

Sequential Post Emergence Herbicide Application to Dry Direct Sown Rice

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ABSTRACT

A field trial was undertaken on sandy clay loam soils of agricultural research station Ragolu, AP India during two *kharif* seasons of 2015 and 2016. The trial was conducted in Completely Randomized Block Design with three replications and nine weed control treatments viz., “post emergence application of Bis-pyribac sodium @ 25 g ai/ha at 20 DAS fb Amine salt of 2,4 D @ 0.58 kg ai/ha, metsulfuron methyl + chlorimuron ethyl (Almix) 4 g ai/ha, Ethoxysulfuron @ 20 g ai/ha, Fenoxaprop P ethyl with safenor (Rice star) @ 625ml/ha, Cyhalofopbutyl @100 g ai/ha + amine salt of 2,4, D @ 0.58 kg ai/ha Ethoxysulfuron @ 20 g ai/ha+ Fenoxaprop P Ethyl

with safenor (Rice star) @ 625ml/ha at 40 DAS, Post emergence application of Penoxulam@ 25g ai/ha at 20 DAS fb amine salt of 2, 4, D @ 0.58 kg ai/ha at 40 DAS, Two hand weedings at 20 and 40 DAS and Weedy Check”. The study can be concluded that, post emergence application of Bis-pyribac sodium @ 25 g ai/ha at 20 DAS followed by Ethoxysulfuron @ 20 g ai/ha+ Fenoxaprop P Ethyl with safenor (Rice star) @ 625 ml/ha at 40 DAS recorded maximum plant height, higher number of tillers m⁻², higher dry matter production, greater number of panicles m⁻² with higher number of filled grains/panicle with higher test weight ultimately resulted in to the 94 % higher grain yield, 63 % higher straw yield over weedy check with lowest values of weed index and higher weed control efficiency and found at par to hand weeding twice.

Keywords Dry direct sown rice, Post emergency herbicides, Yield, Weed growth, Economics.

INTRODUCTION

More than 50 % cultivated area during *kharif* was occupied by rice in north coastal districts of Andhra Pradesh where rice cultivated over an extent of 4 l ha. Though the transplanting was the traditional way of rice establishment, due to multiple reasons, rice cultivators are progressively switching over to dry direct sown rice system and now this system occupies about 50 % of the rice area in this zone i.e., about 2.0l ha. Dry direct sown rice is the system “where the seeds are sown in dry soil by broadcasting or line sowing or

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drilling and grown as rainfed crop for 30 to 45 days and with the availability of canal water dry sown rice is converted in to wet system and is maintained up to the harvest of the crop just like lowland rice". "Weed is the major challenge for success of direct sown rice" (Rao *et al.* 2007). "Hand weeding in rice becoming more tedious, difficult, costly and less effective because of labor scarcity at critical time of weeding and increasing labor costs besides seedlings of some grassy weeds such as *Echinochloa crusgalli* (L.) look similar to rice seedlings" (Chauhan 2012). In this context, use of herbicides is inevitable in direct sown rice system as it is more effective, easy. "Usage of either single application of pre emergence or post emergence herbicides fails to control diverse weed flora observed in direct sown rice necessitates the use of a broad-spectrum herbicide program including pre and post emergence herbicides for season-long effective weed control and to avoid shifts towards problematic weed species" (Chauhan and Opena 2012). Though pendimethalin being accepted and adopted by the farmers in this system, information on effective post emergence herbicides and their combinations are not available. Therefore this study was conducted to know the effective post emergence herbicides for entire critical period of crop weed competition in dry direct sown rice.

MATERIALS AND METHODS

A field trial was undertaken on sandy clay loam soils of agricultural research station Ragolu, AP India during two *kharif* seasons of 2015 and 2016. The trial was conducted in Completely Randomized Block Design with three replications and nine treatments viz., "T₁- post emergence application of Bis-pyribac sodium @ 25 g ai/ha at 20 DAS fb amine salt of 2,4 D @ 0.58 kg ai/ha at 40 DAS, T₂- post emergence application of Bis-pyribac sodium @ 25 g ai/ha at 20 DAS fb metsulfuron methyl + chlorimuron ethyl (Almix) 4 g ai/ha at 40 DAS, T₃- post emergence application Bis-pyribac sodium @ 25 g ai/ha at 20 DAS fb Ethoxysulfuron @ 20 g ai/ha at 40DAS, T₄- post emergence application Bis-pyribac sodium @ 25 g ai/ha at 20 DAS fb post emergence application of Fenoxaprop P ethyl with safenor (Rice star) @ 625ml/ha at 40 DAS, T₅- post emergence application Bis-pyribac sodium @ 25 g ai/ha at 20 DAS fb post

