

Bioefficacy of Imazethapyr and Chlorimuron-ethyl in Clusterbean and their Residual Effect on Succeeding Rabi Crops

S. S. Punia, Samunder Singh and Dharambir Yadav

Department of Agronomy

CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

ABSTRACT

Bioefficacy and phytotoxicity of imazethapyr and chlorimuron in clusterbean and its carryover effect on succeeding **rabi** crops was studied in field experiments at CCSHAU, Hisar during **kharif** 2006-07 and 2007-08. Weed flora of the experimental field was dominated by *Digera arvensis*, *Trianthema portulacastrum*, *Physallis minima*, *Corchorus olitorius*, *Solanum nigrum* and *Cyperus rotundus*. Post-emergence application of chlorimuron at 6 and 8 g/ha although provided good (90-92%) control of weeds but caused 20-30% injury to clusterbean resulting in severe yield reductions. PPI (pre-plant incorporation), PRE (pre-emergence) and POE (post-emergence) application at 21-28 DAS at 80-100 g/ha of imazethapyr provided season long control (85-95%) of clusterbean weeds. POE application of imazethapyr at 80 and 100 g/ha although caused mild injury to clusterbean in terms of yellowing of leaves and stunted crop growth upto 7 DAT, but it diminished within three weeks without any yield reduction. Maximum seed yield (1424 kg/ha) of clusterbean was obtained with imazethapyr at 100 g/ha PRE which was at par with weed free check, but during 2007, PRE application of imazethapyr at 80 g/ha gave maximum seed yield (1720 kg/ha) which was at par with its application at 80 and 100 g/ha as PRE, PPI or post-emergence 21 DAS. Chlorimuron and imazethapyr, irrespective of their dose and time of application, did not cause any injury to wheat, barely and chickpea planted as succeeding crop after harvest of clusterbean, but both these herbicides caused severe injury to mustard.

Key words : Efficacy, crop injury, residual effect, mustard, wheat, barely, chickpea

INTRODUCTION

Clusterbean is an important **kharif** season catch crop of south-western Haryana. It is a drought tolerant legume and excellent rotational crop with mustard, wheat, chickpea and barely. Clusterbean is a poor competitor with weeds and suffers heavily due to the presence of *Digera arvensis*, *Trianthema portulacastrum*, *Cleome viscosa*, *Dactyloctenium aegypticum*, *Physallis minima*, *Cenchrus echinatus*, *Brachiaria* sp., *Amaranthus* sp., *Cyperus* sp., *Cynodon dactylon* and *Corchorus olitorius* from the early growth stage due to favourable environment for weeds to thrive well (Anonymous, 2007). Critical period of crop-weed competition in clusterbean has been identified as 20-30 days after sowing (DAS) and presence of weeds beyond this results in yield reductions by 47 to 92% (Bhadoria *et al.*, 2000). Many pre-emergence (PRE) and pre-plant incorporated (PPI) herbicides such as pendimethalin, fluchloralin and trifluralin recommended for use in clusterbean do not control entire weed flora and are not effective for a adequate length of time, requiring hand

weeding to prevent yield loss from escaped weeds. No post emergence herbicide is registered for use in clusterbean. As this crop is phenotypically similar to soybean, so herbicides with longer residual activity such as chlorimuron and imazethapyr which provide season long weed control in soybean (Claus, 1987; Krausz *et al.*, 1992) may provide effective weed control in clusterbean also. Imazethapyr controls monocot and dicot weeds when applied PRE, PPI or post-emergence (POE) and has a strong residual life (Taylor *et al.*, 1988). Keeping it in view, field experiments were planned to study the effect of application time and dose of imazethapyr and chlorimuron on weed control and crop injury in clusterbean and residual carryover effect of these herbicides on the succeeding **rabi** crops.

