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Evaluation of methods of sowing and post emergence herbicides for efficient weed control in zero till sown rice fallow black gram *Vigna mungo* L

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ABSTRACT

A field experiment was conducted at Agricultural College and Research Institute, Madurai to evaluate different methods of sowing and post-emergence herbicides for efficient weed control in zero till sown rice fallow black gram during Rabi season of two consecutive years 2004 and 2005. The experiment was laid out in split plot design replicated thrice. The main plot consisted of different methods of sowing viz broadcasting of seeds in the standing crop of rice with and without sand mix application of pendimethalin @ 1 kg ha^{-1}, dibbling the seeds immediately after harvest of rice with and without sand mix application of pendimethalin @ 1 kg ha^{-1} and dibbling the seeds three days after pre-sowing application of paraquat @ 0.5 kg ha^{-1}. Different weed management practices like post-emergence application (PoE) of fenoxaprop-p-ethyl @ 75 g ha^{-1}, imazethapyr @ 100 g ha^{-1} and cyhalofop butyl @ 100 g ha^{-1}, one manual weeding at 20 days after sowing (DAS) and unweeded check were assigned to sub-plots. All post-emergence herbicides were applied at 15 DAS. The dominant weed flora observed on sandy clay loam soils of rice fallow blackgram were *Echinochloa colonum, E crusgalli*, *Panicum repens*, *Cyperus rotundus*, *Sphaeranthus indicus* and *Eclipta alba*. Grasses were found to be dominant followed by broad leaved weeds and sedges. Among different methods of sowing, pre-sowing application of paraquat @ 0.5 kg ha^{-1} followed by dibbling the seeds three days after application registered significantly lower values of weed density, weed dry matter production and higher values of weed control efficiency, crop growth parameters and yield of rice fallow blackgram. Among different weed management practices, post-emergence application of fenoxaprop-p-ethyl @ 75 g ha^{-1} or cyhalofop butyl @ 100 g ha^{-1} on 15 DAS significantly reduced the dominant grassy weed population and increased the growth and yield of rice fallow black gram. The interaction effect was also found to be significant. The best combination to manage the weeds effectively and efficiently and to exploit higher seed yield potential in zero till sown rice fallow black gram was dibbling the seeds three days after pre-sowing application of paraquat @ 0.5 $kgha^{-1}$ with post-emergence application of either fenoxaprop-p-ethyl @ 75 g ha^{-1} or cyhalofop butyl @ 100 g ha^{-1} on 15 DAS. However higher monetary returns were obtained in dibbling the seeds three days after pre-sowing application of paraquat followed by PoE application of fenaxoprop-p-ethyl @ 75 g ha^{-1}.

Keywords: Rice fallow black gram; zero till sown; methods of sowing. post-emergence herbicides; weed control

INTRODUCTION

Pulses are the major source of dietary protein in the vegetarian diet in India. Besides being a rich source of protein they maintain soil fertility through biological nitrogen fixation in soil and thus play a vital role in furthering sustainable agriculture. Pulses are cultivated under irrigated as well as rainfed conditions. They are also cultivated in another unique eco-system known as rice fallow crop. In Tamil Nadu rice fallow pulses contribute 40-50 per cent of total pulse production in which black gram occupies a major share. The productivity of rice fallow black gram is always far below the normal. The main reasons for low productivity are poor plant population and severe weed infestation due to zero tilled conditions. The traditional practice of broadcasting of seeds in the standing crop of rice does not ensure uniform plant population and severe weed infestation under zero tilled conditions deprives the crop of its major requirements of nutrients and moisture which results in poor crop growth and yield. Weed infestation in black gram may culminate yield up to an extent of 45 to 60 per cent. Manual weeding is also difficult and uneconomical to practice in this system because of dense rice stubbles and non availability of labour in time. The application of either pre-sowing or pre-emergence herbicides is also difficult due to lack of field preparation and limited period of their application. Under these circumstances the present research work was planned to develop good management techniques for establishing optimum plant stand and controlling weeds already established before sowing and those germinated in rice fallows thus providing weed free environment to the crop during the critical period of crop weed competition.

MATERIAL AND METHODS

Field investigations were conducted to evaluate different methods of sowing and post-emergence herbicides for their efficiency and selectivity in zero till sown rice fallow black gram at Agricultural College and Research Institute, Madurai during Rabi season of 2004 and 2005.The experimental field was characterised by tropical climate with mean annual rainfall of 808.2 mm and the daily mean maximum and minimum temperatures were 30.9^{o}C and 21.1^{o}C. The soil of the experimental field was sandy clay loam in texture, about neutral in pH and low, medium and high in available N, P and K respectively. Black gram variety ADT 3 released by Tamil Nadu Agricultural University was selected for this study. The experiments were laid out in split plot design with methods of sowing of rice fallow black gram under zero tilled conditions as main plots and weed management practices as sub-plot treatments replicated thrice. The treatment details are as follows.

