EFFICACY OF DIFFERENT POST EMERGENCE HERBICIDES IN CONTROLLING WEEDS IN WHEAT

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ABSTRACT

A field experiment was conducted at the Agronomic Research Area, Department of Agronomy, University of Agriculture, Faisalabad during winter season 2010-2011 to assess the efficacy of different post emergence herbicides to control weeds in wheat crop and their effect on crop yield. The experiment was arranged in a Randomized Complete Block design (RCBD) and each treatment was repeated three times. Herbicides of different companies were compared to know about their efficacy to control different weeds species grown in association with wheat crop. Different post emergence herbicides such as Isoproturon 500 WP @ 1000 g a.i.ha^{-1}, Isoproturon 500 WP @ 1000 g a.i.ha^{-1}, clodinafop + propargyl @ 45 g a.i. ha^{-1}, clodinafop propargyl @ 45 g a.i. ha^{-1}, bromoxynil + MCPA @ 500 g a.i. ha^{-1}, bromoxynil + MCPA @ 500 g lit a.i. ha^{-1}, Bristal @ 125 g a.i. ha^{-1}, Puma super @ 93.75 g a.i. ha^{-1} were sprayed as post emergence herbicides including weedy control. All herbicidal treatments significantly reduced weeds population but level of efficacy was different for each herbicide. Among all weed control treatments clodinafop propargyl @ 300 g a.i. ha^{-1} effectively controlled weeds which caused increase in crop plant growth and yield. Clodinafop propargyl @ 300 g a.i. ha^{-1} gave the maximum net profit of Rs. 105955 ha^{-1}. However, maximum MRR (%) of 3311 was obtained by applying clodinafop propargyl @ 300 g a.i. ha^{-1} followed by Bristal @ 1.25 lit a.i. ha^{-1} with the MRR (%) of 1480.

Key words: bromoxynil + MCPA, herbicide efficacy, isoproturon, mulching, *Triticum aestivum.*

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INTRODUCTION

Wheat *(Triticum aestivum* L.) is the most important food crop in Pakistan and it is cultivated on an area of 9.03 million hectares

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having an annual production of 25.3 million tons (Govt. of Pakistan, 2014). We are getting lesser yield than potential yield of wheat varities in Pakistan. There are many factors which lead towards the lower crop yield, one of the main factor is weed infestation (Kumar and Sundari, 2002). Weeds reduce the yield of wheat by 37-50% and weed infestation is the main reason of declining the yield of wheat in Pakistan (Baluch, 1993; Nayyar *et al.,* 1995; Waheed *et al.,* 2009). Weeds deteriorate the quality of the crops and decrease their market value as well as reduce the yield by competing with cop plants for available resources. Weeds may increase the chances of the disease by providing the shelter and as an alternate host for the pest (Marwat *et al.,* 2008).

Proper control of weeds is a key factor to sustain crop yield. Literature revealed that intensity of weeds and their competition time with crop plant are very important factors to determine the yield losses. High weeds intensity and more competition time with crop plants causes more reduction in crop yield (Chaudhary *et al*., 2008; Dalley *et al.,* 2006). Weed competition at early growth stages of crop cause more reduction in growth and yield (Reddy *et al.,* 2004). Altering emergence time of weeds and their timely control are essential components to shift weed-crop completion in favor of crop (Akhtar *et al.,* 2000). If the proper weed control methods are not operated during the critical period of competition then effective weed management and profit are not be attained (Tanveer *et al.,* 1999).

Different methods of weeds control depending upon the type of weeds, availability of resources and purpose of crop produce are used to control weeds. Among the all methods of weed control the most common, efficient and economical method of weed control is the chemical control (Dalley *et al.,* 2006; Marwat *et al.,* 2008). But continuous use of same herbicide for years may create resistance or hardening in weeds plants against that herbicide which reduce herbicide efficacy and we have to use higher herbicide dose to get effective weed control (Owen *et al*., 2007). Reduction in herbicide efficacy is mostly due to start of resistance mechanism in weeds. So we must stop the use of those herbicides before the resistance developed which is only possible when we know about the herbicide efficacy. Use of alternate herbicides avoids the development of herbicide resistance (Owen *et al*., 2007). Therefore, the present study was conducted to evaluate the efficacy of different post-emergence herbicides which are commonly used in Pakistan.