MATERIALS AND METHODS

To evaluate the bioefficacy of imazethapyr and chlorimuron-ethyl and their residual effect on succeeding crops, an experiment was conducted during **kharif** and **rabi** seasons of 2006-07 and 2007-08 at Agronomy

Research Area of CCS Haryana Agricultural University, Hisar. The experimental soil was sandy loam (Typic Ustochrepts) with 61% sand, 22.1% silt and 19.1% clay, medium in fertility with 0.29% organic carbon and a pH of 8.2. Clusterbean variety HG-365 was drilled on July 21, 2006 and July 14, 2007 in a plot size of 20 x 4.5 m, keeping row to row distance of 45 cm by using a seed rate of 18 kg/ha. The study was arranged in randomized block design replicated thrice. Recommended doses of fertilizers and irrigations were applied uniformly. Herbicides, chlorimuron and imazethapyr, were applied at various doses and times and compared with trifluralin, fluchloralin and pendimethalin (Table 1). Due to severe crop toxicity, chlorimuron at 6 and 8 g/ha treatments 28 DAS were replaced with imazethapyr at 80 and 100 g/ha 21 DAS in the second year. To study the residual effect of herbicides applied in clusterbean after its harvest on succeeding **rabi** crops, clusterbean, wheat, barley, mustard and chickpea were sown after slight disking the field without disturbing the original layout. Clusterbean plot size of 20 x 4.5 m was divided into four equal parts for each crop. These crops were raised as per package of practices recommended by CCSHAU, Hisar. Visual injury ratings to clusterbean were estimated at 7 and 21 days after treatment (DAT) on a scale of 0=no clusterbean injury to 100=complete clusterbean mortality. Above ground weed biomass was sampled 60

DAS using a quadrant of 0.5 x 0.5 m. Plant material was dried at 65°C for 48 h before determining dry weight and this was used for calculating weed control efficiency (WCE). Data on weed density, weed control efficiency, per cent weed control, crop injury and seed yield of clusterbean were analyzed by analysis of variance, and means were separated with least significant difference at the 0.05 level of significance. To measure the residual effect of herbicides applied in clusterbean on **rabi** crops, data on plant height, number of leaves/plant and fresh weight/plant were recorded 30 DAS and grain yield of these **rabi** crops was recorded at maturity. Based on data of weed dry weight 60 DAS, WCE was calculated by the formula given below :

$$\text{WCE (\%)} = \frac{\text{Weed dry weight in weedy check} - \text{Weed dry weight in treated plot}}{\text{Weed dry weight in weedy check}} \times 100$$

RESULTS AND DISCUSSION

Effect of Herbicides in Clusterbean

During 2006, weed flora of the clusterbean field consisted mainly of *D. arvensis* (49%), *T. portulacastrum* (21%), *P. minima* (17%) and *S. nigrum*

Table 1. Effect of different herbicides on weeds and clusterbean (2006-07)

Treatments	Dose (g/ha)	Time of application	Weed density (No./m ²) 45 DAS			WCE (%)	Visual weed control (%)		Crop phytotoxicity (%)		Seed yield (kg/ha)
			<i>Digera arvensis</i>	<i>Trianthema portulacastrum</i>	<i>Physallis minima</i>		30 DAS	60 DAS	7 DAT	21 DAT	
Trifluralin	1000	PPI	1.3 (1.51)	1.7 (1.64)	2.6 (1.89)	48.5	70	45	0	0	1225
Pendimethalin	1000	PRE	1.0 (1.41)	0.6 (1.26)	0 (1)	52.0	70	40	0	0	1190
Fluchloralin	750	PPI	2.0 (1.73)	1.7 (1.64)	2.6 (1.89)	43.8	75	45	0	0	1266
Chlorimuron	6	21 DAS	0.4 (1.18)	0 (1)	1.3 (1.5)	86.0	-	90	15	20	896
Chlorimuron	8	21 DAS	0 (1)	0 (1)	0 (1)	89.6	-	92	15	25	852
Chlorimuron	6	28 DAS	0 (1)	2.1 (1.76)	0 (1)	83.3	-	90	20	30	782
Chlorimuron	8	28 DAS	0 (1)	1.7 (1.64)	0 (1)	90.7	-	92	20	32	810
Imazethapyr	80	PPI	0 (1)	0 (1)	0.6 (1.26)	88.7	95	90	0	0	1380
Imazethapyr	100	PPI	0 (1)	0 (1)	0 (1)	92.6	98	92	0	0	1418
Imazethapyr	80	PRE	0 (1)	0 (1)	1.3 (1.51)	90.0	65	90	0	0	1390
Imazethapyr	100	PRE	0 (1)	0 (1)	0 (1)	94.0	67	90	0	0	1424
Imazethapyr	80	21 DAS	1.7 (1.64)	3.3 (2.07)	0 (1)	88.6	-	82	5	2	1360
Imazethapyr	100	21 DAS	0 (1)	1.7 (1.64)	0 (1)	92.0	-	85	5	12	1364
Imazethapyr	100	28 DAS	0 (1)	3.3 (2.07)	0 (1)	94.3	-	85	3	0	1376
Weed free	-	-	0 (1)	0 (1)	0 (1)	100	100	100	0	0	1482
Weedy check	-	-	46.7 (6.9)	11.3 (3.5)	14.0 (3.87)	0	0	0	0	0	688
LSD (P=005)			0.34	0.39	0.26	6.2	5.0	3.6	-	-	74

