



Efficacy of post-emergence herbicide imazethapyr for weed management in different mungbean (*Vigna radiata*) cultivars

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Mungbean [*Vigna radiata* (L.) Wilczek] is an important pulse crop grown in India. During 2008-09, it was grown on 2.84 million hectares with a production of 1.03 million tonnes of grain, giving an average yield of 386 kg/ha (Anonymous 2011) which is much below the potential yield. Weed infestation is one of the major factors limiting growth and productivity of mungbean. Weeds compete with crop for space, nutrients, water and light and reduce the grain yield of mungbean by 23.5-45.8% (Punia *et al.* 2004). Presently, only pre-plant/pre-emergence herbicides are available which are recommended to control weeds in mungbean. As mungbean is sown during rainy season, sometimes due to early rains soon after sowing make it impossible to spray pre-emergence herbicides. Further, many times weeds emerge at a later stage, which need to be controlled with post-emergence herbicide. Therefore, there was a need to find out effective post-emergence herbicidal weed management in mungbean.

Imazethapyr is an imidazolinone herbicide and it has soil and foliar activity, thus allowing flexibility in application timing. Previous studies reported promising results of imazethapyr when applied post-emergence at 50 to 75 g/ha in dry beans (Blackshaw and Esau 1991, Arnold *et al.* 1993), at 75-100 g/ha in soybean (Raskar and Bhoi 2002), in blackgram at 100 g/ha (Sumachandrika *et al.* 2003) and at 48 and 96 g/ha in mungbean (Windley *et al.* 1999). Cultivars of a crop may differ in tolerance to herbicides so, the present study was carried out to find the efficacy of imazethapyr against weeds in mungbean and to investigate the tolerance of different mungbean cultivars to imazethapyr sprayed as post-emergence.

A field experiment was conducted during *kharif* 2008 and 2009 at the experimental area of Punjab Agricultural University, Ludhiana on mungbean. The soil of the experimental field was loamy sand in texture, normal in soil reaction, medium in organic carbon, low in available

nitrogen, phosphorus and potassium. The experiment was laid out in a split plot design with eight weed control treatments [Imazethapyr at three doses, i.e. 50, 75 and 100 g/ha sprayed 15 or 25 days after sowing (DAS), two hand weeding (20 and 40 DAS) and unweeded control] in the main plots and three mungbean cultivars (ML 267, ML 818 and PAU 911) in the sub plots. Seedbed was prepared by two cultivations followed by double planking. The sowing was done on 14 July and 5 July in 2008 and 2009 respectively in rows 30 cm apart using a seed rate of 20 kg/ha for all the cultivars. The spray of herbicide was done with the help of knap-sack sprayer fitted with flat fan nozzle using 250 litres of water/ha. Other practices were adopted as per the recommendations.

The data on weeds were recorded by putting a 50 cm × 50 cm quadrat at two random spots in each plot. At maturity, data on plant height, branches/plant, pods/plant and 100-seed were recorded. Biological yield and grain yield were recorded on a plot basis and harvest index was calculated. Data so collected were analyzed statistically using analysis of variance (ANOVA). Weed control efficiency (WCE) was calculated by the given formula:

$$WCE = [(Dry\ weight\ of\ weeds\ in\ weedy\ check - dry\ weight\ of\ the\ weeds\ in\ treatment) \times 100] / Dry\ weight\ of\ weeds\ in\ weedy\ check$$

Gross returns were calculated by taking the sale price of mungbean as ₹ 36/kg. Net returns and benefit : cost ratio were also worked out.

The major weed flora in the experimental fields included *Dactyloctenium aegyptiacum* (crow foot grass), *Cyperus rotundus* (purple nut sedge), *Cynodon dactylon* (bermuda grass), *Commelina benghalensis* (benghal dayflower), *Eragrostis pilosa* (soft love grass), *Trianthema portulacastrum* (horse purslane), *Digitaria arvensis* (wild crab grass) etc. during the two years of study. All weed control treatments significantly reduced the weed dry weight (Table 1). In 2008, both at 60 DAS and at harvest, the minimum dry weight of weeds was recorded in two hand weeding (20 and 40 DAS) which was significantly lower than all other weed control treatments. Among the different herbicide treatments, lowest weed dry weight, when recorded

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Table 1 Effect of imazethapyr on dry matter of weeds and weed control efficiency in mungbean

Treatment	Dry matter of weeds (kg/ha)			Weed control efficiency (%)		
	At 60 DAS		At harvest	At 60 DAS		At harvest
	2008	2008	2009	2008	2008	2009
Weed control treatments						
Imazethapyr 50 g/ha 15 DAS	679	808	1036	68.3	69.6	52.4
Imazethapyr 75 g/ha 15 DAS	564	705	628	73.7	73.4	71.1
Imazethapyr 100 g/ha 15 DAS	526	628	541	75.4	76.3	75.1
Imazethapyr 50 g/ha 25 DAS	833	1013	1172	61.1	61.8	46.1
Imazethapyr 75 g/ha 25 DAS	654	782	968	69.5	70.5	55.5
Imazethapyr 100 g/ha 25 DAS	577	654	750	73.0	75.4	65.5
Two hand weedings (20 and 40 DAS)	346	423	526	83.8	84.1	75.8
Unweeded control	2141	2654	2175			
CD ($P = 0.05$)	145	180	159			
Cultivars						
ML 267	793	986	947			
ML 818	850	990	970			
PAU 911	726	899	1006			
CD ($P = 0.05$)	NS	NS	NS			

