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EVALUATION OF VARIOUS HERBICIDES AND THEIR COMBINATIONS FOR WEED CONTROL IN WHEAT CROP

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Abstract

A field experiment on weed control in wheat was conducted at Agriculture Research Institute, (Tarnab) Peshawar during 2008-09. The experiment was laid out in a randomized complete block design, replicated three times, and consisted of 14 treatments including six herbicide treatments; fenoxaprop-P-ethyl (P), pinoxadan (A), bromoxynil+MCPA (B), trisulfuron (L), clodinafop-propargyl (T) and fluroxypur+MCPA (S) that were used individually; and in seven different combinations i.e. T+B, T+S, P+B, P+S, B+A, L+A and L+T, and one treatment was kept as weedy check for comparison. All the herbicide treatments provided significant control of weeds causing significant reduction in density of target weed flora and also significantly improved the grain yield in comparison with the weedy check. Highest mortality of weeds (90.7%) and maximum grain yield of 3925 kg ha^{-1} (with 30.25% increase in grain yield over weedy check) were recorded where clodinafop-propargyl and bromoxynil+MCPA were applied together. The weed population and grain yield in weedy check were 161 weeds m^{-2} and 2744 kg ha^{-1}, respectively. However, no crop injury was observed in any of the herbicide treatments. Among the herbicides used alone, bromoxynil+MCPA produced the highest grain yield (3827 kg ha^{-1}) increased over check by 28.29%. In light of the results, it is concluded that bromoxynil+MCPA in alone, and its combination with clodinafop-propargyl are most effective and best option for achieving a desirable weed control and increase in grain yield of wheat in irrigated conditions of Peshawar.

Introduction

Wheat (*Triticum aestivum* L.) is the most important cereal crop in Pakistan regarded as the staple food crop. More than 50% of the agricultural land through out the country is cultivated with wheat crop during its cropping season. It was grown on an area of 9.046 M ha with total production of 24.033 M t and average yield of 2657 kg ha^{-1} at national level. The figures at provincial level of Khyber Pakhtunkhwa were 0.7695 M ha, 1.2045 M t and 1565 kg ha^{-1}, respectively (Anonymous, 2009). Due to the rapid annual population growth rate in the country, there is a dire need of improvement in the yield of wheat crop. Actual farm yield of wheat in Pakistan is about 30-35% of the total potential yield. Why this much low yield even all possible efforts have been made for years to improve the yield. In fact, yield improvement is achieved each year through various means but the pace of improvement is far behind the speed of population growth.

Regardless of all the other ways of crop yield enhancement, weed control is also a key factor in crop yield improvement to cope with the annual population blast in Pakistan. Severe weed infestation is one of the major causes of low yield of wheat in the country. Weeds are hidden enemies of wheat and cause huge losses to crop yields which amount to Rs. 115 to 200 billion annually (Atta & Khaliq, 2002). Hamid *et al*., (1998) reported that weed competition in wheat crop decreased yield by 42-56%. Grain yield of wheat is significantly increased by use of different chemicals for weed control as compared with weedy check (Tariful *et al*., 1998; Chaudhry *et al.*, 2008). For the past few decades, several herbicides have been employed for weed management in wheat. The development of herbicide resistance by certain weeds like Canada thistle, wild oats etc. is mainly due to the use of single herbicides over a long period. Bahranini & Khajehpour (1999) studied relative performance of single and mixture of different herbicides in wheat. Hand weeding though considered to be the most effective weed management tool (Fayed *et al*., 1998) but it is never an economical weed control method (Akhtar *et al*., 2000). Though the chemical method is being discouraged world wide, however, its immediate effect and economic return cannot be ignored totally by the farmers of countries like Pakistan. Instead the ill effects of herbicides can be minimized through their judicious use at recommended doses.