Main plots: Methods of sowing of rice fallow black gram under zero tilled condition:

M_1: Broadcasting of seeds in the standing crop of rice

M_2: Broadcasting of seeds in the standing crop of rice followed by sand mix application of pendimethalin @ 1 kg ha^{-1}

M_3: Dibbling the seeds immediately after harvest of rice

M_4: Dibbling the seeds immediately after harvest of rice followed by sand mix application of pendimethalin @ 1 kg ha^{-1}

M_5: Pre-sowing application of paraquat @ 0.5 kg ha^{-1} followed by dibbling the seeds three days after paraquat application

Sub plots: Weed management practices (WMP):

S_1: Fenoxaprop-p-ethyl @ 75 g ha^{-1}

S_2: Imazethapyr @ 100 g ha^{-1}

S_3: Cyhalofop butyl @ 100 g ha^{-1}

S_4: One manual weeding at 20 days after sowing of black gram

S_5: Unweeded check

All post-emergence herbicides were applied at 15 DAS.

Black gram seeds were treated with multi-strain rhizobium @ 600 g ha^{-1} and recommended seed rates of 40 kg ha^{-1} and 20 kg ha^{-1} were used in broadcasting and dibbling methods respectively. In case of broadcasting the treated seeds were broadcasted uniformly in the standing crop of rice 5 days before the harvest when the soil was in wet condition. In case of dibbling two to three seeds were dibbled per hill at a depth of 3 to 4 cm adopting a spacing of 30 x 10 cm. Pendimethalin @ 1 kg ha^{-1} was mixed with sand and applied as per treatment schedule on the same day of broadcasting or dibbling the black gram seeds. Paraquat @ 0.5 kg ha^{-1} was sprayed on existing weeds after harvesting of rice and black gram seeds were dibbled 3 days after paraquat application. Foliar spraying of 2 per cent DAP was given twice at flower initiation stage and 15 days after the first spray. Data on weed parameters like weed density and weed dry matter production were recorded before spraying of PoE herbicides and at 30 and 50 DAS.

RESULTS AND DISCUSSION

Weed Flora

The weed flora observed in the experimental field during the course of study consisted of grasses, sedges and broadleaved weeds. The predominant weeds were grasses followed by broad leaved weeds and sedges. Among grassy weeds *Echinochloa colonum* was the

dominant species. The major weeds were *Echinochloa colonum* (L) Link, *E crusgalli* Beav and *Panicum repens* (L) among grasses, *Cyperus rotundus* (L) *and C differmis* (L) among sedges and *Sphaeranthus indicus* (L), *Eclipta alba* (L) Hassk and *Cleome viscosa* (L) among broad leaved weeds.

Effect on weeds

Before spraying of post emergence herbicides

Weed density of grasses, sedges and broad leaved weeds before spraying of post-emergence herbicides was significantly influenced by different methods of sowing in both years of study (Table 1).

Dibbling the black gram seeds three days after pre-sowing application of paraquat @ 0.5 kg ha^{-1} (M_5) recorded lowest grassy, sedge and broad leaved weed densities of 37.32, 3.12 and 6.92 no m^{-2} in 2004 and 32.89, 4.04 and 6.40 no m^{-2} in 2005 respectively. The next best method of sowing was dibbling the seeds after harvest of rice followed by application of pendimethalin @ 1 kg ha^{-1} (M_4) in recording lower grassy and broad leaved weed densities. There was no significant variation on sedge weed density among other methods of sowing in both years. Total weed dry matter production before spraying of PoE herbicides was also significantly influenced by different methods of sowing in both the years of study. Dibbling the seeds three days after pre-sowing application of paraquat @ 1 kg ha^{-1} (M_5) recorded lower total weed dry matter production of 35.20 kg ha^{-1} in 2004 and 32.21 kg ha^{-1} in 2005 and highest total weed DMP was recorded under broadcasting of seeds in the standing crop of rice (M_1).

After spraying of post emergence herbicides

In both years of study methods of sowing and weed management practices exerted significant influence in reducing total weed density and weed dry matter production at 30 and 50 days after sowing (DAS) of black gram in rice fallows (Table 2).