MATERIALS AND METHODS

A field experiment was conducted to assess the efficacy of eight post emergence herbicides to control weeds commonly grown in wheat crop at Agronomic Research Area, University of Agriculture, Faisalabad. Experimental plots were arranged under Randomized Complete Block design (RCBD) with three replications for each treatment. Net size of each experimental plot was 6.0 × 3.0 m on sandy clay loam soil. The treatments used in the experiment have been presented in Table-1. Moldboard plow and dish plough were used to prepare the experimental field and leveled by using land leveler. Sehar-2006 was sown with hand drill keeping 25 cm row to row distance during 3rd week of November using 125 kg ha^{-1} seed rate. Other management practices during the crop growth till maturity were kept constant fot all treatments. Treatments were applied after first irrigation when soil was in moist condition, at tillering stage of crop 21 days after sowing. The herbicides were sprayed with a Knapsack hand sprayer using T-Jet nozzle. Each plot of treatment was manually harvested at physiological maturity of wheat crop. Following parameters about weeds including weed density and weed biomass (m^{-2}) was recorded 15, 30 & 45 days after spray from one square meter area randomly selected from two different locations from each plot. To calculate the number of spike bearing tillers one square meter area was selected randomly from each plot and for thousand weight evaluation three samples of 1000 grains were randomly collected from each plot. To evaluate the plant height and number of grain per spike ten plants were selected randomly from each plot. The biological and grain yield were calculated from each plot and then converted to kg ha^{-1} and weed count per unit area. After counting number of weeds per unit area they were harvested from ground surface. To record dry weight weeds were oven dried for 24 hours at 70°C.

Table-1. Different post-emergence herbicides used in wheat during 2010-11

Herbicides	Dose (kg a.i ha^{-1})
W_1=(Puton 800 g acre^{-1}) isoproturon 50%WP	2.0
W_2= (Proton 800 g acre^{-1}) isoproturon 50%WP	2.0
W_3= (Safnar 120 g acre^{-1}) clodinafop propargyl 15%WP	0.5
W_4= (Topik 120 g acre^{-1}) clodinafop propargyl 15% WP	0.5
W_5= (Warden 500 ml acre^{-1}) bromoxynil + MCPA 40%EC	1.25
W_6= (Selector 500 ml acre^{-1}) bromoxynil + MCPA 40%EC	1.25
W_7= (Bristal 500 ml acre^{-1}) clodinfop+ fenoxaprop 10% EC	1.25
W_8= (Puma super 500 ml acre^{-1}) 7.5%EW	1.25
W_9= Weedy check/control plot	

RESULTS AND DISCUSSION

Weed density m^{-2}

Results revealed that all the post emergent herbicides reduced weed density significantly but the level of reduction was different depending on the type of herbicides. Different weeds including *Achyranthes aspara*, *Anagallis arvensis*, *Asphodelus tenuifolius*, *Convolvulus arvensis, Fumaria indica, Medicago polymorpha*, *Melilotus indica*, *Polygonum plebejum* and *Rumex dentatus* were present at the time of herbicides application. However, *Fumaria indica, Melilotus indica* and *Rumex dentatus* were dominant. The data about weed control at 15, 30 & 45 DAS are presented in Table-2. Results showed that the minimum density of weeds (4.00) was found in plot treated with clodinafop propargyl (W_4) which is not statistically different from other treatments as compared to weedy check. Maximum weed density (12.00) was noticed in the treatment (W_9) weedy check where no herbicide was used. The data regarding the weed control after 30 DAS showed that minimum weed density (3.33) was found in treatment W_4 where clodinafop propargyl was applied. Maximum weed density (13.00) was found in the treatment W_9 weedy check. The data regarding the weed control at 45 DAS revealed that maximum weed control (3.00) was found in plots treated with treatment (W_4) clodinafop propargyl and all other treatments also gave the same results as compared to weedy check (13.33) in which minimum weed control was found. The reason of low density of weed species in weedy check plots is the continuous removal of weeds through manual hoeing. While the maximum density of weeds was due to the reason that less competition and more time to explore the nutrients from the soil and crop plants by the weeds. These achievements are supported by Hashim *et al*. (2002) and Khan *et al*. (2003).

Weed biomass (g)

Data regarding weed biomass at 15 DAS revealed that maximum reduction in weed biomass was found in plot treated with Topik (clodinafop propargyl) treatment W_4 which is statistically similar with other treatments except treatment W_9 weedy check. Minimum reduction in weed biomass was found in weedy check. Data regarding the weed biomass after 30 DAS revealed that the plot treated with Topik (clodinafop+ propargyl) give maximum reduction in wed biomass which is statistically not different from all other treatments as compared to weedy check in which minimum reduction in weed biomass was found. Data concerning the weed biomass at 45 DAS showed that maximum decline in weed biomass was found in plot treated with Topik (clodinafop propargyl) which is statistically similar with all other treatments except weedy free plots.