Our local farmers have very little and just superficial knowledge of herbicides use. They need to be educated how to calculate and calibrate the herbicide dose. They always use a single herbicide and are never informed of the herbicide rotations or combinations that help avoid resistance development in weeds. Several combinations of herbicides are there that can provide good control of broad and narrow leaved weeds and cause significant reduction in their density and increase yield attributes as compared to check (Chaudhry *et al.*, 2008; Bostrom & Fogelfors, 2002; Khan & Rashid, 1994). However, they did not calculate the synergistic or antagonistic effects of the herbicide combinations. Therefore, an experiment was carried out on various herbicides generally used in wheat crop to evaluate their impact on weed control in alone and in combinations and to assess the efficacy and economics of the herbicides on grain yield of wheat.

Materials and Methods

The experiment was conducted at Agricultural Research Institute Tarnab, Peshawar, during Rabi Season 2008-09 in Randomized Complete Block Design having three replications. The seeds of wheat Cultivar "Pirsabak 2005" were sown in plots of size 5m x 3m. The experiment comprised of overall 14 treatments in which there were 6 different post emergence herbicides i.e.,

Puma super 75EW (fenoxaprop-P-ethyl), Axial 50EC (pinoxadan), Buctril super 60EC (bromoxynil+MCPA), Logran 75WG (trisulfuron), Topik 15WP (clodinafop-propargyl) and Starane-M (fluroxypur+MCPA); they were used in sole and in seven different combinations with their recommended doses (Table 1) along with a weedy control making a total of 14 treatments. All the phosphorus, potash and half of the recommended dose of nitrogen fertilizers were applied at the time of sowing while remaining half of the nitrogen was applied with second irrigation. Crop sowing was done in November 2008 with the help of hand hoe. Herbicides were sprayed after one month of sowing when different grassy and broad leaved weeds emerged. Among the six herbicides three were grassy and three broad leaf weeds killers. The herbicide combinations were sprayed in such a way that, instead of doing tank mixing, the second herbicide was sprayed a day after the first one.

Table 1. List of the herbicide treatments with trade and common names and recommended rates.

S.#	Treatments (Trade Names)	Common Names	Rate ha^{-1}
1.	Topik 15WP (T)	clodinafop-propargyl	300 g
2.	Puma super 75EW (P)	fenoxaprop-P-ethyl	1250 ml
3.	Buctril super 60EC (B)	bromoxynil+MCPA	1.5 lit
4.	Axial 50EC (A)	pinoxadan	750 ml
5.	Logran 75WG (L)	trisulfuron	25 g
6.	Starane M (S)	fluroxypur+MCPA	750 ml
7.	Weedy check	---	---
8.	Topik 15WP+Buctril super 60EC (T+B)	clodinafop-propargyl+ bromoxynil+MCPA	300 g + 1.5 lit
9.	Topik 15WP + Starane M (T+S)	clodinafop-propargyl + fluroxypur+MCPA	300 g + 750ml
10.	Puma super 75EW + Buctril super 960EC (P+B)	fenoxaprop-p-ethyl + bromoxynil+MCPA	1.25 lit + 1.5lit
11.	Puma super 75EW + Starane M (P+S)	fenoxaprop-p-ethyl + fluroxypur+MCPA	1.25 lit + 750ml
12.	Buctril super 60EC + Axial 50EC (B+A)	bromoxynil+MCPA + pinoxadan	1.5 lit + 750 ml
13.	Logran 75WG + Axial 50EC (L+A)	trisulfuron + pinoxadan	25 g + 750 ml
14.	Logran 75WG + Topik 15WP (L+T)	trisulfuron + clodinafop-propargyl	25 g + 300 g

Data were recorded on weed density m^{-2} of various weed flora, grain yield and grains $spike^{-1}$. Increase in yield over weedy check and percent increase was also calculated for all the treatments. The data on weed density m^{-2} were recorded after two weeks of the herbicides spray in all the treatments including control. A quadrate of size 1m x 1m was thrown three times randomly in each treatment for recording weed density m^{-2}; the values were totaled and then averaged. For the data on number of grains $spikes^{-1}$, ten plants were randomly selected from the central two rows and the grains in their spikes were counted separately and then averages were computed. The mid two rows in each treatment were harvested, bundled and threshed separately for calculating the grain yield. The generated values were later on converted to per hectare. All standard cultural practices were kept uniform for all the treatments.

