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AGRONOMY

Efficacy of imazethapyr and other herbicides on weed growth and yield of *kharif* blackgram

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Abstract

A two year field experiment was conducted during the the *kharif* season of 2014 and 2015 at Agricultural Farm, Institute of Agriculture, Visva-Bharati, Sriniketan, West Bengal, with blackgram variety '*WBU-108*' to study the effect of imazethapyr and other herbicides on weed growth, productivity and economics of *kharif* blackgram. The experiment was laid out in a randomized block design with three replications and eight treatments. From the investigation it revealed that *Digitaria sanguinalis* among the grasses; *Cyperus iria* among the sedges and *Ludwigia parviflora* and *Croton bonplandianum* among the broadleaved weeds were predominant throughout the cropping period. Higher doses of imazethapyr (75, 100 and 125 g ha^{-1}) applied at 20 DAS effectively controlled the grasses, broadleaved and sedges in blackgram at 45 DAS. Yield reduction due to weed competition was to the extent of 26-29% in *kharif* blackgram. Lower values of weed density, total weed dry weight, weed index and higher values of weed control efficiency, seed yield, net return and return per rupee invested were registered with application of imazethapyr at 75 g ha^{-1} at 20 DAS which was at par with by imazethapyr at 100 g ha^{-1} at 20 DAS. These treatments may be recommended for managing complex weed flora and obtaining higher yield and net return of *kharif* blackgram in the lateritic belt of West Bengal, India.

Highlights

- Imazethapyr at 75 g ha^{-1} at 20 DAS effectively managed complex weed flora and produced higher seed yield, net return and return $rupee^{-1}$ invested in *kharif* blackgram.

Keywords: Blackgram, butachlor, imazethapyr, pendimethalin, weed management

Blackgram is one of the most important pulse crops grown in India. India is the largest producer and consumer of blackgram in the world. Blackgram supplies a major share of protein requirement of vegetarian population of the country. It contains about 26 per cent protein which is almost three times that of cereals (Kavitha *et al.,* 2013). It is predominantly grown during *kharif* season in West Bengal where weed infestation causes considerable loss in yield. Different categories of weeds *i.e.* grasses, broad leaves and sedges compete jointly or individually with blackgram for different growth factors. The critical period of weed competition in blackgram is the first 20–40 days after sowing and season long weed competition has been found to reduce black gram yield to the extent of 27-64% depending on the type and intensity of weed flora (Singh, 2011; Bhowmick *et al.,* 2015). Hand weeding, which is usually preferred, adds to the cost of cultivation due to higher labour wages and does not ensure weed removal at critical stage of crop-weed competition (Duary *et al.,* 2015). Moreover, continuous rainfall during the season makes the manual weeding uncertain and impracticable. Hence, chemical weed control became an effective and cheaper alternative to manage weeds in blackgram production. The scope for application of either pre-sowing or pre emergence herbicides under *kharif* conditions is also very little due to narrow elasticity in time of application. Imazethapyr

is reported to be very effective post emergence herbicide for broad spectrum weed control in *kharif* pulses including black gram through the inhibition of enzyme acetohydroxy acid synthase. But its efficacy has not been judged for wide spectrum weed control in *kharif* blackgram under lateritic soil of West Bengal. Therefore, a comprehensive field study was undertaken to find out the suitable dose of imazethapyr for effective control of weeds in *kharif* blackgram under lateritic soil of West Bengal.

Materials and Methods

A two year field experiment was conducted during *kharif* season of 2014 and 2015 in the farmer's field of village Binuria, Sriniketan, Birbhum, West Bengal. The experimental field of the village is situated at about 23°39.757′ N latitude and 87°37.863′ E longitude with an altitude of 58.6 m above the mean sea level. The experimental soil was slightly acidic in reaction (pH 6.6), sandy loam in texture, low in organic C (0.42%) and available N (148.4 kg ha^{-1}), high in available P (27.28 kg ha^{-1}) and medium in available K (129.5 kg ha^{-1}).

The experiment comprised of eight treatments *viz*. imazethapyr at 50, 75, 100 and 125 g ha^{-1}at 20 DAS, pendimethalin at 750 g ha^{-1} a as pre-emergence, butachlor at 1000 g ha^{-1}as pre-emergence, hand weeding twice at 20 and 40 DAS and untreated control was laid out in randomized block design with three replications. Blackgram variety *'WBU-108'* (Sarada) was fertilized with 20 kg N, 40 kg each of P_2O_5 and K_2O per hectare through urea, SSP and MOP respectively.

