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WEED CONTROL IN MAIZE (Zea mays L.) WITH PRE AND POST-EMERGENCE HERBICIDES

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ABSTRACT

Studies were undertaken to determine the effect of some pre and post emergence herbicides on weed control and maize yield at Agricultural Research Institute, Tarnab during 2001 and 2002. In 2001, pre and post-emergence herbicides were tested in one trial and in 2002, pre and post-emergence herbicides were tested separately. In 2001, Sarhad white variety of maize was used as test variety and planted on July 14. Primextra 500 FW, Stomp 330-E, Jinong 38 SL, Merlinc extra as pre-emergence and Primextra 500 FW 2.5 and 1.0 were applied as post-emergence spray. In 2002, maize variety Azam was planted as test crop variety. In 2002, two trials, one pre and second as post-emergence were laid out. Pre-emergence treatments were Primextra gold 720 Sc, Dual gold 960 EC, Aatrax 90 WG. Atrazine 38 SC and Stomp 330 E. Post-emergence herbicides were Primextra 500 FW, Primextra gold 720 SC, Aatrax 90 WG, Atrazine 38 SC, Jinong 38 SL and 2,4-D. During both the years, pre and post-emergence herbicides reduced weed densities significantly over untreated control. Untreated control had a weed density of 189 weeds compared to 43 in the 2,4-D treated plot during 2001. In 2002, weed densities were 72 and 189 in the untreated and hand weeded plots in comparison with 27 and 39 the weed number in the Stomp 330-E and hand weeded plots respectively. 2,4-D and Jinong 38 SL did not control grasses and were therefore less effective compared to Primextra 500 FW, Primextra gold 720 SC, Dual gold 960 EC and stomp 33-E. Cyperus rotundus was the most tolerant to all herbicides. Dual gold 960 EC and Primextra gold 720SC were the most effective herbicides reducing weed density and increasing maize yield. Primextra 500 FW, Primextra gold 720 SC, Dual gold 960 EC and Aatrax 90 WG treated plots produced maize grain yield of 3733, 3533, 4267 and 4000 kg ha^{-1}, respectively compared to 2333 kg ha^{-1} for untreated control plot. Cost/benefit ratio of most effective herbicides was 1 to 5, which clearly demonstrated that chemical control of weeds in maize is a very acceptable intervention, and could be easily adopted by the farmers.

Key words: Maize, *Zea mays*, weed control, grain yield, Primetra gold, atrazine

INTRODUCTION

Maize (*Zea mays* L.) is the second most important crop of NWFP (Anonymous, 2000). In NWFP, maize is grown on 539215 ha with a total production of 836446 tons and per ha yield of 1551 kg. It serves as a food, fodder and feed and it also is a source of raw material for the industry. Average yield of maize in Pakistan and NWFP is very low as compared to other maize growing countries of the world. One of the causes of low

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production could be attributed to high infestation of weeds. Because of acute shortage of labor and frequent monsoon rains, during the early growth period of maize, hand weeding or mechanical weeding operations are usually delayed or left altogether. In such situations, herbicides offer the most practical, effective and economical method of weed control and increase crop yield. The choice of herbicide would depend on availability, selectivity and economics. Chemical weed control in maize has received little attention in Pakistan and particularly in NWFP. Because of improved practices and better inputs, crop stands have improved, but the same practices have also caused an enormous increase in weed population. Chemical weed control studies conducted previously have indicated that it could be an effective alternate method to hand weeding. Becker and Staniforth (1981) obtained higher yield in maize with weedicides than with cultural weed control method. Staniforth (1964) observed that atrazine treated plot at 1.6 kg ha^{-1} produced more yield compared to 1 or 2 mechanical weedings. In another study, Olunugas *et al.* (1983) reported that best weed control was obtained with Primextra 500 FW at 2 or 4 kg ha^{-1} sprayed pre-emergence in maize crop. Veseloskii (1983) reported that Primextra at 4 and Dual at 3 kg ha^{-1} as pre-emergence treatments effectively controlled maize weeds and increased grain yield up to 6010 and 6320 kg ha^{-1}, respectively compared to 4140 kg ha^{-1} of unweeded control. Pandy *et al.* (1969) also reported effective weed control with atrazine at 1.5 kg ha^{-1} in maize. Shakoor *et al.* (1986) worked on the efficacy of different herbicides for weed control in maize and reported that Gesaprim and Primextra were effective herbicides for the management of weeds and increasing maize yield. Jehangire *et al.* (1984) reported that application of selective herbicides provided 65 to 90% weed control and 100 to 150% more maize yields than unweeded control. Detlefsen *et al.* (1983) reported that alachlor and metolachlor each alone and in combination with atrazine at normal and higher rates provided good control of grasses and broad-leaf weeds, respectively. Ndahi (1984) tested atrazine, metolachlor and cyanazine at 1 or 2 kg ha^{-1} and reported that plots receiving 1 kg ha^{-1} and supplemented with one hoeing gave yield comparable to the weed free control. Khan and Saghir (1987) reported excellent weed control and significant yield increases over unweeded control in corn with triazines. Khan *et al.* (1991) and Khan *et al.* (1993) reported good weed control with pre-emergence herbicides such as metolachlor + atrazine, pendimethalin and Cyanazine+ atrazine, Primextra and Bladex plus. The objectives of the present studies were a) to determine the effects of herbicides on weed control and grain yield of maize and b) to determine the most effective and economical herbicide (s) for use in maize in NWFP.

