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Economic Implications of Pree and Post-emergence Weed Control Methods in Lentil (*Lens culinaris* Medik.)

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Abstract: The study on weed control in lentil was conducted at the National Agricultural Research Centre, Islamabad during Rabi, 1987 and 1988. The performance of selected Pre-emergence herbicides; Oxadiazon, Pendimethalin, Isoproturon and Methabenzthiazuron and Post-emergence herbicides; Fomesafen, Fluazifopbutyl and Methabenzthiazuron alone and in combinations were evaluated to know their broad spectrum performance, if any; against a lentil variety Precoz. Hand weeded and weedy plots were kept for comparison of yield and economic gains. Most of the herbicides applied and hand weeded plots controlled the weeds density per unit area by 19 and 100% and significantly increased grain yield by 9 to 113% (440 kg/ha to 936 kg/ha). Among the pre-emergence weedicides, Oxadiazon gave the highest grain yield of 764 kg/ha and earned net return/per rupee investment of Rs. 1:2.15, while post-emergence treatment hand-free check (twice) gave the highest yield of 936 kg/ha or 113% increase over control (440 kg/ha) and earned net return of Rs. 1:2.86, whereas mixture of Fluazifopbutyl + Fomesafen at given rates of 0.50+0.13 a.i./ha and 0.75+0.13 a.i./ha produced 635 and 849 kg/ha respectively by controlling grasses and broad-leaved weeds to the extent of 69/100 and 75/94% and earned net returns of Rs. 1:2.14 and 1: 3.22 respectively.

Key words: Lentil, Pre and post-emergence methods of weed control, Economic analysis

Introduction

In Pakistan, 11.3% of the total crop losses are due to weeds as compared to world losses of 9.5% (Crammer, 1967). Tahira and Khan (1987) reported that annual losses caused by weeds alone may be of Rs. One billion in Pakistan. Ozair (1987) and Riaz (1991) observed that the magnitude of yield losses due to weed pest in kharif pulses range from 75-84%. Nabi and Ansari (1977) reported weeds not only compete with crop for water, light and nutrient but also impart physiological disorder to man and livestock and economic resources. Malik (1983) reported that hand weeding did not increase the seed of chickpea, while application of 1.5 kg/ha Maloran (Chlorbromuron), 2.5 kg Tribunil (Methabenzthiazuron) or 4 kg Igran (Terbutrayl)/ha increased yields from 0.82 to 0.95, 0.91 and 1.41 t/ha respectively. Pastua and Sinsky (1986) observed that pre-sowing herbicides viz Adabex, Dual and Eradicane gave good weed control and after sowing Bladex, Dual and Maloran were effective. Alhawat *et al.* (1981) investigated that clean weeding increased the yield of Bengal gram (*Cicer arietinum*), lentil (*Lens culinaris* Medik), pea (*Pisum sativum*), cowpea (*Vigna unguiculata*) and mung (*Vigna radiata*) by 107, 150, 90, 85 and 90% respectively. Weeding only once increased yields by 72, 113, 57, 40 and 2%. Mahoney (1981) found that net returns were relatively higher with chemical weed control and resulted in seed yields of 1.87 t/ha compared with 1.34 t/ha without weed control. Ali *et al.* (1988), Bernal (1981), Basler (1981), Panday (1981), Elliot (1981), Mittal and Singh (1983), Singhte *et al.* (1984), Talasava (1987), Khatiwada *et al.* (1988) and Kumar (1989) reported that the application of weedicides help in controlling weeds population, increase in grain yields and net return. Binswinger and Shethy (1977) found once hand-weeded plots of sorghum, pearl millet, groundnut, paddy, chilies, pigeonpea and chickpea increased yield by 48, 40, 81, 73, 91, 40, 48 and 60% respectively. Cultural and mechanical methods of weedings are prevalent in our country, although experimental results revealed that chemical operations have been very effective and economical (Nabi and Ansari, 1977). Singhte *et al.* (1984) investigated that incessant rains during the early crop season normally limit the weeding operations, therefore, chemical weeding under such circumstances become indispensable and can be the only mean excellent alternative. The present study was, therefore, conducted to evaluate the effectiveness and economics of

weedicides for lentil, which can be acceptable to the growers of this crop.