at 60 DAS and at harvest during 2008, was recorded in imazethapyr at 100 g/ha applied at 15 DAS and was on par with imazethapyr at 75 g/ha at 15 DAS, imazethapyr at 75 and 100 g/ha at 25 DAS but significantly lower than imazethapyr at 50 g/ha at 15 and 25 DAS. During 2009, minimum dry weight of weeds was recorded in two hand weedings which was on par with imazethapyr at 75 and 100 g/ha applied at 15 DAS but significantly lower than all other weed control treatments. Ram and Singh (2011) also reported that in soybean, application of imazethapyr at 75 g/ha at 20-25 DAS resulted in minimum weed biomass which was significantly lower than weedy check. Different mungbean cultivars showed non-significant differences with respect to their weed suppression potential (Table 1) during both the years of the study.

During 2008, weed control efficiency was highest in two hand weedings followed by imazethapyr at 75 g/ha sprayed 15 or 25 DAS and 100 g/ha at 25 DAS. During 2009, two hand weedings and imazethapyr at 100 g/ha applied at 15 DAS gave similar WCE which might be due to similar dry weight of weeds in these treatments. Weed control efficiency was lowest in imazethapyr at 50 g/ha at 15 as well as 25 DAS due to poor weed control at lower dose during both the years.

The weed management practices improved growth (plant height and branches/plant) and yield attributes (pods/plant and seeds/pod) of mungbean over unweeded control (Table 2). The differences with respect to plant height and branches/plant were found to be non-significant during 2008, whereas in 2009, maximum plant height was recorded in two hand weedings which was significantly higher than all other weed management treatments and unweeded control. During 2009, all the weed management treatments resulted in significantly higher branches/plant over

unweeded control. This shows that application of imazethapyr at different doses and at different times had no adverse effect on growth of mungbean. During 2008, application of imazethapyr at 100 g/ha at 15 DAS resulted in maximum pods/plant which were on par with imazethapyr at 75 g/ha at 15 DAS and two hand weedings and significantly higher than all other weed control treatments. Similar trends for pods/plant in different weed control treatments were observed during 2009. Ram and Singh (2011) also reported that post-emergence application of imazethapyr at 75 g/ha at 20-25 DAS resulted in significantly higher pods/plant than weedy check but on par with two hand weedings (20 and 40 DAS) in soybean. Differences with respect to seeds/pod were found to be non-significant during 2008, whereas in 2009, imazethapyr at 75 g/ha applied at 15 DAS resulted in highest seeds/pod which were on par with two hand weedings and significantly higher than all other weed control treatments. All the weed control treatments resulted in significantly higher 100-seed weight over unweeded control during 2008. Highest 100-seed weight was recorded in imazethapyr at 100 g/ha applied at 15 DAS which was on par with imazethapyr at 75 g/ha applied at 15 DAS and 25 DAS and imazethapyr at 100 g/ha sprayed at 25 DAS and significantly higher than two hand weedings. However, the differences with respect to 100-seed weight in 2009 were found to be non-significant.

During 2008, maximum biological yield was obtained with imazethapyr at 100 g/ha applied at 15 DAS which was statistically on par with imazethapyr at 50 and 75 g/ha applied at 15 DAS, two hand weedings but significantly higher than rest of the weed control treatments (Table 2). During 2009, imazethapyr at 75 g/ha applied at 15 DAS produced highest biological yield which was on par with imazethapyr at 100 g/ha sprayed at 15 DAS, but significantly

Table 2 Growth, yield attributes, yield and economics (two year mean) of mungbean as influenced by different weed control treatments and cultivars