Plant height of Wheat (cm)

Data regarding the plant height showed that maximum plant height (11.53 cm) was observed in plots treated with treatment W_4 Topik (clodinafop propargyl) which is statistically not different from all other treatments except treatment W_9 weedy check. Minimum plant height (84.00 cm) was found in treatment W_9 control plot.

Number of grain per spike

Results about number of grains per spike showed that treatment W_4 (clodinafop propargyl) treated plots produced more number of grain 65.67 spike^{-1} followed by treatment W_8 having 55 grains spike^{-1} which was not significantly different from W_2 treatment treated with Isoproturon 500 WP @ 2 kg a.i.ha^{-1}. Least number of grains 21.33 grains spike^{-1} were produced in (weedy check) W_9 treatment which is statistically at par with W_7 treatment representing intensive weed competition which decreased number of grain per spike, these responses are supported by findings of Khan *et al.* (2003).

Spike length (cm)

All post-emergence herbicides treatments significantly affect spike length. In plots were treatment W_4 (clodinafop propargyl) @ 300 g a.i. ha^{-1} were applied showed maximum spike length (15.07 cm) followed by the plots treated by puma super having spike length (11.33 cm) which is statistiacally at par with treatment W_3 (clodinafop+ propargyl). while minimum spike length (6.17 cm) was noticed in treatment W_9 which is the weedy check and statistically similar with treatment W_5 (Bromoxynil + MCPA). These responses are supported by Chaudhary *et al*. (2008) and Ali *et al*. (2004).

1000 grain weight (g)

Treatment W_4 (clodinafop propargyl) plots yield maximum 1000-grain weight (68 g) followed by treatment W_8 puma super treated plots having (55.93 g) of thousand grain weight. Lowest 1000-grain weight 36.00 g was achieved in treatment W_9 control plot, representing that weed-crop competition cause reduction in 1000-grain weight. Lowest 1000-grain weight in control plots was due to weeds crop interference because weeds compete with palnts for resources and also release allelopathic chemicals with negatively affect crop growth. These outcomes are supported by findings of Ahmad *et al.* (1991) and Mason *et al.* (2006).

Grain yield

Grain yield (tons ha^{-1}) of wheat was more in plots which were treated with herbicidal application than weedy control. Because herbicide applications kills or suppresses the growth of weeds and shift weed crop competition in favor of crop plants. Maximum grain yield (6.33 tons ha^{-1}) was recorded where treatment W_4 (clodinafop propargyl) @ 300 g a.i. ha^{-1} were sprayed which is statistically similar with remaining treatments except control plots. Increase in grain yield of herbicides treated plots occurred due to reduced weed-crop competition but in weedy check weeds were using resources that negatively affect grain produce (Khan *et al*., 2003; Madafiglio *et al*., 2006).

Biological yield

Maximum biological yield (9.92 tons ha^{-1}) was produced in plots treated with W_4 (clodinafop propargyl) @ 300 g a.i ha^{-1} followed by treatment W_8 puma super @ 1.25 L ha^{-1} treated plot (9.13 tons ha^{-1}) which is not significantly different from treatment W_1 Puton @ 2 kg a.i ha^{-1} treated plots. Minimum biological yield (5.40 tons ha^{-1}) was recorded in weedy check due to more weed infestation.

Economic and marginal analysis

Economic analysis of various post emergence herbicides treatments exposed that control of weeds grown in wheat crop by the use of treatment W_4 (clodinafop propargyl) @ 300 g a.i ha^{-1} gave more economic return as compared to all other herbicide treatments (Table-3). Application of (clodinafop propargyl) @ 300 g a.i ha^{-1} gave the maximum net returns (Rs. 105955 ha^{-1}) followed by W_1 Puton @ 2 kg a.i. ha^{-1} with a net return of (Rs. 93045). The maximum benefit cost ratio of 3311% was achieved for treatment W_4 (clodinafop propargyl) @ 300 g a.i ha^{-1} and worked as most economical herbicide to control weeds grown in wheat (Table-3). Thus, according to the results the use of clodinafop propargyl @ 300 g a.i ha^{-1} is more economical than other herbicides.

CONCLUSIONS

From the result of our research about post emergence herbicide use to control weeds in wheat it is concluded that the clodinafop propargyl @ 300 g a.i. ha^{-1} was quite effective to control the total number of weeds present in wheat fields. This herbicide was most effective and economical than other herbicides tested in this study as arbitrated by reduction in weed density and increase in wheat grain yield.