The pre-sowing application of paraquat @ 0.5 kg ha^{-1} followed by dibbling the seeds three days after application (M_5) maintained its superiority in the reduction of total weed density (33.49, 42.94 no m^{-2} at 30 and 50 DAS in 2004 and 35.84, 45.72 no m^{-2} at 30 and 50 DAS in 2005) and total weed DMP (24.51, 31.60 kg ha^{-1} at 30 and 50 DAS in 2004 and 25.43, 33.47 kg ha^{-1} at 30 and 50 DAS in 2005) throughout the crop growth period. This might be due to significant reduction of grasses, sedges and broad leaved weeds achieved by paraquat application and subsequent vigorous crop growth under uniform dibbling of seeds for maintaining required plant population per unit area. Similar findings were reported by Singh et al (2002) under zero tilled conditions. Dibbling the seeds or

Table 1. Effect of methods of sowing on weed parameters before spraying of PoE herbicides in rice fallow black gram

Treatment	Weed density (number m^{-2}) 2004			Weed density (number m^{-2}) 2005			Total weed DMP (kg ha^{-1})	
	Grasses	Sedges	BLW	Grasses	Sedges	BLW	2004	2005
Method of sowing								
M_1	94.87 (1.986)	10.85 (1.108)	27.79 (1.474)	99.69 (2.007)	12.77 (1.169)	29.90 (1.503)	99.20	105.95
M_2	68.60 (1.848)	10.83 (1.108)	21.33 (1.367)	75.24 (1.887)	12.88 (1.172)	23.87 (1.412)	74.78	83.12
M_3	94.78 (1.985)	10.95 (1.112)	27.61 (1.471)	99.58 (2.006)	12.72 (1.167)	29.84 (1.503)	99.13	105.75
M_4	68.43 (1.847)	10.89 (1.110)	21.26 (1.366)	75.14 (1.887)	12.82 (1.170)	23.79 (1.411)	74.90	83.21
M_5	37.32 (1.594)	3.12 (0.709)	6.92 (0.950)	32.89 (1.542)	4.04 (0.781)	6.40 (0.924)	35.20	32.21
SEd	0.045	0.009	0.027	0.040	0.027	0.028	4.06	5.04
$CD_{0.05}$	0.093	0.015	0.051	0.080	0.054	0.057	8.89	10.22

Data in parenthesis are log (x+2) transformed values

Table 2. Effect of methods of sowing and WMP on weed density, weed DMP and WCE at 30 and 50 DAS in rice fallow black gram

Treatment	Total weed density (no m^{-2})				Total weed DMP (kg ha^{-1})				Weed Control Efficiency (%)			
	2004		2005		2004		2005		2004		2005	
	30 DAS	50 DAS	30 DAS	50 DAS	30 DAS	50 DAS	30 DAS	50 DAS	30 DAS	50 DAS	30 DAS	50 DAS
Methods of sowing												
M_1	101.98 (2.017)	142.65 (2.160)	108.83 (2.044)	150.21 (2.182)	74.57	104.13	78.06	109.37	46.37	36.66	46.9	38.53
M_2	73.82 (1.879)	109.99 (2.049)	79.22 (1.909)	118.87 (2.082)	54.41	80.16	58.62	87.58	55.61	45.09	54.15	45.76
M_3	101.95 (2.016)	113.92 (2.064)	108.07 (2.041)	121.86 (2.092)	74.62	82.47	78.15	89.03	46.29	45.13	47.49	46.15
M_4	74.29 (1.882)	84.69 (1.938)	79.31 (1.910)	92.79 (1.976)	54.48	62.23	58.66	67.93	55.66	54.01	54.09	52.69
M_5	33.49 (1.550)	42.94 (1.652)	35.84 (1.578)	45.72 (1.678)	24.51	31.60	25.43	33.47	65.35	64.43	63.46	62.45
SEd	0.018	0.016	0.027	0.018	2.08	3.15	1.65	3.12				
$CD_{0.05}$	0.045	0.032	0.051	0.037	4.17	6.38	3.32	6.27				

Weed Management Practices (WMP)

