Wheat crop is primarily grown in temperate regions and also at higher altitude under tropical climatic areas in winter season. It is the single most important cereal crop that has been considered as integral component of the food security system of the several nations. The productivity wheat in eastern Uttar Pradesh is very low which might be due to the adoption of cereal- cereal (Rice-Wheat) cropping system, Irrigation, poor weed management, poor soil health and imbalance fertilizer used. A field experiment was conducted during *rabi* season 2015-16 at the Agronomy Research Farm, Narendra Deva University of Agriculture and Technology, Ayodhya comprising 10 treatment, i.e. Pendimethalin @ 0.75 kg a.i. ha^{-1}, Sulfosulfuron @0.025 kgkg a.i. ha^{-1}, Metribuzin @0.21 kg a.i. ha^{-1}, Clodinafop @0.06 kg a.i. ha^{-1}, Pendimethalin + metribuzin @1.0+0.175 kg a.i. ha^{-1}, Pendimethalin *fb* sulfosulfuron @1.0+0.018 kg a.i. ha^{-1}, Sulfosulfuron+metsulfuron @0.03+0.002 kg a.i. ha^{-1}, Clodinafop$_+$ metsulfuron(Premix) @0.06+0.004 kg a.i. ha^{-1}, Weed free and Un-weeded control with three replications in RBD design. The experimental site was predominantly infested with different weed species belonging to different families such as grasses, broadleaved weeds and sedges. The application of pendimethalin (PE) *fb* metribuzin (PoE) @ 1.0+0.175 kg a.i. ha^{-1}recorded minimum density and dry weight of weed followed by post emergence application of pendimethalin *fb* sulfosulfuron @ 1.0+0.018 kg a.i. ha^{-1}. Control treatment has high weed growth throughout the crop growing period leads for the reduction yield. Based on the results, it can be concluded that application pendimethalin (PE) *fb* metribuzin (PoE) @ 1.0+0.175 kg a.i. ha^{-1} enhanced the weed control efficiency and also an effective weed management practice with respect to yield and cost of cultivation.

Introduction

Wheat (*Triticum aestivum L.*) is staple food of the world and falls under poaceae family. It is eaten in various forms more than one thousand million human being in the world. In the terms of production wheat occupies the prime position among the food crop in the world. About 91 percent of the total wheat production is contributed by northern states. Among them Uttar Pradesh rank first with respect to area 9.67 m ha and production 33.66 Mt, but the productivity is much lower 3.48 t ha^{-1} as compared to Punjab and Haryana 4.50 t h^{-1} (Anonymous, 2018). Weeds are considered as one of the major constraints in wheat cultivation. Which comparatively require larger amount of water and fertilizers, have created conducive condition for luxuriant growth of weeds with high density. A number of herbicides especially isoproturon and 2,4-D have been tested to control the different weed species in wheat and become every popular among the farmers but now the certain weed species are not being controlled effectively by these herbicides might be due to shifting of weed flora and sort of tolerance be develop in *P. minor*. Now-a-day, a number of high potency herbicides molecules have been developed which proved highly efficient to control the different type of weed flora in wheat. In addition to this to widen the bio-efficiency of herbicide molecules to control the different types of weed flora, a mixture of two or more herbicides mixtures (ready mixed and tank mixed) are also available in the market and being used by the farmers. These new generation herbicides may be proved more effective to control various weed species as well as relatively safer for environmental pollution point of view. By considering these valid issues, the present investigation was under taken to evaluate the effective and economic Weed management through tank mix and premix herbicides in late sown wheat.