Materials and Methods

The experiments were laid out at the Agricultural Research Institute, Tarnab, Peshawar during 2001and 2002. In 2001, pre and post-emergence herbicides were applied in one trial, whereas in 2002, pre and post-emergence herbicides were tested in separate trials. In the first year, seedbed was prepared on July 14 and maize variety Sarhad white was planted on July 15. Pre-emergence herbicides; Primextra 500 FW, Stomp 330-E, Jinong 38 SL and Merline extra (isoxaflutole + atrazine) were applied at the rates of 2.5, 1.65, .95 and 0.65 L ha^{-1}, respectively, on July 16 and post-emergence herbicides Primextra 500 FW and 2,4-D were applied at the rate of 2.5 and 1.0 L ha^{-1}, respectively on August 5. Hand weeding and unweeded control were also included. All the treatments were applied in randomized complete block design with 4 replications. Row to row distance was kept at 75 cm. Plot size was 5 x 3 m^2. Hand weeding was done several times aat its assigned place in the trial. In the second year, sowing of maize

variety Azam was done on July 18 on well-prepared soil. Pre-emergence and post-emergence herbicides trials were conducted separately. Pre-emergence herbicides were Primextra 500 FW, (atrazine + metolachlor), Primextra gold 720 SC, (atrazine + S-metolachlor), Dual gold 960 EC, (S-metolachlor) Aatrex 90 WG,(atrizine), Atrazine 38 SC and Stomp 330-E (pendimathalin) at 2.25, 1.44, 1.92, 2.70 kg, 0.76 kg and 1.49 L ha^{-1}, respectively. Post emergence herbicides were Primextra 500 FW, (2.25 L L ha^{-1}), Primextra gold 720 SC (1.44 L ha^{-1}), Aatrax (2.7 kg ha^{-1}), Atrazine 38 SC (1.3 L ha^{-1}), Jinong 38 SL (0.76 L ha^{-1}) and 2,4-D (1.4 L ha^{-1}). Weed density data were recorded per m^2 (quadrate of 1 m^2 was randomly used to record weed density per m^2). Two central rows, 5 meter long were harvested for grain yield determination. In 2001, maize was harvested on October 2. In 2002, both the experiments were harvested on October 22, and grain yield on dry weight basis was obtained after drying and threshing the cobs. All herbicides were applied with knapsack sprayer with water as carrier at 200 L ha^{-1} at 30 psi after proper calibration. Data were subjected to analysis of variance procedure and means were separated by LSD test as described by Gomez and Gomez (1983).

Results And Discussion

Weed density (m^{-2})

All herbicides, in both the years effectively controlled weeds when compared with unweeded control. Because the weed densities and the effects of herbicides during the two years on weed control and grain yield were different; therefore, the data for both the years are presented separately. Most herbicides proved excellent in controlling both grasses as well as broad-leaf weeds (Tables-1, 3,5). *Digitaria sangunalis* and *Trianthema portulacastrum* were the major weeds present at the site and most herbicides controlled these species effectively during 2001. All herbicidal treatments including hand weeding were at par with one another, however, 2,4-D and Jinong 38 SL did not control grasses; and therefore were not as effective as broad spectrum herbicides such as Primextra 500 FW, Stomp 330-E or hand weeded plots. In the prevalent weed species, *Cyperus rotundus* was the most tolerant to herbicides. In the year 2002 (Table-2), *C. rotundus* was again the most prevalent species in the trial followed by *Digitaria sangunalis*. During this year, *T. portulacastrum* was not a problem weed at the site. Dual gold 960 EC and Primextra gold 720 SC seemed to be the most effective herbicides. In the trial, on evaluation of post emergence herbicides in maize, weed density was far higher than in the pre emergence trial. At this site in addition to *C. rotundus* and two species viz. *Digitaria* and *Convolvulus arvensis* were also in abundance. All post emergence herbicides were very effective against most weeds except that Atrazine 38 SC, Jinong 38 SL and 2,4-D were less effective on grasses such as *Digitaria* species. From the data collected during both the years, it is apparent that both pre emergence as well as post emergence herbicides were equally effective in reducing weed density during both the years. This reduction in the weed density was useful in increasing the maize yield during the current season and also would help reduce weed densities during the future years.