Statistical analysis: Data were statistically analyzed using analysis of variance technique appropriate for randomized complete block design. Means were compared using LSD test at 0.05 level of probability, when the F-values were significant (Steel & Torrie, 1984; Jan *et al*., 2009).

Results and Discussion

Weed density m^{-2}: Weed density per unit area is an important and key parameter in figuring out the impact of treatments on weed growth. The more the weeds the more is the nutrients depletion from the soil and the more is their competition with crop plants. Moreover, the use of herbicides, though discouraged worldwide these days because of environmental and health hazards, is inevitable due to many reasons particularly in the terms of economics and the immediate effect. However, the herbicide use should be judicious and properly operated. The data in the experiment regarding weed density m^{-2} of different weed flora as shown in Table 2 indicated that all the herbicidal treatments convincingly suppressed the weeds growth. Among the herbicides used alone, Buctril super 60EC, Axial and Starane M decreased the weed density to 25, 50 and 51 weeds m^{-2}, respectively. On the other hand, the combination of Topik and Buctril super (15 weeds m^{-2}) was the best of all combinations followed by combination of Puma super + Buctril super (35) and Topik + Starane M (38 weeds m^{-2}) as compared to 161 weeds m^{-2} in weedy check. These three combinations reduced weed population by 90.7, 78.3 and 76.4%, respectively. However, no crop injury was observed in any of the herbicides used in the experiment. Topik, a grassy weed killer and Buctril super, a good broadleaf weed killer; therefore they exhibited best performance in weed control in combination, indicating that there is synergistic effect between the two herbicides. The results are in line with those of Tunio *et al.*, (2004), Khan *et al*., (2002) and Shahid (1994).

Table 2. Mean weed density m^{-2} as affected by different herbicidal treatments in wheat during 2008-09 in Peshawar.

Weeds	WC	T	P	B	S	A	L	T+B	T+S	P+B	P+S	B+A	L+A	L+T	*LSD0.05*
Anagallis arvensis	47	18	15	01	03	04	06	01	05	03	04	02	03	06	03
Avena fatua	18	01	02	07	10	09	12	02	02	02	05	11	07	06	02
Cirsium arvense	12	11	08	02	04	05	05	02	05	04	06	04	02	07	02
Convolvulus arvensis	09	08	09	02	04	03	02	01	03	02	04	02	01	03	03
Coronopus didymus	13	07	10	01	07	03	04	00	03	02	03	00	01	03	02
Euphorbia helioscopia	11	09	11	00	01	02	04	00	01	02	02	02	01	01	02
Fumaria indica	11	08	09	00	02	01	03	01	01	01	03	00	05	03	02
Medicago denticulata	06	10	14	00	02	04	03	01	05	05	02	01	03	05	03
Phalaris minor	09	02	04	06	08	07	09	03	03	05	04	08	04	08	05
Poa annua	25	14	19	06	10	12	14	4	10	09	11	13	13	14	03
Total	161 a	88 c	101 b	25 f	51 e	50 e	62 d	15 f	38 f	35 f	44 ef	43 ef	40 f	56 de	11
Percent reduction	---	45.3	37.3	84.5	68.3	68.9	61.5	90.7	76.4	78.3	72.7	73.3	75.2	65.2	

WC (Weedy Check), T (Topik), P (Puma super), B (Buctril super), S (Starane M), A (Axial), L (Logran), T+B (Topik + Buctril super), T+S (Topik + Starane M), P+B (Puma super + Buctril super), P+S (Puma super + Starane M), B+A (Buctril super + Axial), L+A (Logran + Axial), L+T (Logran + Topik)