Materials and Methods

A field experiment was conducted during rabi, 2015 at Agronomy Research Farm, Narendra Deva University of Agriculture and Technology, Ayodhya. The experimental soil was sandy clay loam with a pH of 7.01, low in nitrogen, medium in phosphorus, high in potassium. The experiment was laid out in randomized block design with eleven treatments and replicated thrice. The treatments involving pre-emergence herbicide viz., Pendimethalin @ 0.75 kg a.i. ha^{-1}, Sulfosulfuron @0.025 kgkg a.i. ha^{-1}, Metribuzin @0.21 kg a.i. ha^{-1}, Clodinafop @0.06 kg a.i. ha^{-1}, Pendimethalin + metribuzin @1.0+0.175 kg a.i. ha^{-1}, Pendimethalin *fb* sulfosulfuron @1.0+0.018 kg a.i. ha^{-1}, Sulfosulfuron+metsulfuron @0.03+0.002 kg a.i. ha^{-1}, Clodinafop$_+$ metsulfuron(Premix) @0.06+0.004 kg a.i. ha^{-1}, Weed free and Un-weeded control. Pre-emergence pendimethalin @ 0.75 kg ha^{-1} applied on 3rd day after sowing and post-emergence Sulfosulfuron @ 0.025 kg ha^{-1}, Clodinafop @ 0.06kg ha^{-1} and Sulfosulfuron+metsulfuron (Total) @ 0.03 + 0.02 kg ha^{-1}, were applied at 30days after sowing of crop. Herbicides were sprayed with the help of manually operated knapsack sprayer fitted with that flat fan nozzle using 600 litres water per hectare. Observations on weed density were recorded with the help of a quadrant 0.25m2 placed randomly at four place in each plot. The growth, yield attributes and yields were recorded from five selected plants in each plot. The treatment differences were worked out at five per cent probability level.

Weed control efficiency (WCE) Weed control efficiency was calculated as per the procedure given by Mani et al. (1973).

WCE (%) = WDWc – WDWt /100 ×WDWc

Where, WCE - Weed control efficiency in percentage

WDWc - Dry weight (g/m2) of weeds in unweeded check

WDWt - Dry weight (g/m2) of weeds in weed control treatments

Results and Discussion

Weed flora

Weeds are considered as one of the major constraints in wheat cultivation. Which comparatively require larger amount of water and fertilizers, have created conducive condition for luxuriant growth of weeds with high density. The prominent weeds noted in wheat are *Phalaris minor, Cynodon dactylon, Cyperus rotundus, Anagallis arvensis, Chenopodium, album, Polygonium plebejum, Vicia sativa* and *Melilotus indica*. Weed infestation in wheat causes heavy reduction in crop yield ranging from 15 to 50% (Gill and Brar, 1975), which may be minimized to a greater extent simply by adopting an appropriate weed management practices.

Effect of initial plant population, length of ear, No. of grains ear^{-1} and test weight

The initial plant population was not affected significantly by various herbicides application as the herbicides were applied pre emergence at 15 days after sowing. The length of ear head increased significantly with weed control treatments. The largest ear head length of 9.10 cm was recorded with weed free which was at par with Pendimethalin + metribuzin @ 1.0+0.175 kg ha^{-1}, pendimethalin fb sulfosulfuron @ 1.0+0.018 kg ha^{-1} and Sulfosulfuron+metsulfuron @ 0.03+0.002 kg ha^{-1}. Amongst herbicide treatments Clodinafop @ 0.06 kg ha^{-1} recorded the lowest length of ear head (7.1cm) against longest spike length of (9.1cm) noted with weedy check. The number of grains^{-1} ear was found significantly more under all the weed control treatments as compare to weedy check. Weed free produced highest number of 43.90 grains spike^{-1} being at par with Pendimethalin+metribuzin @ 1.0+0.175 kg ha^{-1}, pendimethalin fb sulfosulfuron @ 1.0+0.018 kg ha^{-1} (42.5 and 41.5) respectively but significantly superior to the rest of treatments. The lowest grains earhead^{-1} (33.1) was recorded in unweeded plot. The weed control treatments increased the test weight not significantly as compare to un-weeded control. The highest test weight of 40.15g was recorded with weed free (39.80g) closely followed by Pendimethalin+ metribuzin @ 1.0+0.175 kg ha^{-1}.

Effect of weed density and dry weight at 90 DAS

Amongst various herbicides treatments Pendimethalin + metribuzin @ 1.0+0.175 kg ha^{-1} as pre emergence has been found most effective to reduce the population of almost all species of weed flora followed by Pendimethalin fb sulfosulfuron @ (1.0+0.018) kg ha^{-1} as post emergence and both the treatments were found significantly better to control weeds of different species as compared to weedy check and other weed control treatments. The maximum weed dry weight of 18.54 g m^{-1} and minimum weed dry weight of 5.91 g m^{-1} was recorded in un-weeded control and Pendimethalin + metribuzin (1.0+0.175) kg a.i. ha^{-1} respectively.