Grain yield (kg ha^{-1})

The data in Tables 2,4 and 6 indicate that the effects of herbicides on yield increases were consistent with the weed control attained with the application of herbicides (Tables-1,3,5). In both the years, Primextra 500 FW and Stomp 330-E were effective in increasing maize yields. In the year 2002, Primextra gold 720 SC, Dual gold 960 EC and Aatrex 90 WG were also very effective in increasing maize yield over unweeded control and were at

par with hand-weeded plots. In 2001, Primextra and Stomp 330-E treated plots produced 2917 and 2500 kg ha^{-1} yields, respectively significantly different from the unweeded plot with 1083 kg/ha yield. Hand weeded plot produced 2388 kg ha^{-1}, which was statistically similar to Primextra 500 FW and Stomp 330-E treated plots. Primextra 500 FW and Stomp 330-E treated plots produced 170 and 131% higher yields than weedy plot. Cost/benefit ratio calculated for these herbicides indicated a very high ratio between cost incurred and benefit obtained that suggested the technology would be fully acceptable to the farmers for adoption. During the year 2002, broad spectrum herbicides, used as pre emergence, Primextra 500 FW, Primextra gold 720 SC, Dual gold 960 EC and Aatrax 90 WG produced, 3733, 3533, 4267 and 4000 kg ha^{-1} yields, respectively compared to 2333 kg ha^{-1} of weedy plot. These increases were 60, 51, 82 and 71%, respectively, which were very significant increases over the weedy check plots. Hand weeded plot produced similar yields to the herbicides treated plots. Herbicides applied as post emergence were also very effective in increasing maize yield significantly over weedy plots. Primextra 500 FW, Primextra gold 720 SC, Aatrax 90 WG and Atrazine 38 SC treated plot produced 4533, 4000, 3534 and 3867 kg ha^{-1} yield, respectively compared to 2133 kg ha^{-1} for untreated control. These increases were 113, 87, 66 and 81%, respectively which are substantial increases due only to weed control intervention. In the year 2002, also cost/benefit ratio was determined. For the pre emergence herbicides, the ratios were from 1:1 and 1:5 for the less and most effective treatments. Most acceptable treatment produced a ratio of 1:4. This cost/benefit ratio is the most acceptable to the farmers for adoption of the technology. A ratio of 1:1.5 in most cases is acceptable for adoption. In the post emergence herbicides, a ratio of 1:1.5 to 1:7 was obtained; which suggest that even through in maize, pre emergence herbicides are more popular, but this study suggested that post emergence herbicide could be equally good or better than pre-emergence applications. The reason could be that in case of pre emergence spray; if the residual effects are not longer then, post-emergence sprays could be better option because most emerged weeds could be destroyed as has been possible in wheat, where post-emergence applications have replaced pre-emergence uses.

Table-1. Weed density m^{-2} as affected by different herbicides in maize during 2001

Weeds	Weedy control	Primextra 500 FW	Stomp 330-E	Primextra 500 FW	Jinong 38 SL	Merline extra	2,4-D	Hand weeding
Convolvulus arvensis	0	1	1	1	2	1	0	2
Cynodon dactylon	0	0	0	1	1	0	1	1
Cyperus rotundus	27	10	20	23	20	23	10	9
Digeria arvensis	2	0	1	0	0	0	0	0
Digitaria sanguinalis	97	10	3	2	11	2	25	0
Trianthema portulacastrum	63	5	4	6	6	4	7	1
Total:-	189	26	29	33	40	30	43	13
$LSD_{0.05}$ =	39							

Table-2. Grain yield and cost/benefit ratio as affected by different pre-emergence herbicides in maize for 2001