The entire dose of NPK was applied as basal. Hand operated knapsack sprayer fitted with a flat fan type nozzle was used for spraying the herbicides by adopting a spray volume of 500 litres ha^{-1}. All the recommended agronomic and plant protection measures were adopted to raise the crop. The density of grasses, sedges and broadleaved weeds were recorded at 45 DAS by placing a quadrate of 50×50 cm from the marked sampling area of 1.0 m^2 in each plot. For recording their biomass, weed samples were sun-dried and later oven dried at 70 °C until constant weight was attained. These were subjected to square root transformation to normalize their distribution. Seed yield of blackgram was recorded at harvest and statistically analyzed at 5% level of significance. Economics were computed using the prevailing market prices for inputs and outputs.

Weed control efficiency (%) was computed using the following formula:

$$WCE = \frac{\text{Dry wt. of weeds in control plot-Dry wt. of weeds in treatment plot}}{\text{Dry wt. of weeds in control plot}} \times 100$$

Weed Index (WI) was worked out using the formula as suggested by Gill and Vijayakumar (1969).

$$WI = \frac{Y_{WFC} - Y_T}{Y_{WFC}} \times 100$$

Where, WI = Weed index, Y_{WFC} = Yield of the crop in weed free check, Y_T= Yield of the crop in plot under treatment.

Results and Discussion

Twelve weed species belonging to six different families were identified in the experimental field during both the years. *Digitaria sanguinalis* among the grasses; *Ludwigia parviflora* and *Croton bonplandianum* among the broadleaved and *Cyperus iria* among the sedges were predominant throughout the cropping period. Similar weed flora in *kharif* blackgram has been reported by Bhowmick *et al.* (2015).

All weed management practices brought significant reduction in density and dry weight of different weed species compared to unweeded control. The lowest density as well as dry weight of grasses, sedges and broadleaved weeds at 45 DAS was recorded with hand weeding twice at 20 DAS and 40 DAS. During both the years, application of higher doses of imazethapyr at 100 and 125 g ha^{-1} at 20 DAS registered the lowest density and dry weight of grasses at 45 DAS which was statistically at par with imazethapyr at 75 g ha^{-1}. Post emergence application of imazethapyr at 100 and 125 g ha^{-1} at 20 DAS effectively controlled broadleaved weeds and recorded the lowest count which was at par with imazethapyr at 75 g ha^{-1} (Table 1).

Similar trend was observed in case of dry weight of broadleaved weeds present in the experimental field at 45 DAS. Among all the herbicidal treatments, application of higher doses of imazethapyr at 100 and 125 g ha^{-1} at 20 DAS was found more effective in reducing the density and dry weight of sedges at

Table 1: Effect of treatments on density of weeds in blackgram at 45 DAS

Treatments	Weed density (No. m^{-2})							
	Grass		Broad leaved		Sedge		Total	
	2014	2015	2014	2015	2014	2015	2014	2015
Imazethapyr at 50 g ai ha^{-1}	2.80 (7.33)	3.14 (9.33)	3.94 (15.00)	4.10 (16.33)	2.55 (6.00)	2.48 (5.67)	5.37 (28.33)	5.64 (31.33)
Imazethapyr at 75 g ai ha^{-1}	1.08 (0.67)	1.35 (1.33)	1.35 (1.33)	2.04 (3.67)	1.35 (1.33)	1.58 (2.00)	1.96 (3.33)	2.74 (7.00)
Imazethapyr at 100 g ai ha^{-1}	0.91 (0.33)	1.22 (1.00)	1.08 (0.67)	1.68 (2.33)	1.22 (1.00)	1.35 (1.33)	1.58 (2.00)	2.27 (4.67)
Imazethapyr at 125 g ai ha^{-1}	0.71 (0)	1.08 (0.67)	0.71 (0)	1.35 (1.33)	1.08 (0.67)	1.35 (1.33)	1.08 (0.67)	1.96 (3.33)
Pendimethalin at 0.75 kg ai ha^{-1}	2.35 (5.00)	2.80 (7.33)	3.49 (11.67)	3.49 (11.67)	1.87 (3.00)	2.04 (3.67)	4.49 (19.67)	4.81 (22.67)
Butachlor at 1.0 kg ai ha^{-1}	2.04 (3.67)	2.55 (6.00)	3.29 (10.33)	3.58 (12.33)	1.78 (2.67)	2.20 (4.33)	4.14 (16.67)	4.81 (22.67)
Hand weeding twice at 20 and 40 DAS	0.71 (0)	0.71 (0)	0.91 (0.33)	1.08 (0.67)	0.71 (0)	0.71 (0)	0.91 (0.33)	1.08 (0.67)
Unweeded control	4.02 (15.67)	4.18 (17.00)	4.95 (24.00)	5.31 (27.67)	2.80 (7.33)	2.92 (8.00)	6.89 (47.00)	7.29 (52.67)
LSD (0.05)	0.38	0.32	0.47	0.49	0.33	0.28	0.44	0.49

Figures in parentheses are the original values. The data was transformed to SQRT (x + 0.5) before analysis.