Weed control efficiency

All the herbicides resulted more than 77% weed control efficiency and the highest W.C.E. of 94.53% was recorded with pre emergence application of Pendimethalin + metribuzin @ 1.0+0.175 kg ha^{-1} closely followed by post emergence of Pendimethalin fb sulfosulfuron @ 1.0+0.018 kg ha^{-1} of

94.36% while minimum efficiency of 77.37% was recorded with Clodinafop 0.06 kg ha^{-1}.

Weed index

The weed index which denotes the percent reduction in grain yield as compare to weed free plot indicate that infestation of weed reduced the grain yield of wheat by 31.51% and the reduction in grain yield was reduced with control of weeds through herbicides ranging from 10.45% to 28.85%. The minimum reduction in grain yield was noted with pre emergence application of Pendimethalin + metribuzin @ 1.0+0.175 kg ha^{-1} followed by Pendimethalin fb sulfosulfuron @ 1.0+0.018 kg ha^{-1}.

Nitrogen content in grain and protein content was not affected significantly by various herbicidal treatments. However higher content of 1.82% was noted with weed free against lowest content of 1.69% of the weedy check. The highest cost of cultivation of Rs 28150 ha^{-1} was incurred under weed free against the lowest cost of cultivation of Rs.24150ha^{-1} of weedy check. All the treatments higher gross return, net return and benefit cost ratio over weedy check.

Table.1 Effect of initial plant population, length of ear head, No. of grains ear-1 and test weight

Treatment		**initial plant population**	**length of ear head**	**No. of grains ear^{-1}**	**test weight**
T_1	Pendimethalin @ (0.75) kg a.i. ha^{-1}	167.7	7.2	35.2	**38.4**
T_2	Sulfosulfuron @ (0.025) kg a.i. ha^{-1}	168.56	7.4	36.3	**39.0**
T_3	Metribuzin @ (0.21) kg a.i. ha^{-1}	167.76	7.3	35.5	**38.6**
T_4	Clodinafop @ (0.06) kg a.i. ha^{-1}	166.75	7.1	37.6	**38.2**
T_5	Pendimethalin + metribuzin @ (1.0+0.175) kg a.i. ha^{-1}	171.61	8.9	42.5	**39.8**
T_6	Pendimethalin fb sulfosulfuron @ (1.0+0.018) kg a.i. ha^{-1}	170.87	8.8	41.5	**39.4**
T_7	Sulfosulfuron+metsulfuron @ (0.03+0.002) kg a.i. ha^{-1}	169.89	8.7	40.7	**39.2**
T_8	Clodinafop + metsulfuron @ (0.06+0.004) kg a.i. ha^{-1}	169.69	8.5	43.6	**39.2**
T_9	Weed free	173.84	9.1	43.9	**40.15**
T_{10}	Un-weeded control	166.17	8.3	33.1	**38.0**
	SEm ±	3.69	0.7	0.8	**1.92**
	CD at 5%	**NS**	**1.4**	**2.4**	**NS**

Table.2 Effect of weed control treatments on weed control efficiency and weed index

