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Weed Management in Rice Fallow Black Gram through Post-Emergence Herbicides

T. Ramesh* and S. Rathika
Tamil Nadu Rice Research Institute,
Tamil Nadu Agricultural University, Aduthurai - 612 001, Tamil Nadu, India

Field experiments were conducted at Tamil Nadu Rice Research Institute, Aduthurai during *Rabi* season of 2011 and 2012 to find out the suitable early post-emergence herbicides to manage the emerged weeds and re-growth of paddy stubbles in rice fallow black gram. The treatments consisted of three levels (50, 75 and 100 g/ha) of early post- emergence herbicides *viz*., Imazethapyr 10% SL and Quizalofop ethyl 5% EC which were tested alone and in combination and also compared with farmers' practice of no weeding. Results revealed that lesser weed density was obtained with application of imazethapyr + quizalofop ethyl, each at 75g/ha in both the years. Application of quizalofop ethyl alone or in combination with imazethapyr at all the three levels recorded higher weed control efficiency (> 80%) over imazethapyr alone. Higher mean yield of 721 kg/ha was obtained with application of both herbicides each at 50 g/ha and it was comparable with all the quizalofop ethyl treatments as well as application of both herbicides at all the doses. Higher mean net return of Rs.25375/ha was registered with application of both herbicides, each at 50 g/ha. However, higher return per rupee invested (BC Ratio) was obtained under application of quizalofop ethyl alone at 50 g/ha during both the years (3.43). Thus, based on the weed control efficiency, seed yield and returns, it could be concluded that application of quizalofop ethyl at 50g/ha on 20 DAS will be effective for controlling emerged grassy weeds and re-growth of paddy stubbles in rice fallow black gram.

Key words: Imazethapyr, Quizalofop ethyl, Rice fallow blackgram, Seed yield, Weed control efficiency

Black gram (*Vigna mungo* L.) is one of the important pulse crops in Tamil Nadu, grown under irrigated, rainfed and rice fallow conditions. Rice fallow black gram is grown during the month of January to March in Cauvery Delta Zone, Tamil Nadu in an area of 2.0 lakh hectares. It grows in the residual soil moisture, which is broadcasted 7-10 days before the harvest of paddy crop in waxy soil condition. Since black gram is grown under paddy stubbles, it has to survive in the residual nutrients and moisture present in the soil, besides frost and mist available during the period and complete the lifecycle within 65-70 days of sowing. Productivity of rice fallow black gram is low and highly variable (300-500 kg/ha) and mostly depends on the management practices followed. Use of poor quality seeds, poor germination of seeds, water stress at flowering stage, no fertilizer application, non adoption of DAP spraying and no weed management are the reasons for lower yield of rice fallow black gram. Among these factors, occurrence of weeds including re-growth of rice stubbles is one of the important factors during early stages as the weeds compete for scarce soil moisture and nutrients. Since, the black gram is sown under zero till condition, weed growth is severe and effectively competes with the crop.

*Corresponding author email : agronramesh@gmail.com

Under rice fallow black gram, pre emergence application of herbicide is not possible, which forces the farmers to go for hand weeding and it is costly. Hand weeding is also difficult because of the presence of dense rice stubbles in addition to the problem of trampling of black gram seedlings, which are broadcasted on the soil surface. Under these circumstances, early post-emergence herbicides could be a viable option for weed management in rice fallow black gram where concrete solution has not been found so far. There are few findings available in irrigated pulses on the use of early post-emergence herbicides. The potential advantage of imazethapyr as a selective herbicide in different pulses including lentil, field pea, faba bean and annual vetch was investigated by Malik and Smith (1990). Similarly, fluazifop-butyl (0.5 kg/ha) gave good control on cereal volunteers and grasses when applied as post-emergence in chickpea (Yasin *et al.,* 1995). Keeping in view, the present investigation was undertaken to study the effect of chemical weed management in rice fallow black gram.