(2%) as broadleaf weeds and *Cyperus iria* (4%) among sedges. In 2007, *D. arvensis* with a relative density of 61% was the most dominant weed followed by *P. minima* (13%), *C. olitorius* (9%) and *Phyllanthus niruri* (4%) as broadleaf weeds and *C. iria* (3%) among sedges.

All herbicide treatments proved very effective against weeds (Table 1). Clusterbean was very sensitive to chlorimuron and its POE application 21 and 28 DAS caused leaf chlorosis, growth stunting, yellowing and black lesions on leaves. Injury ratings were relatively low 7 DAT but increased 21 DAT. Although symptoms of general plant stunting and yellowing of clusterbean leaves developed with imazethapyr at 80 and 100 g/ha 21 DAS, but to a lesser degree as shown by data on injury rating 7 DAT and the crop recovered by 21 DAT (Tables 1 and 2) without any reduction in seed yield of clusterbean. Similar stunting and chlorosis on clusterbean with the use of chlorimuron and imazethapyr was observed by Olson *et al.* (2007). Trifluralin and fluchloralin (PPI) at 1.0 and 0.75 kg/ha, respectively, and PRE application of

pendimethalin at 1.0 kg/ha although provided 70-75% control of weeds up to 30 DAS, but 60 DAS, due to fresh emergence of weeds, visual control of weeds reduced to 40-50% in all these herbicides during both the seasons (Tables 1 and 2). Application of imazethapyr either as PPI or PRE at 80 and 100 g/ha each provided 80-90% control of weeds up to 60 DAS without any phototoxic effect on clusterbean. Post-emergence application of chlorimuron (6 and 8 g/ha) 28 and 35 DAS although provided 80-90% control of weeds particularly *D. arvensis* and *P. minima*, but caused 20-30% phytotoxicity to clusterbean in both the years of experimentation. During 2006, maximum seed yield of clusterbean (1684 kg/ha) was obtained in weed free check which was at par with imazethapyr at 100 g/ha applied as PPI as well as pre emergence, but during 2007 maximum seed yield (1720 kg/ha) was obtained with imazethapyr at 80 g/ha applied PRE which was at par with imazethapyr at 80 g/ha applied as PPI and 21 DAS, imazethapyr at 100 g/ha as PPI or PRE and weed free treatments.

Table 2. Effect of different herbicides on weeds and clusterbean (2007-08)

