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Weed dynamics, growth, yield and economics of wheat *(Triticum aestivum* L.) crop as affected by fenoxaprop-p-ethyl and clodinafop herbicides

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ABSTRACT

A field experiment was conducted at Agronomy Research Farm of Narendra Deva University of Agriculture and Technology, Kumarganj, Faizabad (U.P.) during winter (*rabi*) season of 2010-11 with an objective to find out the effect of fenoxaprop-p-ethyl and clodinafop on growth and yield of wheat and to study the effect of various doses of fenoxaprop-p-ethyl on *Phalaris minor* and weed control efficiency and to work out the economics of various treatments. The experiment was replicated thrice in randomized block design having ten number of treatments viz. fenoxaprop-p-ethyl 10% EC at 75, 100, 120, 150, 200 and 240 /ha, and clodinafop 60 g/ha with two checks – weedy and weed free. The crop was sown 20 cm apart by ferti-seed drill on 23 December, 2010 with the wheat variety Malviya-234. The density of narrow leaved and other weeds as well as dry weight were recorded significantly less with fenoxaprop 240 g *a.i.*/ha as compared to rest of the herbicidal treatments. All the growth and yield contributing characters viz. plant height, leaf area index, dry matter accumulation, number of shoots and spikes, spike length as well as grain and straw yields of wheat crop except test weight were significantly higher in weed free check and fenoxaprop (whipsuper) 120 g *a.i.*/ha. It can be concluded that fenoxaprop (whipsuper) 120 g *a.i.*/ha proved superior herbicide with respect to weed control, crop yield and monetary benefits in wheat followed by fenoxaprop 120 g *a.i.*/ha and clodinafop 60 g/ha.

Key words : *Clodinafop, Economics, Fenoxaprop-P-Ethyl, Growth, Herbicides, Weed dynamics, Wheat, Yield*

Introduction

Wheat (*Triticum aestivum* L.) is a staple food of the world. In India, it is cultivated on an area of 27.8 million ha with the total production of 80.6 million tonnes and productivity of 2900 kg/ha. Wheat is an important main *rabi* crop of Uttar Pradesh, contributing towards food security of the country to a large extent. Among the different wheat growing states in the country, Uttar Pradesh ranks first with respect to area (9.3 million ha) and production (25.0 million tonnes) but the productivity is much lower (2790 kg/ha) as compared to Punjab and Haryana (Anonymous, 2009). Furthermore in eastern U.P., the productivity is very low (2500 kg/ha) which might be due to the adoption of cereal-cereal (rice-wheat) cropping system, late sowing, poor weed management, imbalance fertilization etc. Among these causes of low productivity, reduction in wheat yield has been very substantial due to weeds. Yield reduction due to weeds in wheat lies between 15-50%, depending upon the weed density and type of

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weed flora (Azad, 2003). In wheat, acute problem of both grassy and broad leaf weeds is becoming very common in north India. The prominent weeds noted in wheat fields in Faizabad district were *Phalaris minor, Cyperus rotundus, Cynodon dactylon, Chenopodium album, Anagallis arvensis, Avena fatua, Convolvulus arvensis and Lathyrus aphaca* (Tripathi and Vaishya, 1997). *Phalaris minor* is one of the very serious problems in wheat in this cropping system and sometimes almost 100 per cent crop losses have been reported. Continuous use of isoproturon coupled with agronomic practices led to the evolution of resistant biotypes of *P. minor* (Malik and Singh, 1995). New herbicides recommended for the control of isoproturon resistant populations of *P. minor* vary in their efficacy on different weed species of wheat. Keeping all these facts in view, the present investigation was carried out to find out effective herbicide to control the weed flora in wheat crop.

Materials and Methods

The field experiment was conducted at Agronomy Research Farm of Narendra Deva University of Agriculture and Technology, Kumarganj, Faizabad (U.P.) during winter (*rabi*) season of 2010-11 with an objective to find out the effect of fenoxaprop-p-ethyl and clodinafop on growth and yield of wheat and to study the effect of various doses of fenoxaprop-p-ethyl on *Phalaris minor* and weed control efficiency and to work out the economics of various treatments. The soil of the experimental field was silt loam in texture having pH 7.9, organic carbon 0.33%, available N, P and K 181.3, 10.2 and 225.1 kg/ha, respectively. The experiment was replicated thrice in randomized block design having ten number of treatments viz. fenoxaprop-p-ethyl 10% EC at 75, 100, 120, 150, 200 and 240 g *a.i.*/ha, fenoxaprop (whipsuper) 120 g *a.i.*/ha and clodinafop 60 g/ha with two checks – weedy and weed free. The herbicide treatments were executed at 35 days after sowing of wheat crop with the help of manually operated knapsack sprayer fitted with flat fan nozzle using 600 litres of water/ha. The crop was sown 20 cm apart in lines by ferti-seed drill on 23 December, 2010 with the wheat variety Malviya-234. Species-wise and total numbers of weeds were recorded from three places selected at random in each plot at various stages. A quadrat of 50 cm × 50 cm size was used for recording the weed density and weeds within the quadrate were identified and counted and it was expressed in /m^2. Weed dry matter were recorded from three places selected randomly. After sun drying, weeds were dried in hot air oven at 70^{0}C ± 1^{0}C for 48 hours to obtain a constant weight. Observations on crop growth and yield were also recorded and economics of different treatments were calculated. The oven dried and thoroughly ground weed and crop samples were digested and nitrogen was determined by micro Kjeldahl method. The percentage of nitrogen content was multiplied by the respective total dry weight of weeds/crop to obtain nitrogen uptake.