S_1	53.66 (1.745)	72.29 (1.871)	58.03 (1.778)	77.55 (1.889)	40.29	54.24	40.86	57.02	62.25	56.57	60.25	56.33
S_2	66.43 (1.835)	87.99 (1.954)	69.99 (1.857)	93.77 (1.981)	44.77	63.23	51.87	65.54	51.38	46.45	51.59	46.93
S_3	53.88 (1.747)	72.39 (1.871)	57.88 (1.777)	77.43 (1.899)	40.21	54.33	41.76	57.39	61.87	56.49	60.31	56.45
S_4	79.45 (1.910)	103.45 (2.023)	85.13 (1.940)	110.78 (2.052)	58.23	75.13	62.49	80.91	41.64	36.74	40.80	36.79
S_5	132.09 (2.127)	158.06 (2.204)	140.23 (2.153)	169.93 (2.235)	95.22	113.66	101.92	122.99	-	-	-	-
SEd	0.009	0.008	0.012	0.009	1.15	2.14	1.10	2.05				
CD	0.015	0.016	0.021	0.019	2.28	4.28	2.20	4.12				

Data in parenthesis are log (x+2) transformed values

broadcasting of seeds followed by pendimethalin application (M_2 and M_4) also reduced the weed density and weed dry matter production to a considerable extent. This reduction of DMP of weeds by the application of pendimethalin was due to reduction of weed population. The method of sowing of black gram seeds in the standing crop of rice (M_1) recorded highest total weed density and weed DMP at all stages of crop growth. It was found to be inferior to dibbling the seeds after harvest of rice in reducing total weed density and weed DMP. This was due to maintenance of optimum density of 33 plants m^{-2} under dibbling method of sowing which filtered sunlight reaching the ground level to suppress the weed growth. The smothering effect of crop on the weeds at later stages (50 DAS) of crop growth decreased the weed density and DMP considerably.

Weed management through application of PoE herbicides significantly reduced the total weed density and weed DMP when compared to one manual weeding at 20 DAS and un-weeded check. Application of fenoxaprop-p-ethyl @ 75 g ha^{-1} (S_1) or cyhalofop butyl @ 100 g ha^{-1} (S_3) recorded lower total weed density and weed DMP in both years of study and were found at par with each other. These two herbicides reduced the population of dominant grassy weeds significantly but were found to be ineffective against sedges and broad leaved weeds. This was in accordance with the findings of William (2000) and Choubey et al (2001). Though the effect of imazethapyr @ 100 g ha^{-1} on reduction of grassy weeds was next to fenoxaprop-p-ethyl and cyhalofop butyl it reduced density and DMP of broad leaved weeds. However application of post-emergence (PoE) herbicides was superior in reducing total weed density and weed DMP in rice fallows compared to one manual weeding which was found to be difficult because of presence of dense rice stubbles.

Higher values of weed control efficiency of 65.35 and 64.43 per cent in 2004 and 63.46 and 62.45 per cent in 2005 at 30 and 50 DAS respectively was recorded under M_5 because of significant reduction in weed density and weed DMP (Table 2). The effective control of grassy weeds which constituted the major portion of total weed population by application of either fenoxaprop-p-ethyl or cyhalofop butyl was reflected in increased WCE values. Similar findings were reported by Singh and Tripathi (2003).

Effect on crop

Plant population per unit area was markedly influenced by different methods of sowing. The dibbling method of sowing (M_3, M_4 and M_5) maintained a uniform plant population of 33 plants m^{-2} compared to broadcasting method. Dibbling the seeds three days after pre-sowing application of paraquat @ 0.5 kg ha^{-1} recorded higher values of plant height (36.4 cm and 34.8

Table 3. Effect of methods of sowing and WMP on growth characters of rice fallow black gram

Treatment	2004					2005				
	Plant height (cm)	LAI	DMP (kg ha^{-1})	CGR (g m^{-2}day^{-1})	NAR (mg cm^{-2} day^{-1})	Plant height (cm)	LAI	DMP (kg ha^{-1})	CGR (g m^{-2} day^{-1})	NAR (mg cm^{-2} day^{-1})
Method of sowing										
M_1	28.1	2.30	1143	3.69	0.172	27.5	2.22	1022	3.21	0.156
M_2	30.8	2.53	1280	4.30	0.178	29.9	2.47	1163	3.68	0.160
M_3	31.5	3.20	1549	5.28	0.180	30.7	3.05	1393	4.58	0.161
M_4	34.1	3.44	1691	5.97	0.185	32.7	3.31	1520	5.09	0.164
M_5	36.4	3.65	1834	6.52	0.189	34.8	3.57	1649	5.59	0.166
SEd	1.1	0.05	32	0.14	0.002	0.8	0.06	28	0.11	0.001
$CD_{0.05}$	2.3	0.10	67	0.32	0.004	1.9	0.12	56	0.32	0.002
Weed Management Practice (WMP)										
S_1	34.8	3.26	1671	5.88	0.193	33.0	3.18	1491	5.04	0.170
S_2	32.6	3.06	1528	5.26	0.183	31.4	2.97	1375	4.53	0.164
S_3	34.3	3.25	1656	5.80	0.191	33.6	3.21	1502	5.07	0.171
S_4	30.7	2.88	1392	4.69	0.173	30.0	2.75	1251	4.01	0.156
S_5	28.6	2.67	1250	4.13	0.161	28.0	2.51	1129	3.49	0.148
SEd	0.8	0.03	28	0.12	0.005	0.7	0.04	20	0.14	0.003
$CD_{0.05}$	1.6	0.06	58	0.25	0.008	1.2	0.08	44	0.20	0.006

