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Studies on Economic Viability of Weed Management Practices in Zero Till Sown Rice Fallow Black gram (*Vigna mungo* L.)

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Abstract- Field experiments were conducted consecutively over a period of two years at Agricultural College & Research Institute, Madurai to study the economic viability of weed management practices in zero till sown rice fallow black gram during *rabi* season. The experiments were laid out in split plot design replicated thrice. In the experimental field, grasses were found to be dominant followed by broad leaved weeds and sedges. Among different methods of sowing, dibbling the seeds three days after pre-sowing application of paraquat @ 0.5 kg ha^{-1} recorded significantly lower values of total weed density, total weed dry matter production and weed index in both years of study and hence better growth and reproductive parameters were obtained under the same treatment. Application of fenoxaprop-p-ethyl @ 75 g ha^{-1} or cyhalofop butyl @ 100 g ha^{-1} on 15 DAS significantly reduced the density and dry weight of dominant grassy weeds over the other treatments and increased the yield of rice fallow black gram. The interaction effect was also found to be significant. The maximum seed and haulm yield were recorded with dibbling the seeds three days after pre sowing application of paraquat @ 0.5 kg ha^{-1} with post emergence application of either fenoxaprop-p-ethyl @ 75 g ha^{-1} or cyhalofop butyl @ 100 g ha^{-1}. However, higher monetary return was obtained in dibbling the seeds three days after pre sowing application of paraquat followed by post emergence application of fenoxaprop-p-ethyl @ 75 g ha^{-1}.

Index Terms- Economics, Methods of sowing, Post emergence herbicides, Rice fallow black gram, Weed control and Zero till

I. INTRODUCTION

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 % 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 reason for low productivity is 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 (Rao, 2000). Weed infestation in black gram may culminate yield up to an extent of 45 to 60 % (Rao *et al*., 2001). 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. In the light of the above report, the present investigation was carried out to find out economically viable weed management practices for 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.

II. MATERIAL AND METHODS

Field investigations were conducted for efficient weed management in zero till sown rice fallow black gram at Agricultural College & Research Institute, Madurai during *rabi* season of 2004 and 2005. The experimental field was characterized by tropical climate with mean annual rainfall of 808.2 mm, 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. The soil was 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 (WMP) as sub plot treatments replicated thrice. The treatment details were as follows.

Main plots: Methods of sowing of rice fallow black gram under zero tilled condition (5)

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): 5

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 (PoE) 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 at 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 30X10 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 % DAP was given twice at flower initiation stage and 15 days after the first spray. Data on parameters like weed density, weed dry matter production, crop seed yield and haulm yield were recorded. Details of post emergence herbicides used for the study are furnished below.

Common name	Fenoxaprop-p-ethyl	Imazethapyr	Cyhalofop butyl
Manufacturer	Aventis	BASF	Denocil
Trade name	Whip Super	Pursuit	Clincher
Formulation	9 % EC	10 % SL	10 % EC
Chemical group	Aryloxyphenoxy	Imidazolinones	Phenoxy propionics
Mode of action	Inhibits fatty acid synthesis	Inhibits amino acid bio synthesis	Inhibits fatty acid synthesis

III. 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, *Echinochloa crusgalli* Beav and *Panicum repens* (L.) among grasses, *Cyperus rotundus* (L.) *and Cyperus difformis* (L.) among sedges and *Sphaeranthus indicus* (L.), *Eclipta alba* (L.) Hassk and *Cleome viscosa* (L.) among broad leaved weeds.