Materials and Methods

Field experiments were conducted at Tamil Nadu Rice Research Institute, Aduthurai during *Rabi* (January to March) 2011 and 2012 to find out suitable

early post-emergence herbicides to manage the emerged weeds in rice fallow black gram. The soil of the experimental field was alluvial clay with pH 7.7 and EC 0.3 dS/m. The experimental soil was low, high and medium in available nitrogen, phosphorus and potassium contents, respectively. The experiment was laid-out in a randomized block design. Treatments consisted of three levels (50, 75 and 100 g/ha) of early post- emergence herbicides *viz*., Imazethapyr 10% SL and Quizalofop ethyl 5% EC, which were tested alone and in combination, and also compared with farmers' practice of no weeding. Black gram (ADT 3) seeds were sown on 10 days before the harvest of *samba* paddy and herbicides were sprayed using flat-fan nozzle as per the treatment schedule on 10 days after the harvest of samba paddy i.e.20 days after sowing of black gram. No weeding was followed in the farmers practice as in rice fallow black gram none of the farmers practice weeding. Observations on weed dynamics, plant height, yield attributes *viz*., pods per plant, seeds per pod and seed yield were recorded. Weed count was recorded by using 0.25 m^2 quadrate at four places in each plot and expressed as number/m^2 as suggested by Burnside and Wicks (1965). The values were subjected to square root transformation (X+0.5) as described by Bartlett (1947) and analyzed statistically. Weed control efficiency was worked out on 40 DAS and expressed as the percentage reduction in weed density due to weed management practices over control. Economics of weed management was worked out by using the current market price of inputs and black gram seed. All the recorded data were analyzed statistically as per the method suggested by Gomez and Gomez (1984).

Results and Discussion

Effect on weeds

Weed species like *Echinochloa colonum (L.), Cynodon doctylon(L.),* and *Panicum repens(L.),* in grasses, *Ammania baccifera(L.), Cyanotis axillaris(L.), Eclipta prostrata(L.), Stemodia viscosa*

Table 1. Effect of early post-emergence herbicides in rice fallow black gram

Treatments	Weed density (Nos./m^2) at 40 DAS			Weed control efficiency (%)		
	2011	2012	Mean	2011	2012	Mean
T_1: Farmers practice	117.6	56.5	87.1	-	-	-
	(9.3)	(7.52)	(9.3)			
T_2: Imazethapyr 50 g/ha	80.0	15.7	47.9	63.5	72.9	68.2
	(6.9)	(3.96)	(6.9)			
T_3: Imazethapyr 75 g/ha	40.0	15.2	27.6	66.8	73.8	70.3
	(5.3)	(3.89)	(5.3)			
T_4: Imazethapyr 100 g/ha	48.4	9.7	29.1	72.1	83.6	77.9
	(5.4)	(3.11)	(5.4)			
T_5: Quizalofop ethyl 50 g/ha	52.6	10.5	31.6	79.1	82.1	80.6
	(5.6)	(3.24)	(5.6)			
T_6: Quizalofop ethyl 75 g/ha	24.0	11.3	17.7	82.1	80.7	81.4
	(4.2)	(3.36)	(4.2)			
T_7: Quizalofop ethyl 100 g/ha	26.0	10.3	18.2	84.1	82.5	83.3
	(4.3)	(3.21)	(4.3)			
T_8: Imazethapyr 50 g/ha + Quizalofop ethyl 50 g/ha	33.2	11.7	22.5	82.1	80.0	81.1
	(4.7)	(3.42)	(4.7)			
T_9: Imazethapyr 75 g/ha + Quizalofop ethyl 75 g/ha	16.0	7.3	11.7	86.7	87.9	87.3
	(3.4)	(2.70)	(3.4)			
T_{10}: Imazethapyr 100 g/ha + Quizalofop ethyl 100 g/ha	18.0	7.7	12.9	83.4	87.1	85.3
	(3.6)	(2.77)	(3.6)			
SEd	0.4	0.3	0.4	-	-	-
CD (P=0.05)	0.8	0.6	0.7	-	-	-

(L.) and *Sphaeranthus indicus(L.)* in broad leaved weed; *Cyperus rotuntus(L.)* in sedges were the predominant weed species found in the experimental field. Among the weeds, re-growth of paddy stubbles and germinated rice seedlings from shattered grains (51.2%) were dominant in the experimental field followed by grasses (36.6%), sedges (6.4%) and broad leaved weeds (5.81%).