Table-2. Effect of different herbicide treatments on wheat yield during 2010-11

Treatment	Weed density (m^{-2})			Weed biomass (m^{-2})			Plant height (cm)	Spike length (cm)	No.of grains/spike	1000 grain wt. (g)	Biological yield (t ha^{-1})	Grain yield (t ha^{-1})
	15DAS	30DAS	45DAS	15DAS	30DAS	45DAS						
W_1	7.33 bc	3.33 d	7.66 bc	11.65 ab	18.72 d	33.81 cd	103.00 b	9.33 cd	42.67 cd	49.33 bc	9.13 b	5.73 ab
W_2	5.00 cd	5.66 c	6.00 cd	7.00 cd	16.11 de	32.28 cd	105.33 b	8.67 de	49.67 bc	45.00 cd	7.23 de	4.60 c
W_3	5.66 bcd	9.00 b	7.00 bc	9.50 bcd	31.01 bc	44.66 bc	102.00 b	11.33 b	40.33 d	41.6 cde	7.70 cd	4.90 bc
W_4	4.00 d	3.33 d	3.00 d	4.94 d	10.12 e	16.15 e	115.33 a	13.83 a	65.67 a	68.00 a	9.92 a	6.33 a
W_5	7.33 bc	9.00 b	9.33 b	10.58 bc	34.29 ab	28.32 de	108.3 ab	8.00 e	36.67 de	38.66 de	6.63 e	4.76 bc
W_6	7.00 bc	9.00 b	7.66 bc	9.08 bcd	31.92 b	52.00 ab	103.67 b	9.67 cd	30.33 ef	39.33 de	7.27 d	4.40 c
W_7	8.00 b	7.66 bc	7.00 bc	10.43 bc	22.35 cd	35.90 cd	100.67 b	9.17 de	25.33 fg	47.86 bc	8.03 c	5.07 bc
W_8	5.66 bcd	6.66 c	6.00 cd	7.29 bcd	20.82 d	27.49 de	100.33 b	11.33 b	55.33 b	55.93 b	8.70 b	5.30 bc
W_9	12.00 a	13.00 a	13.33 a	15.92 a	40.62 a	62.68 a	84.00 c	6.17 e	21.33 g	36.00 e	5.40 f	2.93 d
$LSD_{.05}$	2.37	2.05	3.19	4.63	2.13	15.53	9.60	1.33	8.80	8.26	0.62	1.01

Any two means not sharing the same letter in a column differ significantly at 0.05 probability level.

Table-3. Economic analysis of different weed control treatments

Treatments	Grain Yield (t ha^{-1})	Adjusted Yield (t ha^{-1})	Gross Income (Rs. ha^{-1})	Variable weed control cost			Fixed cost	= Total cost (Fixed + Variable)	Net Benefit.
				Spray R.	Herbicide C.	Labour C.			
W1	5.73	5.16	122550	90	715	1005	28500	29505	93045
W2	4.60	4.14	98325	90	650	940	28500	29440	68885
W3	4.90	4.41	104738	90	450	740	28500	29240	75498
W4	6.33	5.70	135375	90	630	920	28500	29420	105955
W5	4.76	4.28	101650	90	500	790	28500	29290	72360
W6	4.40	3.96	94050	90	630	920	28500	29420	64630
W7	5.07	4.56	108300	90	670	960	28500	29460	78840
W8	5.30	4.77	113288	90	600	890	28500	29390	83898
W_9	2.93	2.69	63888	0	0	0	28500	28500	35388

Table-4. Marginal analysis of different weed control treatments

Treatments	Cost that varied	Net Benefit	MRR(%)*
W_1	1005	93045	D**
W_2	940	68885	894
W_3	740	75498	3311
W_4	920	105955	D
W_5	790	72360	D
W_6	920	64630	D
W_7	960	78840	1480
W_8	890	83898	568
W_9	0	35388	----

Prevailing market prices of herbicides
Puton @ Rs. 715; Proton/ Isoproturon @ Rs. 650; Safnar @ Rs. 450 Topik @ Rs.630
Wardan (Bromoxynil + MCPA) @ Rs. 500 Selector (Bromoxynil + MCPA) @ Rs. 630
Bristal @ Rs. 670 Puma super @ Rs. @ Rs. 600.
Market price of wheat grain @ Rs. 950 per 40 kg
Variable cost is the cost that is incurred on different inputs used to produce a particular crop.

$$\text{*Marginal rate of return (MRR\%)} = \frac{\text{Change in net benefit} \times 100}{\text{Change in variable cost}}$$

**D = dominated, any treatment that had net.

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