Effect on weed parameters

Total weed density and weed dry matter production before spraying of post emergence herbicides and at maturity were significantly influenced by different methods of sowing in both years of study (Table 1). Before spraying of post emergence herbicides, dibbling the black gram seeds three days after pre sowing application of paraquat @ 0.5 kg ha^{-1} (M_5) recorded lowest total weed density of 47.36 and 43.33 No. m^{-2} in 2004 and 2005 respectively. This was in accordance with the findings of Subramanian *et al.* (2001) who reported that paraquat was an excellent contact herbicide to kill the establishing weeds. 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 total weed density. This was due to effective suppression of newly emerging grasses and broad leaved weeds by the application of pendimethalin after dibbling of black gram seeds. Similar findings were also reported by Murti *et al.* (2004). However, pendimethalin had no effect on control of sedges and on established weeds. Higher total weed density of 144.06 No. m^{-2} in 2004 and 152.51 No. m^{-2} in 2005 was recorded at maturity under broadcasting of seeds in the standing crop of rice (M_1) which was found to be inferior to dibbling the seeds after harvest of rice (M_3) in reducing weed density and weed dry matter production (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 of crop growth decreased the weed density and DMP considerably.

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 DMP at maturity in both years of study and were found at par with each other (Table 1). These two herbicides reduced the population of dominant grassy weeds significantly but found to be ineffective against sedges and broad leaved weeds. This was in accordance with the findings of William (2000) and Choubey *et a*l. (2001). Though the effect of imazethapyr @ 100 g ha^{-1} on reduction of grassy weds was next to fenoxaprop-p-ethyl and cyhalofop butyl, it reduced density and DMP of broad leaved weeds. However, application of PoE herbicides was superior in reducing weed density and weed (DMP) of grasses in rice fallows compared to one manual weeding which was found to be difficult because of presence of dense rice stubbles. 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 lower weed index values. Similar findings were reported by Singh and Tripathi (2003). Lower values of weed index were recorded with the combination of M_5S_1 in 2004 and M_5S_3 in 2005.

Effect on crop parameters

Dibbling the seeds three days after pre sowing application of paraquat recorded higher values of seed yield, haulm yield and harvest index (1072 kg ha^{-1}, 2366 kg ha^{-1} and 0.312 in 2004 and 945 kg ha^{-1}, 2087 kg ha^{-1} and 0.309 in 2005) respectively (Table 2). This might be due to reduction of weed competition in early stages of crop growth with simultaneous increase in crop growth parameters. Among WMP, application of fenoxaprop-p-ethyl or cyhalofop butyl were found comparable in recording crop parameters during both years of study (Table 2). 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. Application of imazethapyr increased the crop yield next to fenoxaprop-p-ethyl and cyhalofop butyl. A similar effect on growth parameters and yield 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 post emergence 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.

Economics

The highest net return of Rs. 14,707 ha^{-1} in 2004 and Rs. 12,111 ha^{-1} in 2005 and B:C ratio of 3.14 in 2004 and 2.76 in 2005 were recorded with dibbling the seeds three day after pre sowing application of Paraquat @ 0.5 kg ha^{-1} (Table 3). Among WMP, application of fenoxaprop-p-ethyl @ 75 g ha^{-1} recorded maximum net return and B:C ratio of Rs. 10,855 $ha^{-1}$and 2.72 in 2004 and Rs. 9326 ha^{-1} and 2.37 in 2005 respectively.

IV. CONCLUSION

The investigation conclusively proved that integration of dibbling the black gram seeds three days after pre sowing application of Paraquat @ 0.5 kg ha^{-1} with post emergence application of either fenoxaprop-p-ethyl @ 75 g ha^{-1} or cyhalofop butyl @ 100 g ha^{-1} at 15 DAS effectively controlled the weeds and increased the seed yield of rice fallow black gram. However, higher monetary return was obtained in dibbling the seeds three days after pre-sowing application of Paraquat with fenoxaprop-p-ethyl @ 75 g ha^{-1} in zero till sown rice fallow black gram.