Materials and Methods

The experiment was planted on 10th November, 1987 and 13th November, 1988 during rabi season at National Agricultural Research Centre, Islamabad. Lentil variety Precoz was drilled manually within rows at the rate of 25 kg/ha at 30 cm inter-row spacing. Plants were thinned four weeks after sowing to maintain optimum plant population. Fertilizer was applied at 20:50:00 NPK at the time of land preparation. Crop management practices included two pre-plant ploughings and levellings with land plucker. There were no rains till 3-4 weeks after planting, therefore, flood irrigation was done. Chemical, commercial, common names, formulation, herbicide dose (kg.a.i./ha) and mode of application are given in Table 1. Pre-emergence herbicides namely Methabenzthiazuron, Pendimethalin, Oxadiazon and Isoproturon were applied at 1.25, 1.25, 3.00 and 1.50 kg a.i./ha respectively, whereas post-emergence herbicides Fluazifopbutyl and Fomesafen were applied alone and in combinations at 0.50, 0.75, 0.13, 0.50+0.13, 0.75+0.13 and 1.25 a.i. kg/ha. Hand weeding and weedy checks treatments were kept for comparison purposes. Weedicides were applied with a manually operated knapsack sprayer mounted with a hollow-cone type brass nozzle. Pre-emergence herbicides were applied three days after sowing, while post-emergence were applied when weeds attained 4-5 leaf growth stages. Weed population was low due to low natural precipitation and drought. Hence, data were also recorded on visual observations for the weed control and lentil phytotoxic herbicides (Table 2), whereas data on weed re-emergence of grass and broadleaf (Total No. and % control), fresh weed bio-mass, germination, plant height, grain yield (weight/ kg and grain loss/%) are reflected in Table 3. Harvesting was done from three randomly selected 1 m² spot in each treated plot. Three samples of chickpea were pooled and threshed. Yield data were averaged and analyzed. Economic analysis was done using the Partial Budget Method, as suggested by the Agricultural Price Commission (APCOM), (Anonymous, 1999). Cost benefit ratios were calculated by dividing extra benefits attained from the enhanced yield by the

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Table 1: Commercial, Common and Chemical names of herbicides, Formulation and doses used in the study

Chemical names	Commercial names	Common names	Formulation Type	Herbicide rate kg. A.i./ha	Application Time
1,3, Diimethyl-3-12-benzothazoly) Urea	Tribunil	Methabenzthiazuron	75% W.P.	1.25	Pre-emergence
N-(1-Ethylpropyl) 3,4, dimethylen 2,6, dinitro	Stomp	Pendi-mathalin 4E.C.	75% W.P.	1.25	---- do ----
2-tert-butyl-4-(2,4-dichloro-5, isopropyl-oxyphesyl-1,3,4,-oxadiiazoline-5-one	Ronstar	2 E.C. 75% W.P.	2 EC 75% W.P.	3.00	---- do ----
3-(4-isoprophyl phenyl-1-1-diimethylurea	Tolkan	Isoproturon	50% W.P. flowable and formulated with different combinations	1.25	---- do ----
Butyl 2-(4-5 trifluoromethyl-2-pyridyloxy (Pgebixt) oricubate	Fusilade	Fluazifopbutyl	2EC 4EC	0.50	Post-emergence
---- do ----	---- do ----	---- do ----	---- do ----	0.75	---do ---
5-(2-chloro-4- (trifluoromethyl) phenoxy)- Niimethyl-nitrobenzamide	Flex	Fomesafen	2 L.C.	0.13	---do ---
S No. 5 + S No. 7	Fusilade + Flex	Fluazifopbutyl + Fomesafen	S No. 5 + S No. 7	0.50 + 0.13	---do ---
S No. 5 + S No.7	---- do ----	---- do ----	---- do ----	0.75 + 0.13	--- do ---
S No. 1	Tribunil	Methabenzthiazuron	7% W.P.	1.25	--- do ---

Table 2: Visual observations for weed control and lentil Phytotoxicity by pre.and post-emergence herbicides

Treatment	Weed category (Rating) m2			Crop growth Remarks
	Grasses	Broadleaf	Sedges	
A. Pre-emergence				
Methabenzthiazuron	2	9	-	Excellent Stand
Pendimethalin	10	10	5	Phytotoxicity, poor germination
Oxadiazon	10	10	6	Phytotoxicity, crop recovering
Isoproturon	10	8	5	Scattered emergence but healthy plants, no chlorosis
B. Post-emergence				
Fluzipof-butyl	10	8	2	Excellent crop
Fluazifop-butyl	10	7	-	---- do ----
Fomesafen	2	10	-	---- do ----
Fluazifop-butyl + Fomesafen	10	10	-	---- do ----
Fluzifop-butyl + Fomesfen	10	10	-	Stunt growth, no apparent phytotoxicity
Methabenzthiazuron	0	10	-	Good emergence, stunted growth
Weed free (Check)	10	10	-	Excellent crop
Weedy (Check)	0	0	0	Weeds suppressed due to drought stress