Treatments	Dose (g/ha)	Time of application	Weed density (No./m ²) 45 DAS			WCE (%)	Visual weed control (%)		Crop phytotoxicity (%)		Seed yield (kg/ha)
			<i>Digera arvensis</i>	<i>Trianthema portulacastrum</i>	<i>Physallis minima</i>		30 DAS	60 DAS	7 DAT	21 DAT	
Trifluralin	1000	PPI	2 (1.73)	2.3 (1.81)	3.3 (2.1)	50	75	50	0	0	1466
Pendimethalin	1000	PRE	1.3 (1.51)	2.3 (1.81)	3.0 (2.0)	54	78	52	0	0	1493
Fluchloralin	750	PPI	2.6 (1.89)	3.0 (2.1)	3.8 (2.19)	48	70	40	0	0	1420
Chlorimuron	6	21 DAS	0 (1)	1.0 (1.41)	1.5 (1.58)	83	80	90	20	25	1268
Chlorimuron	8	21 DAS	0 (1)	0 (1)	0.6 (1.26)	87	80	70	20	25	1260
Imazethapyr	80	PPI	0 (1)	0.6 (1.26)	0 (1)	89	95	85	0	0	1680
Imazethapyr	100	PPI	0 (1)	0 (1)	1.5 (1.58)	86	100	80	0	0	1680
Imazethapyr	80	PRE	0 (1)	0 (1)	0.9 (1.37)	90	95	85	0	0	1720
Imazethapyr	100	PRE	0 (1)	0 (1)	1.3 (1.51)	79	95	90	0	0	1696
Imazethapyr	80	21 DAS	0 (1)	0.3 (1.14)	1.5 (1.58)	76	65	92	5	0	1696
Imazethapyr	100	21 DAS	0 (1)	0.7 (1.3)	0 (1)	72	68	95	8	2	1584
Imazethapyr	60	30 DAS	0 (1)	1.3 (1.51)	1.3 (1.51)	94	-	90	0	0	1588
Imazethapyr	80	30 DAS	0 (1)	0.6 (1.26)	1.3 (1.51)	85	-	90	5	0	1648
Imazethapyr	100	30 DAS	0 (1)	0 (1)	1.7 (1.64)	89	0	90	10	1	1604
Weed free	-	-	0 (1)	0 (1)	0 (1)	100	100	100	0	0	1696
Weedy check	-	-	39.6 (6.37)	8.5 (3.08)	6.8 (2.6)	0	0	0	0	0	1048
LSD (P=0.05)			0.42	0.29	0.49	6.6	3.7	7.0	-	-	114

Residual Effect of Herbicides Applied in Clusterbean on Succeeding Rabi Crops

During 2006-07, plant height of wheat, barely

and chickpea did not vary significantly due to the residual effect of herbicides applied in clusterbean, but plant height of mustard was significantly reduced by imazethapyr and chlorimuron compared to pendimethalin, trifluralin,

pendimethalin, weed free and untreated weedy (Table 3). Fresh weight/plant, plant height and number of leaves/plant 75 DAS and seed yield varied significantly only among mustard crop treatments. Fresh weight/plant in imazethapyr and chlorimuron treated plants was 2.8-4.8 g/plant as against 141-148 g/plant in untreated check during 2006-07, whereas during 2007-08, residues of chlorimuron and imazethapyr caused less injury to succeeding crop of mustard as compared to 2006-07, as shown by data on fresh weight/plant, number of leaves/plant, plant height and seed yield of mustard (Table 5). Imazethapyr applied at 80 g/ha either PPI, PRE or 21 DAS did not cause any reduction in fresh weight/plant, number of leaves/plant and plant height and seed yield of mustard in comparison to untreated check, but residues of 100 g/ha application reduced the plant height, number of leaves/plant, fresh weight/plant and seed yield of mustard significantly over untreated check and other recommended herbicides. It might be due to enhanced microbial degradation of these herbicides due to 254 mm of rainfall occurred between time of herbicide application and planting of mustard in **kharif** 2007. During **kharif** 2006, amount of rainfall was only 85

mm, so little microbial dissipation due to drier conditions might have occurred which may be responsible for high residual carrying over on mustard that year. Leon and Reinhardt (2001) reported leaching of imazethapyr in coarse textures soils with low in clay and organic matter content. Johnson and Talbert (1993) also observed injury to mustard crop planted after 16 weeks following application of chlorimuron. Growth of canola (*Brassica napus* L.) was reduced by imazethapyr residues after 40 months of application (Anonymous, 1998). Similarly, seed yield of barley, gram and wheat was not affected due to residues of chlorimuron and imazethapyr and other herbicides applied in clusterbean (Tables 4 and 6). No injury to wheat crop was observed with the application of chlorimuron (20-140 g/ha) and imazethapyr (50-300 g/ha) applied in soybean (Talbert *et al.*, 1989; Krausz *et al.*, 1992).

