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Bio-efficacy and economics of herbicides against weeds of black gram [*Vigna mungo* (L.) Hepper] grown in rice-fallow

K. R. K. NAIDU, A. V. RAMANA AND B. DE

Department of Agronomy
Agricultural College
Naira 532 185, Andhra Pradesh

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ABSTRACT

A field experiment was conducted during rabi 2009-10 at the Agricultural College Farm, Naira of Acharya N. G. Ranga Agricultural University to study the efficacy and economics of different pre- and post-emergence herbicides in rice-fallow blackgram. Density and dry weight of weeds were significantly reduced by hand weeding compared to other treatments and was at par with imazethapyr @200 g a.i. ha^{-1}. All other herbicides except, quizalofop-p-ethyl @ 50 and 75 g a.i. ha^{-1} significantly reduced the density and dry weight of weeds compared to un-weeded check. Imazethapyr at both the doses showed phyto.-toxicity on blackgram. At lower dose the crop recovered quickly while, at higher dose no such recovery was noticed. Hand weeding was significantly superior to other treatments in respect of crop dry matter accumulation, yield attributes and yield of crop. However, on considering economics, pendimethalin @ 1.0 kg a.i. ha^{-1} was found to be a cost effective method.

Key words: Herbicides, pre- and post-emergence, rice-fallow

Cultivation of pulses in rice-fallows is a common practice in coastal areas of Andhra Pradesh and Tamil Nadu. In Andhra Pradesh, black gram is cultivated in 2.69 lakh ha of rice-fallows, with a production of 1.80 lakh tonnes and productivity of 670 kg ha^{-1} (Plant Doctors Diary, 2010). Among the different constraints in cultivation of rice-fallow blackgram, weed menace receives special attention as it reduces the yield to an extent of 53 per cent (Appanna *et al.*, 1998). The normal methods of weed management like hand weeding is not practiced by farmers in rice-fallow blackgram system because of the problem of trampling of crop, which leads to loss of crop stand and also difficult to practice due to presence of dense stubbles of rice crop. Hence, selective herbicide can be one of the best alternatives for economic and timely weed control in rice-fallow blackgram. With this objective, bio-efficacy of different herbicides in comparison to hand weeding was evaluated in rice-fallow blackgram.

MATERIALS AND METHODS

A field experiment was conducted at the Agricultural College Farm, Naira of Acharya N. G. Ranga Agricultural University on a sandy clay loam soil during *rabi* 2009-10. The experiment, consisted of twelve treatments, and was laid out in a Randomized Block Design with three replications. The soil of the experimental field was sandy clay loam in texture with pH 7.3 and was low in available nitrogen (179 kg ha^{-1}) and high in available phosphorus (54 kg ha^{-1}) and potassium (346 kg ha^{-1}). The sprouted seeds of black gram (cv. LBG – 645) were broadcast uniformly in the standing rice crop two days prior to harvest. The pre-emergence herbicides were applied by mixing the required quantity of herbicide in dry sand @ 50 kg ha^{-1} and were broadcast uniformly at 7 DAS followed by water spray @ 500 L ha^{-1} in order to provide sufficient moisture for herbicide absorption. The post-emergence herbicides were applied at 15 DAS using a spray volume of 500 L ha^{-1}. The crop did not receive any fertilizer and irrigation and survived entirely on residual moisture and fertility only, whereas, the preceding rice crop received a fertilizer dose of 120 kg N, 60 kg P_2O_5 and 60 kg K_2O ha^{-1}. The gross and net plot sizes were 6×4m^2 and 4.5 ×3m^2, respectively. The phyto-toxic effect of herbicides on black gram was assessed by using a simple rating scale of 0 to 10 (equal to 0 to 100%) as suggested by Rao (2000).