Treatments	Grain yield kg ha^{-1}	Increase over check kg ha^{-1}	Income Rs ha^{-1}	Added Cost Rs ha^{-1}	Net benefit Rs ha^{-1}	Cost benefit ratio
Weedy control	1083	-	10289	-	10289	-
Primextra 500 FW	2917	1834	27712	2950	24762	1:4.06
Stomp 330-E	2500	1417	23750	3200	20550	1:3.75
Primextra 500 FW	1920	837	18240	1850	16105	1:3.21
Jinong 38 SL	1667	584	15837	1825	14012	1:2.04
Merline extra	1833	750	1714	-	17414	-
2,4-D	1500	477	14250	1100	13150	1:2.60
Hand weeding	2388	1305	22686	3010	18676	1:2.79
$LSD_{0.05}$	916					

Table-3. Weed density m^{-2} as affected by different pre-emergence herbicides in maize during 2002

Weeds	Weedy control	Primextra 500 FW	Primextra gold 720 S	Dual gold 960 EC	Aatrax 90 WG	Atrazine 38 SC	Stomp 330-E	Hand weeding
Convolvulus arvensis	4	2	3	2	3	4	3	1
Cynodon dactylon	4	0	0	2	2	3	2	0
Cyperus rotundus	25	19	17	7	22	4	13	4
Digeria arvensis	2	0	0	0	0	0	0	1
Digitaria ascendens	5	1	0	0	0	0	1	0
Digitaria sanguinalis	22	3	1	2	2	4	6	2
Portulaca oleracea	2	0	0	0	0	0	0	0
Sorghum halepense	3	0	0	2	3	0	0	0
Trianthma portulacastrum	5	0	0	0	0	0	2	0
Total	72	25	21	15	32	15	27	8
$LSD_{0.05}$	16.17							

Table-4. Grain yield kg ha^{-1} and cost/benefit ratio as affected by different pre-emergence herbicides in maize for 2002

Treatments	Grain yield kg ha^{-1}	Increase over check kg ha^{-1}	Income Rs. ha^{-1}	Added Cost Rs. ha^{-1}	Net benefit Rs. ha^{-1}	Cost benefit ratio
Weedy check	2333	-	20597	-	-	-
Primextra 500 FW	3733	1400	33597	2800	8400	1:3
Primextra gold 720 SC	3533	1200	31797	3000	6600	1:2.2
Dual gold 960 EC	4267	1934	38403	3100	12300	1:4
Aatrax 90 WG	4000	1667	36000	3200	10100	1:3
Atrazine 38 SC	3000	667	27000	2700	2630	1:1
Stama 330 E	2900	567	26100	2800	2340	1:1
Hand weeding	4633	2300	41697	3400	15000	1:4
LSD$_{0.05}$	846					

Table-5. Weed density m^{-2} as affected by different post-emergence herbicides in maize.

Weeds	Weedy control	Primextra 500 FW	Primextra gold 720 SC	Aatrax 90 WG	Atrazine 38 SC	Jinong 38 SL	2,4-D	Hand weeding
Cirsium arvense	6	0	0	0	0	0	0	1
Convolvulus arvensis	39	2	3	2	1	2	3	1
Cynodon dactylon	10	1	0	0	1	0	0	0
Cyperus rotundus	33	10	8	11	10	6	5	3
Digera arvensis	3	4	0	0	0	1	0	2
Digitaria ascendens	25	1	1	0	2	6	0	7
Digitaria sanguinalis	29	0	0	9	12	9	10	7
Dactyloctenium aegyptium	12	0	1	4	2	3	1	2
Echinochloa colonum	16	0	5	3	0	0	5	10
Sorghum halepense	6	1	1	2	0	0	0	0
Tranthema portulacastrum	10	2	1	0	0	5	6	3
Total	189	21	20	31	28	32	27	39
LSD		27.08						

Table-6. Maize grain yield (kg ha^{-1}) and cost/benefit ratio as affected by different post-emergence herbicides in 2002

Treatments	Grain yield kg ha Rs. ha^{-1}	Increase over check kg ha Rs. ha^{-1}	Income Rs. ha^{-1}	Cost treat. Rs ha^{-1}	Net benefit (Rs.ha^{-1})	Cost benefit Ratio
Weedy control	2133	-	-	-	-	-
Primextra 500 FW	4533	2400	21600	2800	16400	1:6.8
Primextra gold 720 SC	4000	1867	16600	3000	11900	1:5
Aatrax 90 WG	3534	1401	12600	2800	8400	1:4
Atrazine 38 SC	3867	1734	15600	2900	10900	1:5
Jinong 38 SL	2340	207	1860	2800	1650	1:1
2,4-D	2967	834	7500	2500	4100	1:2.6
Hand weeding	3667	534	13800	3400	8800	1:3.6
LSD at P=0.05	984					

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