So, on the basis of two years' study, it can be summarized that imazethapyr at 80 g/ha applied at PPI, PRE or POE 21 DAS can be safely used for weed control in clusterbean if wheat, barely and chickpea are to be planted as succeeding crops, but mustard should not be planted after use of these two herbicides.

Table 3. Residual effect of different herbicides applied in clusterbean on succeeding **rabi** crops (2006-07)

Treatments	Dose (g/ha)	Time of application	Plant height (cm) 75 DAS				Fresh weight/plant (g) 75 DAS				No. of leaves/plant 75 DAS
			Barley	Wheat	Mustard	Chickpea	Barley	Wheat	Mustard	Chickpea	Mustard
Trifluralin	1000	PPI	77.8	35.0	91.5	33.3	39.4	28.1	148.0	7.4	28
Pendimethalin	1000	PRE	72.7	33.0	91.7	35.3	39.7	27.8	142.5	7.1	29
Fluchloralin	750	PPI	73.9	34.5	93.4	36.0	38.0	28.5	145.4	7.8	36
Chlorimuron	6	21 DAS	75.0	37.0	28.0	33.0	38.3	30.0	2.8	7.9	6
Chlorimuron	8	21 DAS	78.7	35.0	31.6	31.6	35.8	31.4	4.6	6.3	5
Chlorimuron	6	28 DAS	77.5	37.0	34.6	35.0	35.4	26.9	4.1	7.4	6
Chlorimuron	8	28 DAS	71.8	36.0	30.2	34.6	38.1	29.3	2.9	7.5	4
Imazethapyr	80	PPI	73.8	36.5	30.1	36.0	37.8	30.5	3.2	7.3	5
Imazethapyr	100	PPI	76.9	36.5	33.3	35.0	36.5	29.6	4.5	8.1	3
Imazethapyr	80	PRE	77.2	36.5	34.0	32.6	37.2	27.6	3.8	7.2	5
Imazethapyr	100	PRE	79.2	37.0	37.7	34.6	35.0	31.0	4.6	8.0	4
Imazethapyr	80	21 DAS	76.8	36.5	21.4	34.0	36.5	29.6	2.5	7.3	5
Imazethapyr	100	21 DAS	79.2	36.8	15.3	33.3	37.0	28.6	2.4	7.8	3
Imazethapyr	100	28 DAS	74.1	36.5	36.4	32.3	38.0	28.3	4.8	7.7	5
Weed free	-	-	76.2	36.0	91.7	36.0	37.5	26.9	145.5	7.5	36
Weedy check	-	-	74.7	37.2	92.5	36.1	35.7	26.6	141.2	7.8	38
LSD (P=0.05)			NS	NS	3.5	NS	NS	2.8	0.45	NS	2.2

NS–Not Significant.

Table 4. Residual effect of different herbicides applied in clusterbean on succeeding **rabi** crops yield (2006-07)

Treatments	Dose (g/ha)	Time of application	Barley	Wheat	Mustard	Chickpea
Trifluralin	1000	PPI	4260	4600	1550	1640
Pendimethalin	1000	PRE	4180	4820	1496	1600
Fluchloralin	750	PPI	4000	4800	1420	1560
Chlorimuron	6	21 DAS	4200	4750	110	1480
Chlorimuron	8	21 DAS	4140	4700	116	1560
Chlorimuron	6	28 DAS	4250	4694	126	1480
Chlorimuron	8	28 DAS	4200	4860	134	1540
Imazethapyr	80	PPI	4000	4800	129	1620
Imazethapyr	100	PPI	4360	4960	120	1580
Imazethapyr	80	PRE	4260	4860	136	1596
Imazethapyr	100	PRE	4200	4750	158	1487
Imazethapyr	80	21 DAS	4180	4900	204	1850
Imazethapyr	100	21 DAS	4000	4820	125	1700
Imazethapyr	100	28 DAS	4208	4900	120	1680
Weed free	-	-	3980	4830	1480	1580
Weedy check	-	-	4100	4820	1460	1600
LSD (P=0.05)			NS	NS	220	NS

NS–Not Significant.