45 DAS during both the years. However, these were statistically at par with lower dose *i.e.* imazethapyr at 75 g ha^{-1}. Higher doses of imazethapyr (100 and 125 g ha^{-1}) were found more effective in suppressing the growth of complex weed flora present in the experimental field at 45 DAS and registered the lowest number and dry weight of total weeds among the herbicidal treatments but these were statistically at par with imazethapyr at 75 g ha^{-1} (Table 1 and 2). The highest weed control efficiency (WCE) was registered with hand weeding treatment during both years of study (Fig. 1).

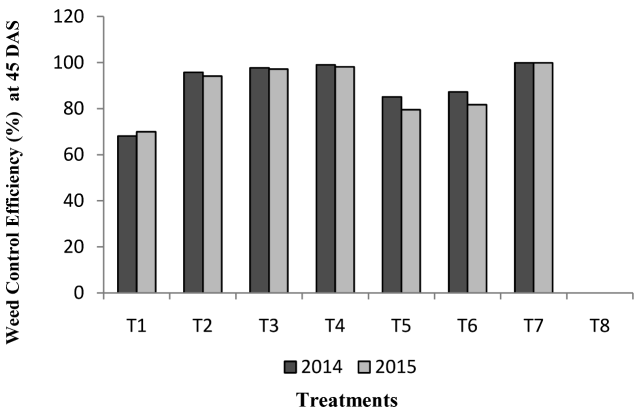

Fig. 1: Effect of treatments on Weed Control Efficiency in kharif blackgram at 45 DAS

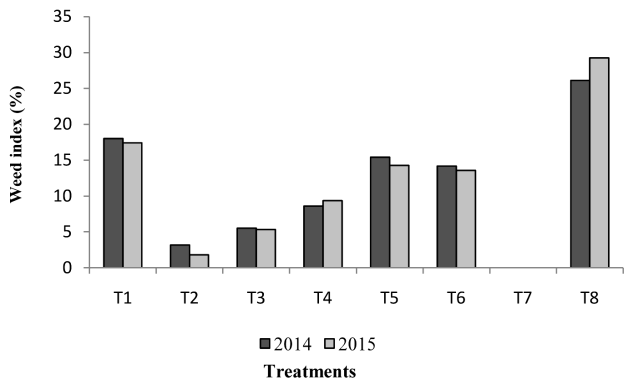

Fig. 2: Effect of treatments on weed index of kharif blackgram during 2014-15

Application of imazethapyr at 75, 100 and 125 g ha^{-1} at 20 DAS resulted higher weed control efficiency at 45 DAS among the herbicidal treatments during both years of study. The higher weed control efficiency with these treatments might be attributed to the lower weed density as well as dry matteraccumulation of weeds in these treatments. The lower value of weed index was recorded in treatments with post emergence application of imazethapyr at 75 g ha^{-1} and imazethapyr at 100 g ha^{-1} (Fig. 2). Malik and Duary (2013), Prachand *et*

Table 2: Effect of treatments on dry weight of weeds in blackgram at 45 DAS

Treatments	Weed dry weight (g m^{-2})							
	Grass		Broad leaved		Sedge		Total	
	2014	2015	2014	2015	2014	2015	2014	2015
Imazethapyr at 50 g ai ha^{-1}	2.12 (3.98)	2.12 (4.01)	2.17 (4.19)	2.67 (6.63)	2.34 (4.96)	1.97 (3.37)	3.69 (13.13)	3.81 (14.01)
Imazethapyr at 75 g ai ha^{-1}	0.88 (0.27)	1.01 (0.53)	1.07 (0.65)	1.34 (1.30)	1.16 (0.84)	1.20 (0.94)	1.50 (1.76)	1.81 (2.77)
Imazethapyr at 100 g ai ha^{-1}	0.79 (0.12)	0.92 (0.34)	0.82 (0.17)	0.99 (0.47)	1.07 (0.65)	1.00 (0.51)	1.20 (0.94)	1.35 (1.32)
Imazethapyr at 125 g ai ha^{-1}	0.71 (0)	0.85 (0.220	0.71 (0)	0.79 (0.13)	0.96 (0.42)	1.01 (0.53)	0.96 (0.42)	1.17 (0.88)
Pendimethalin at 0.75 kg ai ha^{-1}	1.70 (2.39)	2.00 (3.52)	1.83 (2.87)	2.05 (3.70)	1.18 (0.90)	1.69 (2.34)	2.58 (6.15)	3.17 (9.56)
Butachlor at 1.0 kg ai ha^{-1}	1.57 (1.98)	1.76 (2.59)	1.74 (2.53)	2.08 (3.83)	1.11 (0.74)	1.63 (2.14)	2.40 (5.25)	3.01 (8.56)
Hand weeding twice at 20 and 40 DAS	0.71 (0)	0.71 (0)	0.73 (0.04)	0.76 (0.08)	0.71 (0)	0.71 (0)	0.73 (0.04)	0.76 (0.08)
Unweeded control	3.91 (14.76)	3.96 (15.15)	4.22 (17.28)	4.76 (22.12)	3.11 (9.18)	3.15 (9.43)	6.46 (41.22)	6.87 (46.70)
LSD (0.05)	0.22	0.15	0.18	0.21	0.18	0.16	0.68	0.75

Figures in parentheses are the original values. The data was transformed to SQRT (x + 0.5) before analysis.