Results and Discussion

Weed dynamics (flora and density) and weed growth (dry matter)

Among non-grassy weeds, *Chenopodium album* was the pre-dominant weed species and its density was found highest followed by *Melilotus alba* throughout the growing period of crop in weedy check plot. *Phalaris minor* was the pre-dominant weed species noticed throughout the growing period of the crop among grasses, which came up at 30 days stage of crop growth and continued till harvest of crop (Table 1). At 60 DAS, density of *P. minor* and other weeds was recorded significantly less due to fenoxaprop applied @ 240, 200 and 150 g *a.i.*/ha over rest of the treatments. However, fenoxaprop 120 g *a.i.*/ha of both formulation and clodinafop 60

Table 1. Spectrum of weed flora (density/m^2 and percentage) in weedy check at different stages of crop growth

Days after sowing	Weeds					
	Phalaris minor	*Chenopodium album*	*Melilotus alba*	*Anagallis arvensis*	Others	Total
30	25.3(17.6)	55.6(38.6)	31.2(21.7)	13.2(21.7)	18.7(1.0)	144.0
60	40.2(18.3)	83.7(38.1)	49.9(22.7)	23.8(10.8)	22.3(10.1)	219.9
90	35.1(14.3)	95.7(39.1)	62.5(25.5)	37.2(15.2)	14.1(5.8)	244.6
At harvest	18.7(7.5)	72.3(29.0)	145.8(58.4)	2.0(0.8)	10.8(4.3)	249.6

Values in parentheses are the percentage

g/ha, being at par with each other, decreased the density of *P. minor* and other weeds over lower dose of fenoxaprop. As far as the density of broad leaf weeds is concerned, it was found non-significant due to various herbicidal treatments as fenoxaprop and clodinafop are the narrow leaf weed killer (Table 2). Weed dry matter was significantly affected due to different treatments at all the stages except at 30 DAS. Significantly lowest weed dry weight was recorded with fenoxaprop 240 g *a.i.*/ha (statistically at par with fenoxaprop 200 g *a.i.*/ha at 60 DAS) at 90 DAS and harvest stage. Fenoxaprop @ 75, 100, 120 g *a.i.*/ha and clodinafop 60 g/ha were equally effective while highest and lowest weed dry weight were recorded with weedy and weed free check treatments, respectively. Malik *et al.* (2005) also reported that density and dry weight of weeds were significantly low due fenoxaprop and clodinafop herbicide which have a very close negative correlation between the weed density and dry weight and crop growth, yield contributing characters and yield.

Nitrogen uptake by weeds, weed control efficiency and weed index

Fenoxaprop (whipsuper) 120 g *a.i.*/ha, fenoxaprop 120 g *a.i.*/ha, clodinafop 60 g/ha and fenoxaprop 100 g *a.i.*/ha, being at par with each other, recorded significantly lowest nitrogen uptake by weeds over rest of the treatments whereas highest and lowest nitrogen uptake by weeds were recorded with weedy and weed free check treatments, respectively (Table 2). The highest weed control efficiency was recorded with fenoxaprop 240 g *a.i.*/ha (95.4%) which was very much comparable with weed free check treatment (100%). As weed index indicates reduction in grain yield due to weeds, it was found lowest with fenoxaprop (whipsuper) 120 g *a.i.*/ha (6.5) which was very much comparable with weed free treatment (0).