Total weed density on 40 DAS reveled that application of imazethapyr + quizalofop ethyl at all the three levels (50, 75 and 100 g/ha) recorded lesser total weed density (Table 1). The minimum weed density was recorded with application of imazethapyr + quizalofop ethyl each at 75 g/ha in both the years. Higher weed density was recorded with farmers' practice of no weeding. Between

Table 2. Effect of early post-emergence herbicides on plant height, pods per plant and seed yield in rice fallow black gram

Treatments	Plant height at harvest (cm)			Number of pods/ plant			Seed yield (Kg/ha)		
	2011	2012	Mean	2011	2012	Mean	2011	2012	Mean
T_1: Farmers practice	36.3	51.2	43.8	13.3	21.9	17.6	384	502	443
T_2: Imazethapyr 50 g/ha	38.3	52.0	45.2	14.4	25.9	20.2	510	593	552
T_3: Imazethapyr 75 g/ha	41.6	51.5	46.6	15.5	25.0	20.3	602	585	594
T_4: Imazethapyr 100 g/ha	39.6	50.2	44.9	15.3	22.1	18.7	568	530	549
T_5: Quizalofop ethyl 50 g/ha	39.3	54.2	46.8	16.8	27.2	22.0	685	665	675
T_6: Quizalofop ethyl 75 g/ha	41.2	52.8	47.0	17.5	33.5	25.5	725	714	720
T_7: Quizalofop ethyl 100 g/ha	39.6	52.5	46.1	18.2	30.1	24.2	705	687	696
T_8: Imazethapyr 50 g/ha + Quizalofop ethyl 50 g/ha	40.5	54.6	47.6	18.8	32.6	25.7	736	706	721
T_9: Imazethapyr 75 g/ha + Quizalofop ethyl 75 g/ha	43.9	53.6	48.8	19.2	29.4	24.3	758	671	715
T_{10}: Imazethapyr 100 g/ha + Quizalofop ethyl 100 g/ha	42.1	53.0	47.6	18.7	29.8	24.3	704	663	684
SEd	2.5	1.8	2.1	1.0	1.7	1.4	44	37	41
CD (P=0.05)	5.2	3.9	4.2	2.2	3.6	2.9	95	81	88

herbicides, quizalofop ethyl registered lesser number of weeds than imazethapyr as the rice fallow situation dominated by grassy weeds and re-growth of paddy stubbles which were controlled by quizalofop ethyl.

Application of quizalofop ethyl alone or in combination with imazethapyr at all the three levels recorded higher weed control efficiency (>80%) over imazethapyr alone. Higher weed control efficiency of 87.3% was recorded with application of imazethapyr + quizalofop ethyl each at 75 g/ha. However, this was comparable with all other treatments except treatments which received imazethapyr alone and farmers' practice. Rice fallow black gram fields were dominated with re-growth of paddy stubbles and grassy weeds which were all controlled by quizalofop ethyl as it affects the acetyl CoA synthesis in plants. Similarly, spraying of quizalofop-ethyl at 50 g/ha as selective post-emergence herbicide recorded lower grasses density and dry weight at 30 DAS and at harvest stages in black gram (Mundra and Maliwal, 2012).

Effect on growth and yield of black gram

Growth and yield of rice fallow black gram varied significantly by the weed management practices (Table 2). Higher plant height of 48.8 cm was registered with application of imazethapyr + quizalofop ethyl each at 75 g/ha. Shorter plants were noticed under farmers' practice where no weeding was given. Mean maximum number of pods per plant (25.7) were recorded with imazethapyr + quizalofop ethyl each at 50 g/ha. This was comparable with application of imazethapyr + quizalofop ethyl each at 100 and 75 g/ha and application of quizalofop ethyl alone at 75 and 100 g/ha. Application of imazethapyr alone recorded lesser number of pods per plant in all the doses than quizalofop ethyl or both the herbicides. Farmers' practice recorded significantly lesser number of pods per plant in both the years.