cm at 45 DAS), LAI (3.65 and 3.57 at 45 DAS), crop DMP (1834 and 1649 kg ha^{-1} at 45 DAS), CGR (6.52 and 5.59 g m^{-2} day^{-1}) and NAR (0.189 and 0.166 mg cm^{-2} day^{-1}) in 2004 and 2005 respectively (Table 3). Among weed management practices application of fenoxaporp-p-ethyl or cyhalofop butyl was found comparable in recording higher values of plant height, LAI, crop DMP , CGR and NAR in both years of study (Table 3). Application of post-emergence herbicides (S_1 or S_3) provided a weed free situation by timely control of weeds during the critical period of crop weed competition in rice fallow black gram. This effect was reflected in producing taller plants, increased LAI, DMP, CGR and NAR values. Application of imazethapyr increased the crop growth parameters next to fenoxaprop-p-ethyl and cyhalofop butyl. A similar effect on growth parameters by the application of imazethapyr was also reported by Vasuki (2001). The conventional method of one manual weeding at 20 DAS was inferior to the application of PoE herbicides to obtain increased crop growth parameters. This might be due to the growth of weeds up to one manual weeding at 20 DAS and subsequent rejuvenation of weeds registered in traditional manual weeding practice. However manual weeding maintained its superiority over unweeded check in obtaining increased crop growth parameters.

Crop seed yield

Interaction effect between methods of sowing and weed management practices on seed yield was significant (Table 4). Higher seed yield of 1207 kg ha^{-1} in 2004 and 1072 kg ha^{-1} in 2005 was registered under M_5S_1 and M_5S_3 respectively. These two promising treatment combinations were comparable in both years of study. The increase in growth parameters and growth

Table 4. Effect of methods of sowing and WMP on seed yield (kg ha^{-1}) of rice fallow black gram

Treatment	2003-04						2004-05					
WMP	Method of sowing						Method of sowing					
	M_1	M_2	M_3	M_4	M_5	Mean	M_1	M_2	M_3	M_4	M_5	Mean
S_1	600	760	910	1129	1207	921	536	677	777	968	1053	802
S_2	506	666	820	1061	1135	838	466	607	705	920	1010	741
S_3	580	739	890	1111	1190	902	557	698	800	989	1072	823
S_4	426	584	740	970	1050	754	388	529	624	824	910	655
S_5	247	350	464	709	780	510	223	320	434	608	680	453
Mean	472	620	765	996	1072	434	566	668	862	945		

indices obtained in the above treatment combinations could contribute increased seed yield of rice fallow black gram. The minimum seed yield of 247 kg ha^{-1} in 2004 and 223 kg ha^{-1} in 2005 was recorded in the combination of broadcasting of seeds in the standing crop of rice with un-weeded check (M_1S_5). However higher B:C ratio of 3.54 in 2004 and 3.08 in 2005 was recorded under M_5S_1 and lower B:C ratio of 1.08 in 2004 and 0.97 in 2005 was registered with M_1S_5.

REFERENCES

Choubey NK, Kolhe SS and Tripathi RS 2001. Relative performance of cyhalofop butyl for weed control indirect seeded rice. Indian Journal of Weed Science **33(3&4)**: 132-135.

Singh G, Singh Y, Singh VP, Rajesh Kumar Singh and Amal Saxena 2002. Bio-efficacy of herbicides in zero till wheat in rice-wheat cropping system. Indian Journal of Weed Science **34(1&2)**: 5-8.

Singh MK and Tripathi SS 2003. Study on chemical weed control in French bean (*Phaseolus vulgaris* L) under Tarai of Uttaranchal. Crop Research **25(2)**: 215-218.

Vasuki V 2001. Evaluation of the bio-efficacy of new generation herbicides in soybean cultivation. MSc (Agric) thesis, Ac & RI, Madurai.

Williams BJ 2000. Barnayard grass (*Echinochloa crusgalli*) control in clear field rice. Proceedings of Weed Science Society **40**: 273.

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