RESULTS AND DISCUSSION

Effect on weeds

The predominant weed flora of the experimental field were *Vicia sativa, Cardiospermum halicacabum* L. var. *luridum*, *Grangea maderaspatana*, *Chrozophora rottleri*, *Phyllanthus maderaspatensis* and *Xanthium strumarium* and all were broad leaved weeds. The weed density and dry weight recorded at 30 DAS (Table 1) indicated that all the treatments significantly reduced the weed density and dry weight compared to un-weeded check except, post-emergence application of quizalofop-p-ethyl @50 and 75g a.i. ha^{-1}. Post-emergence application of imazethapyr @ 200 g a.i. ha^{-1} recorded significantly lower density and dry weight than rest of the treatments. Almost similar affect was observed at 60 DAS except, with imazethapyr @200g a.i ha^{-1}, which was at par with hand weeding. Quizalofop-p-ethyl, at 50g and 75g a.i. ha^{-1} was found ineffective in controlling weeds both at 30DAS and 60DAS. The poor performance of quizalofop-p-ethyl might be due to absence of grassy weeds in crop-weed ecosystem. Higher dose of imazethapyr (200g a.i. ha^{-1}) application recorded significantly lower density and dry weight of weeds than lower dose (150g a.i. ha^{-1})

E-mail: krknaidu1986@gmail.com

Table 1: Effect of treatments on weed density, weed dry weight, crop injury and crop stand in black gram grown under rice-fallow

Treatments	*Weed density (No. m^{-2})		*Weed dry weight (kg ha^{-1})		% Crop injury score at			Crop stand (No. m^{-2}) at maturity
	30 DAS	60 DAS	30 DAS	60 DAS	7 DAS	14DAS	21DAS	
T_1 : Pendimethalin @ 0.75 kg a.i ha^{-1} (PE)	16.5 (271.7)	18.9 (356.7)	9.5 (90.1)	19.6 (384.0)	0	0	0	31.7
T_2 : Pendimethalin @ 1.0 kg a.i ha^{-1} (PE)	15.7 (246.0)	18.1 (327.0)	9.2 (84.4)	18.9 (357.0)	0	0	0	31.7
T_3 : Alachlor @ 0.5 kg a.i ha^{-1} (PE)	17.0 (288.7)	19.4 (376.0)	9.7 (93.9)	20.1 (403.8)	0	0	0	31.0
T_4 : Alachlor @ 1.0 kg a.i ha^{-1} (PE)	16.0 (255.7)	18.5 (341.7)	9.4 (88.2)	19.2 (368.4)	0	0	0	32.0
T_5 : Oxyfluorfen @ 0.1 kg a.i ha^{-1} (PE)	17.3 (299.0)	20.5 (419.7)	10.2 (103.8)	20.8 (432.4)	0	0	0	31.0
T_6 : Oxyfluorfen @ 0.2 kg a.i ha^{-1} (PE)	17.1 (292.0)	19.8 (391.7)	10.0 (99.8)	20.4 (416.0)	0	0	0	28.7
T_7 : Imazethapyr @ 150 g a.i ha^{-1} (PoE)	15.3 (233.7)	17.6 (309.3)	8.9 (79.0)	18.7 (349.5)	40	10	0	29.0
T_8 : Imazethapyr @ 200 g a.i ha^{-1} (PoE)	12.3 (151.0)	13.8 (190.0)	6.6 (43.4)	15.3 (233.9)	60	60	60	24.3
T_9 : Quizalofop-p-ethyl @ 50 g a.i ha^{-1} (PoE)	21.2 (449.0)	24.1 (580.3)	12.0 (143.8)	24.9 (619.8)	0	0	0	31.0
T_{10} : Quizalofop-p-ethyl @ 75 g a.i ha^{-1} (PoE)	20.7 (428.0)	23.9 (570.7)	11.8 (139.0)	24.7 (609.9)	0	0	0	29.0
T_{11} : Unweeded check	21.4 (457.3)	24.3 (590.0)	12.3 (151.1)	25.5 (650.1)	0	0	0	28.5
T_{12} : Weed free check (HW at 15 and 30 DAS)	14.8 (218.7)	13.2 (173.7)	8.6 (73.8)	13.3 (176.7)	0	0	0	28.5
SEm (±)	**0.79**	**1.15**	**0.60**	**1.05**	-	-	-	**1.32**
LSD (0.05)	**2.30**	**3.40**	**1.80**	**3.10**	-	-	-	**3.9**

*Note: *The data were subjected to square root transformation. Figures in parentheses are original values.*
PE: Pre-emergence, PoE: Post-emergence, HW: Hand weeding, DAS: Days after sowing.