Treatment		Weed density at 90 DAS	Weed dry wt. (g) at 90 DAS	W.C.E. (%)	W.I. (%)
T_1	Pendimethalin @ (0.75) kg a.i. ha^{-1}	(92.45) 9.66	(87.13) 9.33	**73.18**	27.64
T_2	Sulfosulfuron @ (0.025) kg a.i. ha^{-1}	(91.9) 9.63	(69.81) 8.41	**78.51**	26.07
T_3	Metribuzin @ (0.21) kg a.i. ha^{-1}	(100.58) 10.07	(72.22) 8.55	**77.76**	27.59
T_4	Clodinafop @ (0.06) kg a.i. ha^{-1}	(111.22) 10.59	(93.71) 9.73	**71.15**	28.70
T_5	Pendimethalin + metribuzin @ (1.0+0.175) kg a.i. ha^{-1}	(51.81) 7.26	(33.93) 5.91	**89.55**	8.20
T_6	Pendimethalin fb sulfosulfuron @ (1.0+0.018) kg a.i. ha^{-1}	(55.78) 7.53	(40.73) 6.45	**87.46**	9.92
T_7	Sulfosulfuron+metsulfuron @ (0.03+0.002) kg a.i. ha^{-1}	(64.71) 8.10	(43.95) 6.7	**86.47**	13.73
T_8	Clodinafop + metsulfuron @ (0.06+0.004) kg a.i. ha^{-1}	(77.89) 8.88	(50.09) 7.14	**84.58**	17.81
T_9	Weed free	(0.00) 1.00	(0.00) 1.00	**100**	0
T_{10}	Un-weeded control	(178.24) 13.38	(324.87) 18.54	**0**	36.51
	SEm ±	1.81	1.02		
	CD at 5%	**4.12**	**2.76**		

* The value in parentheses are original values

** Value transformed by $\sqrt{x+1}$

Table.3 Effect of weed control treatments on yield and economic of production

Treatments	Nitrogen content in grain (%)	Protein content in grain (%)	Total cost of cultivation (`/ha)	Grain yield q/ha	Straw yield q/ha	Gross return (`/ha)	Net return (`/ha)	B:C ratio
T_1 Pendimethalin (0.75)	1.72	10.75	26120	30.9	51.63	64083	37963	1.45
T_2 Sulfosulfuron (0.025)	1.74	10.87	25550	33.0	53.91	67803	42253	1.65
T_3 Metribuzin (0.21)	1.73	10.81	25960	31.20	52.73	64808	38848	1.49
T_4 Clodinafop (0.06)	1.71	10.68	25550	30.26	50.37	62808	37258	1.45
T_5 Pendimethalin + metribuzin (1.0+0.175)	1.81	11.31	26300	40.70	60.37	80968	54668	2.08
T_6 Pendimethalin fb sulfosulfuron (1.0+0.018)	1.79	11.18	25970	39.50	59.03	79666	53696	2.07
T_7Sulfosulfuron+metsulfuron (0.03+0.002)	1.78	11.12	25610	38.60	58.15	77263	51653	2.02
T_8 Clodinafop + metsulfuron (0.06+0.004)	1.75	10.94	25890	39.9	57.6	70965	45075	1.74
T_9 Weed free	1.82	11.38	28150	43.10	63.32	81475	58325	1.89
T10Un-weeded control	1.69	10.56	24150	22.7	42.55	49513	25360	1.05
SEm ±	0.01	0.13	-	1.98	1.81	-	-	-
CD at 5%	NS	NS	-	5.82	5.32	-	-	-

The maximum gross income of Rs. 81475 ha^{-1} was obtained with weed free closely followed by Pendimethalin + metribuzin @ 1.0+0.175 kg ha^{-1} (Rs. 80968 ha^{-1}) against lowest gross income of Rs. 49513ha^{-1} of weedy check. Weed free recorded the highest net return of Rs. 58325 ha^{-1} closely followed by pre emergence application of Pendimethalin + metribuzin @ 1.0+0.175 kg ha^{-1} (Rs. 54668 ha^{-1}), post emergence application of pendimthalin fb sulfsulfuron @1.0+0.018 kg ha^{-1} (Rs. 53696 ha^{-1}) and against lowest net return of Rs. 25360 ha^{-1} noted with weedy check. Weed free as well as Pendimethalin + metribuzin @ 1.0+0.175 kg ha^{-1}, pendimthalin fb sulfsulfuron @1.0+0.018 kg ha^{-1} and Sulfosulfuron + metsulfuron @ 0.03+0.002 kg ha^{-1} treatments also recorded highest benefit cost ratio of 2.08,2.07 and 2.02 as compared to weedy check of 1.89.

In conclusion, application of pendimethalin fb metribuzin @ 1.0+0.175 kg a.i. ha^{-1} applied at 1-2 days after sowing and at 30 days after sowing respectively may be adopted in wheat crop to gain highest grain yield, B: C ratio and control of weeds.

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