Table 5. Residual effect of different herbicides applied in clusterbean on succeeding **rabi** crops (2007-08)

Treatments	Dose (g/ha)	Time of application	Plant height (cm) 75 DAS				Fresh weight/plant (g) 75 DAS				No. of leaves/plant 75 DAS
			Barley	Wheat	Mustard	Chickpea	Barley	Wheat	Mustard	Chickpea	Mustard
Trifluralin	1000	PPI	78.4	38.0	96.5	35.6	45.6	34.5	164.0	10.2	30
Pendimethalin	1000	PRE	76.7	37.0	96.2	34.5	43.8	36.2	172.0	9.6	32
Fluchloralin	750	PPI	78.0	38.3	97.4	36.2	44.0	35.0	165.9	8.7	29
Chlorimuron	6	21 DAS	76.0	38.6	45.0	36.0	45.3	34.9	34.6	9.6	11
Chlorimuron	8	21 DAS	77.3	37.6	452	34.9	42.9	32.8	31.4	8.4	12
Imazethapyr	80	PPI	75.8	38.4	85.9	35.0	42.9	34.0	173.2	9.2	28
Imazethapyr	100	PPI	76.0	37.0	42.5	34.1	43.9	35.2.	46.7	9.0	18
Imazethapyr	80	PRE	77.0	38.6	84.0	34.0	43.6	35.4	178.6	10.8	26
Imazethapyr	100	PRE	77.2	38.4	39.8	36.8	45.0	36.7	45.8	8.7	13
Imazethapyr	80	21 DAS	77.0	37.2	91.4	34.9	44.0	35.4	182.3	9.4	27
Imazethapyr	100	21 DAS	79.0	36.9	65.1	35.0	45.2	35.1.	37.9	7.9	14
Imazethapyr	60	30 DAS	76.4	38.0	91.7	36.0	44.7	33.4	175.6	8.4	30
Imazethapyr	80	30 DAS	77.0	38.0	96.3	35.8	45.0	33.9	185.6	7.9	12
Imazethapyr	100	30 DAS	74.8	36.5	93.0	36.2	45.0	33.0	177.4	7.8	25
Weed free	-	-	75.6	38.4	62.0	35.7	45.0	33.8	40.6	8.5	12
Weedy check	-	-	76.5	38.0	92.5	35.1	44.0	34.6	181.0	7.8	28
LSD (P=0.05)			NS	NS	3.1	NS	NS	NS	4.7	NS	3.1

NS–Not Significant.

Table 6. Residual effect of different herbicides applied in clusterbean on succeeding **rabi** crops yield (2007-08)

Treatments	Dose (g/ha)	Time of application	Barley	Wheat	Mustard	Chickpea
Trifluralin	1000	PPI	3774	3774	1667	1570
Pendimethalin	1000	PRE	3940	3940	1708	1532
Fluchloralin	750	PPI	3996	3996	1692	1508
Chlorimuron	6	21 DAS	3829	3829	840	1167
Chlorimuron	8	21 DAS	3857	3857	810	1160
Imazethapyr	80	PPI	3940	3940	1826	1600
Imazethapyr	100	PPI	3968	3968	1302	1167
Imazethapyr	80	PRE	4079	4079	1627	1590
Imazethapyr	100	PRE	3857	3857	1429	1600
Imazethapyr	80	21 DAS	4107	4107	1786	1650
Imazethapyr	100	21 DAS	3918	3918	1230	1720
Imazethapyr	60	30 DAS	3774	3774	1588	1580
Imazethapyr	80	30 DAS	3996	3996	1548	1608
Imazethapyr	100	30 DAS	3900	3900	1180	1572
Weed free	-	-	3900	3900	1682	1572
Weedy check	-	-	4020	4020	1607	1167
LSD (P=0.05)			NS	NS	126	NS

NS–Not Significant.

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