Table 3: Weed control in lentil by pre. and post-emergence herbicides

Treatment	Weeds re-emergence				Fresh	Germination	Plant	Grain yield	
	Grass		Broadleaf					Weight	Grain
	Total	Control	Total	Control					
A. Pre-emergence :									
Methabenzthiazuron	0	100	40	53	425	11	37	575	31
Pendimethalin	4	50	9	89	278	76	35	352	(-)20
Oxadiazon	4	50	3	96	330	12	36	764	74
Isoproturon	6	25	29	66	1074	8	36	480	9
B. Post-emergence:									
Fluzipof-butyl	5	37	60	29	41	10	36	635	44
Fluzifop-butyl	0	100	69	19	449	12	37	511	16
Fomesafen	4	50	31	63	568	12	36	515	17
Fluzifop-butyl + Fomesfen	2	75	5	94	175	9	34	652	40
Fluzifop-butyl + Fomesafen	0	100	20	76	173	11	35	849	93
Methabenzthiazuron	8	0	4	95	750	10	40	537	22
Weed free (Check)	5	37	21	75	59	12	36	936	113
Weedy (Check)	8	-	85	-	1157	12	37	440	-

Measured by 1-m² quadrat when crop started senescence to assess the longitivity of herbicidal effects. *Fumaria indica*, *Anagalis arvensis*, *Convolvulus arvensis* *Sorghum halepense*, *Eachinochloa colona*, *Cynodon dectylon*. Note = The values are average of two years.

incurred for each treatment. Cost includes labor charges at Rs. 30/man day for 25 man days for first weeding and 20 man days for second weeding, herbicides prices, labor charges for herbicides application and equipment charges Rs. 300/- in

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Table 4: Economics of weed control methods in lentil

Treatment	Price (Rs./Kg)	Yield (Kg/ha)	Cost of weedicides (Rs./ha)	Increase in yield	Value of increase in yield	Total expenses on weed control	Net return over control	Return/ Rs. Spent
A. Pre-emergence:								
Methabenzthiazuron	295	575	369	135	1350	685	665	(-) 0.03
Pendimethalin	196	352	247	(-) 88	(-) 880	659	(-) 1458	(-) 2.21
Oxadiazon	180	764	540	324	3240	1072	2305	2.15
Isoproturon	180	480	270	117	1170	788	601	(-)0.24
B. Post-emergence:								
Fluzipof-butyl	450	635	225	262	2620	945	2024	2.14
Fluzifop-butyl	450	511	388	138	130	819	677	(-) 0.13
Fomesafen	275	515	36	142	1420	824	860	1.04
Fluzifop-butyl + Fomesafen	725	652	261	212	2120	962	1714	1.78
Fluzifop-butyl + Fomesafen	725	849	374	409	4090	1161	3741	3.22
Methabenzthiazuron	295	537	369	97	970	846	537	(-) 0.37
Weed free (Check)	-	936	1050	496	4960	1365	3910	2.86
Weedy (Check)	-	440	-	-	-	-	-	-

extra costs each case and threshing at Rs. 10/40 kg of lentil (Table 4).

Results and Discussion

Pre-emergence herbicides, Methabenzthiazuron, Pendimethalin, Oxadiazon and Isoproturon were applied at of 1.25 to 3.0 kg a.i./ha and controlled grasses and broad leaf weeds by 100 and 96% respectively. However, initially crop germination suffered from toxic effects of the herbicides at seedling stage in case of Oxadiazon, which was recovered during vegetative growth stage. Other pre-emergence herbicides suppressed the crop growth in general. On an average weed control was obtained by these herbicides (Table 3).

Longevity of pre-emergence herbicides observed through weed quadratic analysis which reveals that Methabenzthiazuron gave good prolonged grass check and medium broad leaf weed control whereas Pendimethalin and Oxadiazon checked 90-96% broadleaf weeds until the end of the crop season. The higher number of weed per quadrat and the subsequent higher fresh weed biomass in Isoproturon treated plots indicate the least persistence throughout the crop season. Pendimethalin though gave a medium broad spectrum weed control and hence least weed biomass and significant crop phytotoxicity reduced yield significantly. Butler and Alexander (1987) and Stringi *et al.* (1988) found that *L. culinaris* tolerated Bladex, Sincor, Stomp, Actazine and Gardoprim at 1,5, 0.35, 1.0, 0.75 and 1.0 kg/ha. After the hand weeded (check), the highest grain yield was to the tune of 74% in case of Oxadiazon, followed by Methabenzthiazuron, which corresponds to medium weed control accumulating the lowest weed biomass. These results are in conformity with Singh *et al.* (1985) that Fluchoralin and Methabenzthiazuron at 1.5 kg/ha pre-em. Increased yield by 79 and 66% respectively. Schultz *et al.* (1984) found that pre-em. application of herbicides alone and in combination controlled weeds by 66-100% and 96-98% in peas and lentil. Aretit applied as post-em. against broadleaved weeds was practically phytotoxic to lentil crop.