emergence application of Cyhalofopbutyl @100 g ai/ha + amine salt of 2,4, D @ 0.58 kg ai/ha at 40 DAS, T₆- post emergence application Bis-pyribac sodium @ 25 g ai/ha at 20 DAS fb Ethoxysulfuron @ 20 g ai/ha+ Fenoxaprop P ethyl with safenor (Rice star) @ 625ml/ha at 40 DAS, T₇- Post emergence application of Penoxulam @ 25g ai/ha at 20 DAS fb amine salt of 2,4, D @ 0.58 kg ai/ha at 40 DAS, T₈- Two hand weedings at 20 and 40 DAS and T₉- Weedy Check".

The seeds of rice was directly sown in lines on dry soil by dibbling 2-3 seeds hill⁻¹ at a spacing of 20 x 10 cm using RGL 2332 (150 days duration) was the test variety. The seed was treated with fungicide Carbendazim @ 1g kg⁻¹ seed. Thinning and gap filling were done at 10 DAS to maintain the uniform plant stand in all the plots. Recommended dose of nutrients i.e., 120 kg N, 60 kg P₂O₅ and 50 kg K₂O per hectare was applied in the form of urea, single super phosphate and murate of potash respectively. Recommended package of practices for *kharif* direct sown rice was followed for this crop except weed control. Pre emergence herbicide Pendimethalin 30% applied @ 750 g ai/ha on the next days of sowing. Different post emergence herbicides applied as per the treatments. The required quantities of pre-and post-emergence herbicides were applied uniformly @ 500 L spray fluid ha⁻¹ using knapsack sprayer fitted with flat fan nozzle. Weed counts and dry weight were recorded randomly with the help of 0.25 m² quadrat at 30 and 50 DAS. The data on weed counts and dry weight were subjected to square root ($\sqrt{x+0.5}$) transformation to normalize their distribution. Data on tillers m⁻², panicles/m², filled grains/panicle, test weight, panicle length, grain and straw yields were recorded following standard procedure and cost of cultivation was computed considering the local market price of inputs used and returns were calculated by adopting standard procedures. Data was analyzed using ANOVA and the significance was tested by Fisher's least significance difference (p= 0.05).

RESULTS AND DISCUSSION

The major weeds noticed in the experimental plots were *Echinochloa colona*, *Echinochloa crus-galli*, *Cyperus rotundus*, *Cyperus iria*, *Cynodon dactylon*, *Commelina benghalensis*, *Digitaria sanguinalis*, *Am-*

Table 1. Effect of post emergence application of herbicides on yield parameters and yield of dry direct sown rice.

Treatment	Grain yield (kg ha ⁻¹)	Straw yield (kg ha ⁻¹)	Harvest index	Cost of cultivation (Rs ha ⁻¹)	Gross returns (Rs ha ⁻¹)	Net returns (Rs ha ⁻¹)	B:C ratio
T ₁ - Bis-pyribac sodium fb Amine salt of 2,4 D	5957	7151	0.44	34902	91988	57086	1.64
T ₂ - Bis-pyribac sodium fb Almix	6286	7400	0.44	34799	96765	61966	1.78
T ₃ - Bis-pyribac sodium fb Ethoxysulfuron	6207	7301	0.44	34645	95747	61102	1.77
T ₄ - Bis-pyribac sodium fb Rice star	6404	7458	0.45	34902	98691	63789	1.83
T ₅ - Bis-pyribac sodium fb cyhalofopbutyl+ 2,4,D amine	6490	7574	0.44	37131	99972	62841	1.69
T ₆ - Bis-pyribac sodium fb Ethoxysulfuron + Rice star	6573	7660	0.44	35158	101211	66054	1.88
T ₇ - Penoxulam fb 2,4, D amine	6259	7325	0.44	34953	96404	61451	1.76
T ₈ - Two hand weedings	6797	7908	0.45	40027	104685	64659	1.62
T ₉ - Weedy check	3385	4690	0.39	32339	53540	21201	0.66
SEm±	172	191	--	809	1780	1021	0.034
CD (0.05)	511	568	--	2405	5294	3035	0.11

monia basifera, *Dactyloctenium aegyptium*, *Digera arvensis*, *Fimbristilis miliacea*, *Spheroclea xylanica*, *Ludwigia parviflora*, *Monochoria vaginalis*, *Marselia quadrifoliata*, *Eclipta alba*, *Cleome viscosa*, *Cleome chelidoni*, *Boerhavia erecta*, *Trianthema portulacastrum*. Ramana *et al.* (2007) also reported similar weed flora under deficit moisture conditions in rice cultivation at Ragolu. Reduction in grain and straw yield due to weeds was 56.64% and 59.31 % respectively in dry direct sown rice (Table 1). “Uncontrolled weed growth in dry direct sown rice was found to reduce the mean grain and straw yield to the tune of 67.48% and 31.79%, respectively” (Vijayalakshmi *et al.* 2020).