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Table 1. Effect of methods of sowing and WMP on weed parameters in zero till sown rice fallow black gram

Treatments	2004				2005			
	Weed density (No. m^{-2})		Weed DMP (kg ha^{-1})	WI (%)	Weed density (No. m^{-2})		Weed DMP (kg ha^{-1})	WI (%)
	Before spraying of PoE herbicides	At Maturity			Before spraying of PoE herbicides	At Maturity		
Methods of sowing								
M_1	133.51 (2.131)	144.06 (2.164)	105.56	26.70	142.25 (2.159)	152.51 (1.161)	112.34	27.60
M_2	100.59 (2.011)	111.76 (2.055)	82.52	23.05	111.81 (2.056)	121.07 (2.090)	89.79	23.59
M_3	133.34 (2.131)	116.36 (2.073)	87.93	19.94	142.25 (2.159)	124.04 (2.100)	92.38	20.62
M_4	100.75 (2.011)	87.09 (1.949)	64.14	14.72	111.93 (2.056)	95.24 (1.987)	71.72	16.07
M_5	47.36 (1.693)	44.50 (1.667)	32.87	13.68	43.33 (1.656)	47.82 (1.697)	36.30	14.80
SEd	0.051	0.040	6.05		0.045	0.045	5.79	
CD (P:0.05)	0.108	0.083	12.38		0.092	0.097	11.54	
Weed Management Practices (WMP)								
S_1	103.14 (2.021)	74.13 (1.881)	55.76	-	110.62 (2.051)	79.94 (1.913)	57.48	2.70
S_2	103.01 (2.021)	89.94 (1.963)	66.51	9.78	110.60 (2.051)	96.01 (1.991)	71.98	10.79
S_3	103.10 (2.021)	74.36 (1.882)	56.08	2.25	110.67 (2.052)	79.52 (1.911)	57.30	-
S_4	103.43 (2.022)	105.30 (2.030)	76.85	19.58	110.60 (2.051)	113.04 (2.060)	81.52	21.66
S_5	102.83 (2.020)	159.95 (2.209)	115.05	46.87	110.58 (2.051)	172.17 (2.240)	124.26	46.98
SEd	0.035	0.030	4.9		0.058	0.032	4.51	
CD (P:0.05)	NS	0.06	9.86		NS	0.065	9.05	

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

Table 2: Effect of methods of sowing and WMP on seed yield, haulm yield and HI of rice fallow black gram

Treatments	Seed yield (kg ha^{-1})	Haulm yield (kg ha^{-1})	HI	Seed yield (kg ha^{-1})	Haulm yield (kg ha^{-1})	HI
Methods of sowing						
M_1	472	1232	0.271	434	1164	0.267
M_2	620	1563	0.276	566	1462	0.275
M_3	765	1877	0.286	668	1686	0.282
M_4	996	2243	0.307	862	1971	0.304
M_5	1072	2366	0.312	945	2087	0.309
SEd	16	28	0.002	17	24	0.003
CD (P:0.05)	46	58	0.004	45	56	0.005
WMP						
S_1	921	2077	0.305	802	1857	0.299
S_2	838	1951	0.296	741	1763	0.291
S_3	902	2048	0.303	823	1887	0.301
S_4	754	1871	0.286	655	1644	0.281
S_5	510	1389	0.263	453	1216	0.264
SEd	10	20	0.001	11	17	0.002
CD (P:0.05)	23	40	0.002	20	34	0.004

Table 3: Economics of methods of sowing & WMP on rice fallow black gram

Treatments	Cost of cultivation (Rs ha^{-1})	2004			2005		
		Gross returns (Rs ha^{-1})	Net returns (Rs ha^{-1})	B:C ratio	Gross returns (Rs ha^{-1})	Net returns (Rs ha^{-1})	B:C ratio
Methods of sowing							
M_1	5797	9436	3639	1.59	8680	2883	1.46
M_2	7225	12396	5119	1.69	11324	4099	1.54
M_3	6097	15296	9199	2.47	13360	7263	2.17
M_4	7527	19920	12393	2.63	17236	9709	2.27
M_5	6789	21448	14707	3.14	18900	12111	2.76
WMP							
S_1	6718	18424	10855	2.72	16044	9326	2.37
S_2	6970	16752	9829	2.38	14832	8201	2.11
S_3	7250	18040	10780	2.47	16464	9213	2.26
S_4	7036	15080	8044	2.12	13100	6064	1.84
S_5	5460	10200	4740	1.83	9060	3599	1.63