Table 2. Effect of various weed control treatments on dry matter of total weeds, nitrogen uptake by weeds, weed control efficiency and weed index in wheat crop

Treatments	Weed density (Number/m²) at 60 DAS						Dry matter of total weeds (g/m²)				Nitrogen uptake by weeds (kg/ha)	Weed control efficiency (%)	Weed index
	P. minor	*C. album*	*M. alba*	*A. arvensis*	Others	Total	30 DAS	60 DAS	90 DAS	At harvest			
Fenoxaprop 10% EC at 75 g *a.i.*/ha	3.0 (8.3)	8.9(78.7)	6.8(45.9)	4.7(21.9)	3.9(14.8)	13.0(169.6)	5.7(31.6)	10.2(103.5)	12.5(155.8)	12.8(163.3)	3.4	44.0	15.1
Fenoxaprop 10% EC at 100 g *a.i.*/ha	2.8 (7.5)	8.9(78.5)	6.9(47.7)	4.8(22.7)	3.1(8.9)	12.9(165.3)	5.6(30.8)	9.9(97.5)	11.8(138.7)	11.3(127.2)	2.5	56.4	10.7
Fenoxaprop 10% EC at 120 g *a.i.*/ha	2.2 (4.2)	9.0(80.8)	7.0(48.6)	4.6(20.8)	3.1(9.2)	12.8(163.6)	5.7(31.4)	9.0(80.5)	11.2(124.9)	11.2(124.9)	2.1	57.2	7.3
Fenoxaprop 10% EC at 150 g *a.i.*/ha	2.0 (3.5)	9.1(81.5)	6.8(45.8)	4.9(23.3)	3.2(9.9)	12.8(164.0)	5.5(29.7)	8.5(71.8)	10.7(113.9)	10.4(107.7)	3.7	63.1	17.3
Fenoxaprop 10% EC at 200 g *a.i.*/ha	2.0 (3.4)	8.9(79.0)	6.9(46.9)	4.6(20.4)	3.0(8.5)	12.5(158.2)	5.5(29.8)	7.8(60.3)	10.4(107.7)	10.1(101.5)	4.6	65.2	22.5
Fenoxaprop 10% EC at 240 g *a.i.*/ha	1.9 (3.0)	9.1(82.3)	6.8(45.6)	4.9(23.7)	2.8(7.3)	12.7(161.9)	5.7(31.9)	7.0(48.5)	8.9(78.7)	8.5(71.8)	3.3	95.4	23.9
Fenoxaprop (Whipsuper) at 120 g *a.i.*/ha	2.1 (3.8)	9.1(81.7)	7.1(49.7)	4.7(21.7)	3.0(8.4)	12.9(165.3)	5.6(30.9)	9.2(84.1)	11.0(120.5)	10.9(118.3)	2.1	59.5	6.5
Clodinafop 15 WP at 60 g/ha	2.1 (4.1)	9.2(83.2)	6.7(44.3)	4.6(20.3)	3.1(9.2)	12.7(161.1)	5.7(32.5)	9.6(91.7)	11.5(131.8)	11.0(120.5)	2.1	58.7	19.3
Weedy check	6.4 (40.2)	9.2(83.7)	7.1(49.9)	4.9(23.8)	4.8(22.3)	14.9(219.9)	5.6(31.2)	11.6(134.0)	17.5(305.8)	13.0(191.9)	6.5	0	33.9
Weed free check	0.7(0)	0.7(0)	0.7(0)	0.7(0)	0.7(0)	0.7(0)	5.7(32.2)	0.7(0)	0.7(0)	0.7(0)	0	100.0	0
SEm±	0.1	0.3	0.3	0.2	0.1	0.8	0.2	0.3	0.5	0.4	0.2	-	-
CD at 5%	0.2	NS	NS	NS	0.4	NS	NS	0.9	1.5	1.1	0.6	-	-

Figures in parentheses are original values, which are subjected to square root transformation ($\sqrt{x+1}$)

Table 3. Growth attributes, yield contributing characters, grain and straw yields and nitrogen uptake by wheat crop as affected by different weed control treatments