The two years mean data revealed that, different weed control treatments exerted noticeable influence

on plant height, tillers m⁻², dry matter production, number of panicles m⁻², filled grains/panicle, test weight, panicle length, grain yield, straw yield and economic parameters, weed counts, weed dry weight of dry direct sown rice. Among various chemical weed management treatments, post emergence application of Bis-pyribac sodium @ 25 g ai/ha at 20 DAS followed by Ethoxysulfuron @ 20 g ai/ha+ Fenoxaprop P Ethyl with safenor (Rice star) @ 625 ml/ha at 40 DAS recorded maximum plant height, higher number of tillers m⁻², higher dry matter production (Table 2) greater number of lengthy panicles m⁻² with higher number of filled grains/panicle and higher test weight ultimately resulted in to the higher grain yield (Table 1). The grain and straw yield was increased by 94.18 and 63.32 % respectively over

Table 2. Effect of post emergence application of herbicides on growth parameters of dry direct sown rice. DMPH- Dry matter production at harvest.

Treatment	Plant height (cm)	Tiller sm ⁻²	Panicle sm ⁻²	Filled grains panicle ⁻¹	1000 grain wt (g)	Panicle length (cm)	DMPH (kg ha ⁻¹)
T ₁ - Bis-pyribac sodium fb Amine salt of 2,4 D	129	526	372	122	22.65	23.13	13661
T ₂ - Bis-pyribac sodium fb Almix	129	541	379	125	22.94	24.19	14238
T ₃ - Bis-pyribac sodium fb Ethoxysulfuron	128	539	390	125	23.12	24.08	14058
T ₄ - Bis-pyribac sodium fb Rice star	129	529	390	130	23.01	23.82	14381
T ₅ - Bis-pyribac sodium fb yhalofopbutyl+2,4,D amine	130	529	391	133	22.87	23.50	14611
T ₆ - Bis-pyribac sodium fb Ethoxysulfuron + Rice star	130	586	401	136	23.24	24.63	14784
T ₇ - Penoxulam fb 2,4, D amine	136	507	377	119	22.41	23.86	14154
T ₈ - Two hand weedings	139	628	412	141	23.34	24.71	15255
T ₉ - Weedy check	124	308	243	85	21.23	22.47	8672
SEm±	18.1	18.1	9.03	3.87	0.17	0.19	511
CD (0.05)	51.5	51.5	26.5	11.5	0.52	0.056	1520

weedy check. The higher grain yield in this treatment might be due to higher growth stature, yield structure because of continuous and stable availability of required resources as per the needs of the crop due to reduced competition from weed growth, which was noticed through reduced weed counts and weed dry weight in this treatment.

However, Post emergence application of Bis-pyribac sodium @ 25 g ai/ha at 20 DAS followed by Ethoxysulfuron @ 20 g ai/ha+ Fenoxaprop P Ethyl with safenor (Rice star) @ 625 ml/ha at 40 DAS was found on par to two hand weedings, and other chemical weed control treatments except post emergence application of Bis-pyribac sodium @ 25 g ai/ha at 20 DAS fb amine salt of 2,4 D @ 0.58 kg ai/ha at 40 DAS with respect to growth, yield parameters and yield shows that, application of Bis-pyribac sodium @ 25 g ai/ha or Penoxulam @ 25g ai/ha at 20 DAS followed by Cyhalofopbutyl+2,4,D amine or Rice star or Ethoxysulfuron or Almix are similar in weed suppression and support for crop growth and yield formation. These findings are in agreement to (McCauley *et al.* 2005) who reported that without the application of post emergence herbicides, the rice

yield may reduce by 9 to 60%.

With regards to economic analysis, post emergence application of Bis-pyribac sodium @ 25 g ai/ha at 20 DAS followed by Ethoxysulfuron @ 20 g ai/ha+ Fenoxaprop P Ethyl with safenor (Rice star) @ 625 ml/ha at 40 DAS resulted into higher gross returns net returns and B:C ratio among different herbicide treatments. Higher rice grain yield coupled with lesser cost of the treatment might be the reason for this higher net profit (Table 1). Similar findings with post emergence application of Bis-pyribac sodium was reported by Khaliq *et al.* (2012). All the sequential application of herbicide treatments yielded better net returns over two hand weedings. Rao *et al.* (2020) also reported the similar findings on economics with respect to sequential application of post emergence herbicides in direct seeded rice. Though the two hand weedings at 20 and 40 DAS recorded highest gross returns, the net returns and B: C ratio was reduced markedly due to higher cost of cultivation.