Fluazifop-butyl at both the rates of 0.50 and 0.75 kg a.i./ha and in combination with Flex at 0.13 kg a.i./ha controlled 100% grasses. Fomesafen alone or with Fluazifop-butyl caused slight phytotoxicity to lentil which however, was recovered at the advanced growth stages. Methabenzthiazuron remained very effective as pre. and post-emergence herbicide. It had no check on grasses but effectively controlled broad-leaf weeds.

Post-emergence Methabenzthiazuron although significantly reduced the weed biomass and subsequently increased the grain yield by 9 to 113% over control. Its performance as post-emergence application was not very appreciable as more grasses were prevalent after the mid season of the crop (Table 2, 3). Mixture of Fluazifopbutyl at 0.75 + 0.13 kg a.i./ha gave the highest broad-spectrum weed kill and the lowest weed biomass, consequently yielded 849 kg/ha grain yield which was the highest increase over weedy check and next after the weed free check. Similarly 75 and 94% control of grass and broad leaf by the same mixture accumulated 175 grams weed biomass at the end of the season which was again highly non-significant and, therefore, grain yield increase was 48% over the weedy check. Each of these herbicides while used alone, gave an appreciable control of either group of weeds which gave significantly higher grain yield, but lower than when mixed together (Table 3). Kukula *et al.* (1985) found that post-emergence herbicides are not recommended due to possible phytotoxic effects, however, 1 kg a.i./ha of Fusilade (Fluazifop-butyl) proved selective control of grass weeds, if applied when grasses were 10-15 cm high. Similar results were also reported by Gill and Brar (1977), Jalis *et al.* (1977), Misra and Tosh (1978), Gill *et al.* (1978) and Majeed *et al.* (1983). Yadav and Singh (1988) reported that Tribunil at 0.75 and 1.50 kg/ha provided the highest yields from chemical control (2.2 t and 2.09 t resp.) followed by Basalin at 0.5 and 1.0 kg. Fusilade was the least effective herbicide and some phytotoxicity was noted from Ronstar (Oxadiazon) which was tested at 0.75-1.50 kg.

All the herbicides, except nitrofen gave more than 100% higher grain yield of green gram than the unweeded control, but Trifluralin and Chloramben proved more promising in clusterbean, giving yield equal to that of hand-weeded treatment (Daulay and Singh, 1982). Hand weeding controlled grasses and broadleaf weeds by 37 and 75% respectively in both the years because of labor intensive strategy, which is even beyond the resource poor farmer. Haqqani *et al.* (1989), Bhardwaj (1978), Misra and Tosh (1978) and Majeed *et al.* (1983) also confirmed these results that hand weeding (generally 2 hoeings and one hand weeding) are as better or at least comparable with chemical herbicides.

Economic analysis: The economic analysis revealed that application of weedicides seems to be economical in all treatments over hand-weeding and more specially over control in enhancing yield level by 9% to 113% (Table 3). Relatively high to low level per Rs. spent was calculated at the tune of Rs. 3.22, 2.86, 2.15, 2.14, 1.78 and 1.04 in case of Fluzifop-butyl + Fomesafen, hand-weeding, Isoproturon, Fluzifop-butyl (alone), Fluzifopbutyl + Fomesafen and Fomesafen (Table 4). Oxadiazon proved its worth in controlling weeds as a pre-emergence herbicide while others responded negative returns. Similar results were reported by Bhardwaj (1978). Majeed and Hussain (1983) and Tahira and Khan (1987) reported that amongst the herbicides and cultural practices, Dicuron M.A. 60 W.P. not only controlled the maximum weeds (96.87) but also yielded the highest return of 3.30/rupee invested, registering an increase of 37% over control. Riaz (1991) found that application of Pendimethalin at 1 kg. a.i./ha and hand weeding at 14 and 28 days after emergence (DAE) increased yield of mungbean by 83% and earned highest cost: benefit ratio of 1:4.95. It is concluded that Dicuron M.A. 60 W.P. at of 2.5 kg/ha, Buctril M at 1.75 l/ha, hand weeding and bar harrowing gave higher grain yield of 55.7, 39.8, 34.9 and 11.0% respectively. Zafar (1988) and Hawkins *et al.* (1971) concluded that the profitability of herbicide use was very high, ranging from US \$ 3.30 to \$ 4.89/\$. The results are also in agreement that net return/ha given by hand weeding and weed-free are \$ 213 and \$ 146-426 respectively. On the basis of present findings, Oxadiazon, Fluzifopbutyl alone and in combination with Fomesafen and Fomesafen alone are recommended as pre. and post-emergence herbicides to benefit the farming community as a whole.

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