Table 2: Effect treatments on dry matter, yield attributes, seed yield and economics of black gram grown in rice-fallow

Treatments	Dry matter accumulation at harvest (kg ha^{-1})	Yield attributes			Seed yield (kg ha^{-1})	Net returns (₹ha^{-1})	Benefit Cost Ratio
		No. of pods plant^{-1}	No. of seeds pod^{-1}	100 seed weight			
T_1 : Pendimethalin @ 0.75 kg a.i ha^{-1} (PE)	1959	10.6	6.3	4.91	751	31710	2.38
T_2 : Pendimethalin @ 1.0 kg a.i ha^{-1} (PE)	2040	11.2	6.6	5.01	849	37340	2.75
T_3 : Alachlor @ 0.5 kg a.i ha^{-1} (PE)	1917	10.6	6.2	4.80	742	31630	2.45
T_4 : Alachlor @ 1.0 kg a.i ha^{-1} (PE)	2015	11.0	6.5	4.94	808	35300	2.68
T_5 : Oxyfluorfen @ 0.1 kg a.i ha^{-1} (PE)	1771	10.6	6.2	4.73	727	30340	2.28
T_6 : Oxyfluorfen @ 0.2 kg a.i ha^{-1} (PE)	1783	10.6	6.2	4.76	733	30020	2.15
T_7 : Imazethapyr @ 150 g a.i ha^{-1} (PoE)	2084	11.4	6.7	5.02	881	38160	2.60
T_8 : Imazethapyr @ 200 g a.i ha^{-1} (PoE)	1525	9.5	6.0	4.73	550	17600	1.14
T_9 : Quizalofop-p-ethyl @ 50 g a.i ha^{-1} (PoE)	1578	9.7	6.0	4.70	653	25380	1.84
T_{10} : Quizalofop-p-ethyl @ 75 g a.i ha^{-1} (PoE)	1628	9.9	6.1	4.73	667	25620	1.78
T_{11} : Unweeded check	1329	9.1	6.0	4.70	493	17280	1.40
T_{12} : Weed free check (HW at 15 and 30 DAS)	2516	13.5	6.8	5.02	1072	44520	2.25
SEm (±)	**117.39**	**0.48**	**0.22**	**0.11**	**64.59**	-	-
LSD (0.05)	**344.00**	**1.40**	**NS**	**NS**	**189.00**	-	-

Note: PE: Pre-emergence, PoE: Post-emergence, HW: Hand weeding, NS: Non significant.

which may be due to its selective post-emergence activity in suppressing the susceptible weeds.

Effect on crop

Post-emergence application of imazethapyr @ 150 g a.i. ha^{-1} caused crop injury to the extent of 40 per cent resulting in moderate stunting growth of seedling and discolouration of developing leaves with partial loss of crop stand (Table 2). However, these symptoms were slowly recovered at later period. Post-emergence application of imazethapyr @ 200 g a.i. ha^{-1} caused crop injury to the extent of 60 per cent resulting in severe stunting growth and discolouration with significant stand loss. The symptoms remain unchanged even at 21 days after spraying. The phytotoxic effect of imazethapyr on blackgram was also reported by Gousia (2005) and Rao (2008). Among all the herbicides, post-emergence application of imazethapyr @ 200 g a.i. ha^{-1} resulted in significantly lower crop stand than other treatments due to its severe phytotoxicity on blackgram, whereas, imazethapyr @ 150 g a.i. ha^{-1} had partial stand loss but it was at par with rest of the treatments except, T_8, imazethapyr @ 200 g a.i. ha^{-1} as post emergent. This was due to less phyto-toxic effect of treatment T_7 on blackgram.