Treatments	Plant height (cm)	Leaf area index	Dry matter accumu-lation (g/m^2)	Number of shoots/m^2	Number of spikes /m^2	Length of spike (cm)	Test weight (g)	Grain yield (kg/ha)	Straw yield (kg/ha)	Harvest index (%)	Nitrogen uptakeby wheat (kg/ha)
Fenoxaprop 10% EC at 75 g *a.i.*/ha	95.4	3.47	730.9	397.3	319.8	7.6	39.0	3533	3975	47.1	74.9
Fenoxaprop 10% EC at 100 g *a.i.*/ha	98.4	3.64	797.7	402.7	322.1	8.0	39.7	3720	4133	47.4	77.8
Fenoxaprop 10% EC at 120 g *a.i.*/ha	99.6	3.64	851.4	412.0	364.6	8.9	40.0	4057	4459	47.6	88.0
Fenoxaprop 10% EC at 150 g *a.i.*/ha	91.4	3.36	790.3	367.7	318.6	7.9	39.1	3620	4133	46.7	75.4
Fenoxaprop 10% EC at 200 g *a.i.*/ha	89.3	3.19	710.9	347.0	281.6	7.5	38.9	3390	3895	46.5	69.2
Fenoxaprop 10% EC at 240 g *a.i.*/ha	87.0	3.11	671.0	331.0	278.4	6.8	38.6	3329	3820	46.6	67.3
Fenoxaprop (Whipsuper) 120 g *a.i.*/ha	101.6	3.77	857.5	413.7	370.0	8.9	40.1	4094	4521	47.5	88.4
Clodinafop 15 WP 60 g/ha	97.6	3.57	829.6	409.3	358.8	8.8	39.8	3756	4404	46.0	83.7
Weedy check	78.9	3.25	614.4	286.7	197.3	6.1	39.5	2888	3426	45.7	58.1
Weed free check	103.3	3.59	869.6	433.7	396.5	9.5	42.2	4375	4741	48.0	95.4
SEm±	3.0	0.12	27.1	18.0	18.1	0.4	1.7	116	125	-	2.2
CD at 5%	9.0	0.37	80.5	53.5	53.9	1.0	NS	345	374	-	6.6

Growth parameters, yield attributes and yield and nitrogen uptake by wheat

All the growth and yield contributing characters viz. plant height, leaf area index, dry matter accumulation, number of shoots and spikes, spike length as well as grain and straw yield of wheat crop were significantly higher in weed free check and fenoxaprop (whipsuper) 120 g *a.i.*/ha (Table 3). However, minimum and maximum value of these characters were recorded with weedy and weed free check treatment, respectively. Yadav *et al.* (2009) and Dahiya *et al.* (2005) also reported similar results with regard to grain and straw yield, respectively. Higher dose of fenoxaprop 200-240 g *a.i.*/ha showed the toxicity symptom on crop for 10-15 days only. Highest value of harvest index was recorded with weed free check followed by fenoxaprop 120 g *a.i.*/ha and fenoxaprop (whipsuper) 120 g *a.i.*/ha. Fenoxaprop (whipsuper) 120 g *a.i.*/ha, fenoxaprop 120 g *a.i.*/ha, clodinafop 60 g/ha, being at par with each other, recorded significantly higher value of nitrogen uptake by wheat crop over rest of the herbicidal treatments while the lowest and highest nitrogen uptake were recorded with weedy and weed free check treatment, respectively.

Economics (gross expenditure, gross and net return and benefit cost ratio)

Gross expenditure was found maximum with weed free check followed by fenoxaprop 240 g *a.i.*/ha while gross and net return were found highest with weed free check followed by fenoxaprop (whipsuper) 120 g *a.i.*/ha and fenoxaprop 120 g *a.i.*/ha. However, benefit cost ratio was recorded highest with clodinafop 60 g/ha followed by fenoxaprop (whipsuper) 120 g *a.i.*/ha and fenoxaprop 120 g *a.i.*/ha.

Conclusion

From the results of this study, it can be concluded that fenoxaprop (whipsuper) 120 g *a.i.*/ha proved superior herbicide with respect to weed control, yield and monetary benefits in wheat crop followed by fenoxaprop 120 g *a.i.*/ha and clodinafop 60 g/ha.

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Table 4. Economics of wheat cultivation as influenced by various weed control treatments

Treatments	Common cost (₹/ha)	Treatment cost (₹/ha)	Cost of cultivation (₹/ha)	Gross return (₹/ha)	Net return (₹/ha)	Benefit cost ratio
Fenoxaprop 10% EC at 75 g *a.i.*/ha	17419	1050	18469	52554	34085	1.85
Fenoxaprop 10% EC at 100 g *a.i.*/ha	17419	1400	18819	55179	36360	1.93
Fenoxaprop 10% EC at 120 g *a.i.*/ha	17419	1680	19099	60033	40934	2.14
Fenoxaprop 10% EC at 150 g *a.i.*/ha	17419	2100	19519	54029	34510	1.77
Fenoxaprop 10% EC at 200 g *a.i.*/ha	17419	2800	20219	50670	30451	1.51
Fenoxaprop 10% EC at 240 g *a.i.*/ha	17419	3360	20779	49744	28965	1.39
Fenoxaprop (Whipsuper) 120 g *a.i.*/ha	17419	1680	19099	60644	41545	2.18
Clodinafop 15 WP 60 g/ha	17419	320	17739	58166	40427	2.28
Weedy check	17419	0	17419	43490	26071	1.50
Weed free check	17419	4200	21619	64535	42916	1.99

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