Table 3: Effect of treatments on plant height, dry matter accumulation, yield and economics of blackgram

Treatments	Plant height at harvest (cm)		Dry matter accumulation at harvest (g/m^2)		Seed yield (kg ha^{-1})		Net return (₹ ha^{-1})		Return per rupee invested	
	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015
Imazethapyr at 50 g ai ha^{-1}	42.7	42.5	250.9	241.5	925	891	22227	20949	1.07	0.97
Imazethapyr at 75 g ai ha^{-1}	53.2	51.3	321.1	304.9	1093	1059	29468	28446	1.39	1.29
Imazethapyr at 100 g ai ha^{-1}	51.2	48.9	310.9	286.2	1066	1021	27861	26278	1.28	1.17
Imazethapyr at 125 g ai ha^{-1}	48.3	46.5	282.6	266.4	1031	977	25739	23723	1.16	1.04
Pendimethalin at 0.75 kg ai ha^{-1}	44.6	45.0	268.1	253.4	954	924	22922	21933	1.07	0.99
Butachlor at 1.0 kg ai ha^{-1}	47.3	45.4	278.3	260.5	968	932	24614	23315	1.21	1.10
Hand weeding twice at 20 and 40 DAS	54.0	52.5	327.2	313.9	1128	1078	27296	25562	1.09	0.99
Unweeded control	41.3	40.7	239.5	228.5	834	763	19367	16361	0.99	0.81
LSD (0.05)	2.56	1.39	11.5	10.9	64.4	60.2	2467	2329	0.13	0.12

al. (2014) also reported similar results in groundnut and soybean respectively. Kumar *et al.* (2015), Yadav *et al.* (2015) and Balyan *et al.* (2016) also put forwarded the similar kind of opinion in blackgram.

Effect on crop

The effect of weed management practices was found significant on plant height and dry matter accumulation at harvest during both the years. Hand weeding twice at 20 and 40 DAS registered the highest plant height and dry matter accumulation at harvest but it was statistically at par with imazethapyr at 75 g ha^{-1}. The loss in seed yield due to unchecked weedgrowth throughout the crop growth period was to the extent of 26-29% in *kharif* blackgram. Bhowmick *et al.* (2015) and Balyan *et al.* (2016) also recorded the yield reduction of 26.4 and 22.2 per cent in *kharif* blackgram due to weed competition. During both the years of 2014 and 2015, hand weeding twice at 20 and 40 DAS recorded the highest seed yield (1128 and 1078 kg ha^{-1}) which

was statistically at par with imazethapyr at 75 g ha^{-1} (1093 and 1059 kg ha^{-1}) and imazethapyr at 100 g ha^{-1} (1066 and 1021 kg ha^{-1}) (Table 3). These might be due to low level of weed competition at critical stages of crop growth which facilitated to utilize the available resources to the maximum extent, which ultimately reflected on higher growth and yield of blackgram. The results are in accordance with the findings of Malik and Duary (2013) in groundnut, Prachand *et al.* (2014) in soybean and Kumar *et al.* (2015), Yadav *et al.* (2015) and Balyan *et al.* (2016) in blackgram who reported that the efficient utilization of soil moisture, nutrients and light created a favourable condition for the luxuriant growth of *kharif* blackgram and soybean ultimately leading to higher seed yield. Unweeded control registered the lowest seed yield during both years of study.

Economics

The highest net returns (₹ 29,468 and 28,446 ha^{-1}) and return per rupee invested (1.39 and 1.29) was fetched with application of imazethapyr at 75 g ha^{-1} at 20 DAS which was statistically at par with imazethapyr at 100 g ha^{-1} (₹ 27,861 and 26,278 ha^{-1} net return and 1.28 and 1.17 return per rupee invested). The higher benefit under these treatments might be due to higher production of pods as well as stover leading to increased monetary returns with comparatively lower cost. These findings are in close vicinity with those reported by Yadav *et al.* (2015) and Balyan *et al.* (2016).

From the results of field experiments, it is concluded that post emergence application of imazethapyr at 75g ha^{-1} at 20 DAS may be recommended for managing complex weed flora and obtaining higher seed yield, net return and return per rupee invested of *kharif* blackgram in the lateritic soil of West Bengal. The recommendation may be passed on to the farmers of blackgram growing areas in eastern India.

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