Number of grains spike^{-1}: Among the yield components number of grains spike^{-1} is vital parameter for assessment of the impact of weed control treatments on yield. Increasing the number of grains spike^{-1} will increase the weight of the spike which in turn definitely improves the ultimate yield. All the weed control treatments significantly boosted the number of grains spike^{-1}. Among the individually used herbicides, Buctril super treated plots resulted in the highest number of grains (104 spike^{-1}), followed by Axial (100 spike^{-1}). The combination of Topik and Buctril super was outstanding resulting in 124 grains spike^{-1} followed by Buctril super + Puma super (104 grains spike^{-1}) as compared to the lowest number of grains (42 spike^{-1}) in control treatments. The possible reason for the increased number of grains spikes^{-1} is that an effective grass killer and an effective broadleaf weed killer are used in combination resulting in control and suppression of almost all weed flora having infested the field. This resulted in efficient utilization of all the available resources by the wheat plants. Khan (1999), Khan *et al*., (2002) and Khan *et al.*, (2003) reiterated that herbicide application does have a heavy effect on parameter of grains spike^{-1}. Our findings are also in line with Cheema & Akhtar (2005) and Arif *et al*., (2004) who reported a significant increase in grains spike^{-1} using these herbicides as emergence in comparison with the weedy check. An experiment is direly needed to know the impact of these treatments on the various wheat cultivars used in the country in order to search out whether all the varieties/cultivars have the same response to these treatments or there is significant variation in their respective responses.

Grain yield (kg ha^{-1}): Grain yield is the principal and primary parameter for assessment of any weed control treatments applied in experimentations. Increase in grain yield in wheat crop is the mostly required and intended parameter of all agricultural experiments in Pakistan. In our experiment the data on grain yield is documented in (Table 3) which revealed that the herbicide treatments had a convincing effect on the grain yield of wheat crop. Among the individually used herbicides, Buctril super performed the best giving the highest grain yield of 3827 kg ha^{-1}, which was 1083 kg ha^{-1} i.e. 28.29% increased over weedy check. On the hand, among the herbicides used in combination Topik + Buctril super resulted in the best grain yield of 3925 kg ha^{-1} that was 1181 kg ha^{-1} and 30.25% higher than weedy control. Due to maximum infestation of weeds, the lowest grain yield of wheat (2744 kg ha^{-1}) was recorded in the untreated control plots. The rest of the table is clear cut sketch of the various treatments effect on yield increase in quantity and percentage over the weedy control. Arif *et al*., (2004) is of the view that the application of herbicides in fact does affect grain yield of wheat. The results are also in conformity with the findings of Awan *et al*. (1990), Hassan *et al*. (2003) and Tunio *et al*. (2004) who reiterated the efficacy of herbicide applications having been influential in raising the grain yield of wheat.

Table 3. Number of grains spike^{-1}, grain yield (kg ha^{-1}), and percent increase in yield as affected by different herbicide treatments.

Treatments	Grains spike^{-1}	Grain yield (kg ha^{-1})	Yield increase over weedy check (kg ha^{-1})	Percent Increase
Weedy Check	42 e	2744 f	---	---
Topik (T)	58 d	3135 de	391	12.47
Puma Super (P)	46 de	2985 e	241	08.07
Buctril Super (B)	104 b	3827 ab	1083	28.29
Starane-M (S)	86 c	3447 cd	703	20.39
Axial (A)	100 b	3495 bc	751	21.48
Logran (L)	90 bc	3250 d	506	15.57
T+B	124 a	3925 a	1181	30.25
T+S	95 bc	3700 b	956	25.83
P+B	104 b	3792 ab	1048	27.64
P+S	98 bc	3505 b	761	21.71
B+A	83 c	3575 bc	831	23.24
L+A	93 bc	3583 bc	839	23.42
L+T	68 d	3300 cd	556	16.85
LSD	15	221		

Means not sharing a letter differ significantly by LSD at 5 % probability level

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