Among the herbicides, the highest crop dry matter accumulation was recorded with imazethapyr @ 150 g a.i. ha^{-1}, which was at par with the rest of the herbicides except, imazethapyr @ 200 g a.i. ha^{-1}, quizalofop-p-ethyl @ 50 g a.i. ha^{-1} and quizalofop-p-ethyl @ 75 g a.i. ha^{-1} at harvest. The highest crop dry weight was recorded with hand weeding than rest of the treatments (Table 2). The highest number of pods $plant^{-1}$ was observed with hand weeding, which had minimum weed competition. Among the herbicide treatments, the maximum number of pods $plant^{-1}$ were recorded with imazethapyr @150g a.i. ha^{-1} and this was, however, on par with the rest of the treatments except, imazethapyr @ 200 g a.i. ha^{-1}, quizalofop-p-ethyl @ 50 g a.i. ha^{-1} and quizalofop-p-ethyl @75g a.i. ha^{-1}. The positive effect on yield attributes in these treatments was perhaps due to better crop growth and drymatter production due to better weed control. The lowest number of branches $plant^{-1}$ and number of pods $plant^{-1}$ were also observed with imazethapyr @ 200 g a.i. ha^{-1}, which might be due to its phytotoxic effect on blackgram.

The maximum seed yield was recorded with hand weeding and was significantly superior to the rest of the treatments (Table 2). Among the herbicide treatments, except imazethapyr @ 200 g a.i. ha^{-1}, quizalofop-p-ethyl @ 50 g a.i. ha^{-1} and 75 g a.i. ha^{-1} all other treatments had significantly higher seed yield compared to unweeded check. Despite the better weed control efficiency of imazethapyr @ 200 g a.i. ha^{-1}, it could not be translated into higher seed yield probably due to its persistent phytotoxic effect on blackgram. Quizalofop-p-ethyl at both the doses had significantly lower yields due to its inefficiency in controlling weeds. The better growing condition prevailed in hand weeding significantly increased the seed yield of 579 kg ha^{-1} (117%) over unweeded check. Significantly the lowest yield of 493 kg ha^{-1} was recorded in un-weeded check.

Economics

The maximum net return of ₹44520 ha^{-1} was obtained with hand weeding closely followed by imazethapyr @ 150 g a.i. ha^{-1} (₹38160 ha^{-1}) and pendimethalin @ 1.0 kg a.i. ha^{-1} (₹37340 ha^{-1}). This might be due to higher seed yield in these treatments. Despite the maximum yield and higher net income recorded with hand weeding, the BCR worked out with this treatment was only 2.25. This was mainly because of higher labour cost involved (₹7500 ha^{-1}) in hand weeding twice. Thus, the higher cost involved in manual weeding was not compensated by the additional seed yield obtained resulting in lower BCR. The highest BCR (2.75) was recorded with pendimethalin @1.0 kg a.i. ha^{-1}, which might be due to higher seed yield coupled with lower cost of chemical (₹300 L^{-1}) followed by alachlor @ 1.0 kg a.i. ha^{-1} (2.68) and imazethapyr @150 g a.i ha^{-1} (2.60). Though imazethapyr @150 g a.i. ha^{-1} had the highest seed yield among herbicide treatments, it failed to give higher BCR due to its high cost of chemical (₹1400 L^{-1}). Imazethapyr @200 g a.i ha^{-1} had minimum BCR (1.14). This is due to reduced seed yield because of severe crop injury in addition to high cost of chemical. From this study, it can be concluded that pre-emergence application of pendimethalin @ 1.0 kg a.i. ha^{-1} is cost effective method of controlling weeds of black gram grown in rice-fallow.

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