Table 3. Economic analysis of herbicidal weed management in rice fallow black gram

Treatments	Net returns (Rs./ha)			Benefit Cost Ratio		
	2011	2012	Mean	2011	2012	Mean
T_1: Farmers practice	11505	17405	14455	2.50	3.26	2.88
T_2: Imazethapyr 50 g/ha	16565	20615	18590	2.85	3.31	3.08
T_3: Imazethapyr 75 g/ha	20545	19695	20120	3.15	3.06	3.11
T_4: Imazethapyr 100 g/ha	18625	16725	17675	2.91	2.71	2.81
T_5: Quizalofop ethyl 50 g/ha	24415	23415	23915	3.48	3.38	3.43
T_6: Quizalofop ethyl 75 g/ha	25615	25065	25340	3.41	3.36	3.39
T_7: Quizalofop ethyl 100 g/ha	23875	22975	23425	3.10	3.02	3.06
T_8: Imazethapyr 50 g/ha + Quizalofop ethyl 50 g/ha	26125	24625	25375	3.45	3.31	3.38
T_9: Imazethapyr 75 g/ha + Quizalofop ethyl 75 g/ha	26005	21655	23830	3.19	2.82	3.01
T_{10}: Imazethapyr 100 g/ha + Quizalofop ethyl 100 g/ha	22145	20095	21120	2.70	2.54	2.62

Significantly higher seed yield of 758 kg/ha was obtained with application of imazethapyr + quizalofop ethyl each at 75 g/ha during 2011 and 714 kg/ha with application of quizalofop ethyl at 75 g/ha during 2012. The mean yield of 721 kg/ha was obtained with application of both herbicides at 50 g/ha, closely followed by application of quizalofop ethyl alone at 75 g/ha. However, it was comparable with application of quizalofop ethyl alone as well as combined

application of both herbicides at all the doses except application of imazethapyr alone (50, 75 and 100 g/ha) and farmers' practice of no weeding. This might be due to that control of grassy weeds, re-growth of rice stubbles as well as germinated rice seedlings during early stages favoured lesser weed competition, which in turn resulted in better crop growth and yield parameters and seed yield of black gram. Between the herbicides used, quizalofop ethyl recorded higher seed yield than imazethapyr at all the levels. Lower seed yield of 443 kg/ha was registered with farmers' practice of no weeding. Similarly, post-emergence application of fenoxaprop-p-ethyl at 75 g/ha or cyhalofop butyl at 100 g/ha on 15 DAS significantly reduced the dominant grassy weed population and increased the growth and yield of rice fallow black gram (Sasikala *et al.,* 2014). Post-emergence herbicides like fenoxaprop-P-ethyl, clodinafop-propargyl and cyhalofop-butyl significantly reduced *Echinochloa colona* growth and increased black gram yield by 27 to 42% over weedy check without any crop injury (Rao, 2008).

Effect on economics in black gram

Higher net returns of Rs.26125/ha and Rs.25065/ha were obtained with the application of imazethapyr + quizalofop ethyl each at 50 g/ha during 2011 and quizalofop ethyl at 75 g/ha during 2012, respectively. However, mean higher net return of Rs.25375/ha was registered with application of both herbicides each at 50 g/ha, closely followed by application of quizalofop ethyl alone at 75 g/ha (Rs.25340/ha). Higher benefit cost ratio was obtained under application of quizalofop ethyl alone at 50 g/ha during both the years and the mean value of 3.43. Lower dose of herbicidal usage incurred lesser expenditure as well as higher seed yield were the probable reasons for getting higher return per rupee invested. This was closely followed by quizalofop ethyl alone at 75 g/ha (3.39) and both herbicides each at 50 g/ha (3.38). Mean minimum net return and BCR were noticed with application of both the herbicides at 100 g/ha mainly due to higher cost of herbicides. Similarly, Rao (2011) found that post-emergence application of quizalofop ethyl at 50 g/ha recorded higher seed yield, net monetary returns and BCR of rice fallow black gram.

Thus, it could be concluded that application of quizalofop ethyl at 50 g/ha on 20 DAS be economically viable will for controlling emerged grassy weeds including re-growth of paddy stubbles in rice fallow black gram.

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