Treatment	Plant height (cm)		Branches/plant		Pods/plant		Seeds/pod		100-seed weight (g)		Biological yield (kg/ha)		Grain yield (kg/ha)		Harvest index		Net returns (₹/ha)	B:C ratio	
	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009			
Weed control treatments																			
Imazethapyr 50 g/ha 15 DAS	65.5	58.6	4.33	5.12	13.03	15.9	11.10	9.80	3.20	3.07	3917	4287	1259	1180	0.32	0.28	33002	3.03	
Imazethapyr 75 g/ha 15 DAS	60.2	63.9	4.37	5.10	14.77	17.8	10.78	10.47	3.30	3.15	3833	5324	1502	1382	0.39	0.26	40637	3.60	
Imazethapyr 100 g/ha 15 DAS	64.2	62.6	4.20	4.83	14.83	18.5	11.40	9.80	3.40	3.15	4306	5139	1513	1431	0.35	0.28	41342	3.55	
Imazethapyr 50 g/ha 25 DAS	60.3	66.5	4.03	5.43	11.80	13.6	10.87	9.60	3.26	2.85	3222	4167	1111	958	0.34	0.23	26342	2.42	
Imazethapyr 75 g/ha 25 DAS	64.2	63.5	4.37	5.60	13.07	15.8	11.43	9.67	3.31	3.13	3583	4537	1291	1083	0.36	0.24	31457	2.79	
Imazethapyr 100 g/ha 25 DAS	64.5	64.0	4.20	5.30	13.30	16.2	11.00	9.67	3.38	3.02	3667	4667	1323	1132	0.36	0.24	32540	2.79	
Two hand weedings (20 and 40 DAS)	63.9	84.9	4.37	5.40	14.30	18.0	11.20	9.90	3.23	3.17	4250	4722	1471	1306	0.35	0.28	35486	2.45	
Unweeded control	62.2	63.6	4.00	3.97	9.73	10.1	11.43	8.20	3.11	2.92	2611	3889	614	771	0.24	0.20	14930	1.49	
CD (P = 0.05)	NS	5.2	NS	0.66	0.79	2.5	NS	0.59	0.12	NS	523	506	166	177					
Cultivars																			
ML 267	66.0	61.5	4.16	5.26	12.60	17.4	10.99	10.14	3.19	3.07	3583	4514	1206	1245	0.34	0.28			
ML 818	62.0	66.9	4.24	4.90	13.10	15.0	11.25	9.58	3.26	3.09	3708	4389	1285	1117	0.35	0.25			
PAU 911	63.2	69.4	4.45	4.74	13.60	14.8	11.21	9.20	3.45	3.01	3729	4872	1290	1104	0.35	0.23			
CD (P = 0.05)	NS	2.8	NS	NS	NS	1.0	NS	0.28	0.08	NS	NS	264	NS	68					

higher than all other weed control treatments including two hand weedings.

Application of imazethapyr at 100 g/ha at 15 DAS gave highest grain yield of mungbean during both the years of study which was on par with imazethapyr at 75 g/ha applied at 15 DAS and two hand weedings but significantly higher than all other weed control treatments. Application of imazethapyr at 100 g/ha at 15 DAS and two hand weedings resulted in 146.4% and 139.6% higher grain yield over unweeded control, respectively during first year of study, while the corresponding values in second year of study were 85.6 and 69.4%. Windley *et al.* (1999) also reported that post-emergence application of imazethapyr at 96 g/ha increased mungbean yield by 20.4% over unweeded control. The higher grain yield in these treatments might be due to better weed control in these treatments which ultimately increased the yield attributes. Highest harvest index was recorded in imazethapyr at 75 g/ha applied at 15 DAS during 2008, whereas it was highest in case of imazethapyr at 50 and 100 g/ha applied at 15 DAS and two hand weedings during 2009.

Application of imazethapyr at 100 g/ha at 15 DAS gave the highest net returns followed by imazethapyr at 75 g/ha applied at 15 DAS (Table 2). Application of imazethapyr at 75 g/ha at 15 DAS realized maximum benefit : cost ratio closely followed by application of imazethapyr at 100 g/ha at 15 DAS. This might be due the better weed control efficiency in these treatments which resulted in higher grain yield and higher returns. Although, gross returns in case of two hand weedings were comparable to those in imazethapyr at 75 and 100 g/ha applied at 15 DAS but higher cost incurred on two hand weedings resulted in decreased net returns and B:C ratio.

The visual observation on growth during 2008 and 2009 showed that all the three cultivars of mungbean, viz. ML 267, ML 818 and PAU 911 showed good degree of tolerance to imazethapyr sprayed at different doses and at different times. No adverse effect of herbicide (imazethapyr) in terms of yellowing, injury or change in morphology was observed in any cultivar. Osten (1996) also reported that post-emergence application of imazethapyr at 96 g/ha at 21 DAS was safe to the *Vigna* spp. In 2008, differences with respect to plant height, branches/plant, pods/plant and seeds/pod were found to be non-significant amongst different cultivars (Table 2). In 2009, PAU 911 produced tallest plants whereas ML 267 recorded highest pods/plant and seeds/pod. The data on biological yield and grain yield (Table 2) showed non-significant differences in the three cultivars in 2008, whereas in 2009, biological yield as well as grain yield was significantly higher in PAU 911 over ML 818 and ML 267.

SUMMARY

Three mungbean cultivars, viz. ML 267, ML 818 and PAU 911 showed good degree of tolerance to imazethapyr sprayed at different doses and at different times during 2008 and 2009. Application of imazethapyr at 75 and 100

g/ha at 15 days after sowing (DAS) and imazethapyr 100 g/ha 25 DAS gave good control of weeds and the weed control efficiency was comparable to that of two hand weedings. Use of imazethapyr at 100 g/ha at 15 DAS gave the highest grain yield of mungbean. Application of imazethapyr at 75 and 100 g/ha at 15 DAS resulted in 144.6 and 146.4% higher grain yield respectively over unweeded control during first year of study, while the corresponding values in second year of study were 79.2 and 85.6%. Application of imazethapyr at 100 g/ha at 15 DAS gave the highest gross and net returns followed by imazethapyr at 75 g/ha sprayed at 15 DAS.

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