Different weed control treatments influenced the weed counts and weed dry weight, weed index,

Table 3. Effect of post emergence application of herbicides on economics of dry direct sown rice. Fig. in parenthesis are original values.

Treatment	Weed count m ⁻²		Weed dry wt (g)		Weed index	Herbicide Efficiency index	Weed control Efficiency (%)	
	30 DAS	50 DAS	30 DAS	50 DAS			30 DAS	50 DAS
T ₁ -Bis-pyribac sodium fb Amine salt of 2, 4 D	6.98 (48.50)	12.24 (150.0)	4.48 (27.56)	10.39 (108.5)	12.33	1.07	79.76	72.29
T ₂ -Bis-pyribac sodium fb Almix	6.99 (48.50)	11.77 (138.5)	4.96 (28.47)	10.09 (103.9)	7.51	1.19	77.88	73.53
T ₃ -Bis-pyribac sodium fb Ethoxysulfuron	6.95 (48.00)	11.64 (135.5)	4.70 (27.90)	9.60 (94.05)	8.67	1.12	78.94	76.04
T ₄ -Bis-pyribac sodium fb Rice star	6.99 (48.50)	11.42 (130.5)	4.93 (28.67)	9.60 (93.57)	5.76	1.19	77.84	76.14
T ₅ -Bis-pyribac sodium fb cyhalofopbutyl + 2,4,D amine	7.17 (51.00)	11.11 (124.0)	5.06 (31.43)	9.63 (86.40)	4.49	1.20	76.01	77.76
T ₆ -Bis-pyribac sodium fb Ethoxysulfuron + Rice star	6.95 (48.00)	9.88 (97.00)	4.53 (26.93)	8.24 (70.01)	3.28	1.16	79.94	82.19
T ₇ -Penoxulam fb 2,4, D amine	0.33 (40.00)	12.63 (163.0)	4.46 (22.31)	11.05 (108.0)	7.89	1.21	82.45	72.01
T ₈ -Two hand weedings	0.71 (0.00)	2.34 (5.00)	0.71 (0.00)	2.14 (3.62)	0.00	1.03	100.00	98.49
T ₉ -Weedy check	10.17 (229.5)	22.32 (497.5)	9.32 (143.1)	8.78 (96.1)	50.15	--	0.00	0.00
SEm±	0.94	1.33	0.71	1.31	--	--	--	--
CD (0.05)	6.82	7.94	6.52	7.52	--	--	--	--

treatment efficiency index and weed control efficiency conspicuously established the effectiveness of different weed control treatments on weed growth (Table 3). The weed counts and weed dry weight were lowest with two hand weeding and highest with weedy check. Among chemical weed management treatments, post emergence application of Penoxulam@ 25g ai/ha at 20 DAS fb amine salt of 2,4, D @ 0.58 kg ai/ha at 40 DAS recorded lesser weed counts and weed dry weight/m² at 30DAS, where as the weed counts and weed dry weight/m² was lowest at 50 DAS with post emergence application of Bis-pyribac sodium @ 25 g ai/ha at 20 DAS followed by Ethoxysulfuron @ 20 g ai/ha+ Fenoxaprop P Ethyl with safenor (Rice star) @ 625 ml/ha at 40 DAS (Table 3). Weed index data of herbicide treatments showed that, the lowest weed index values were associated with Post emergence application of Bis-pyribac sodium @ 25 g ai/ha at 20 DAS followed by Ethoxysulfuron @ 20 g ai/ha+ Fenoxaprop P Ethyl with safenor (Rice star) @ 625 ml/ha at 40 DAS followed by post emergence application Bis-pyribac sodium @ 25 g ai/ha at 20 DAS fb post emergence application of Cyhalofopbutyl @100 g ai/ha + amine salt of 2,4, D @ 0.58 kg ai/ha at 40 DAS. Among Chemical Weed management treatments, the higher treatment efficiency index was noticed with post emergence application of Penoxulam@ 25g ai/ha at 20 DAS fb amine salt of 2,4, D @ 0.58 kg ai/ha at 40 DAS. Whereas the weed control efficiency was highest with post emergence application of Penoxulam@ 25g ai/ha at 20 DAS and at 50 DAS with Post emergence application of Bis-pyribac sodium @ 25 g ai/ha at 20 DAS followed by Ethoxysulfuron @ 20 g ai/ha+ Fenoxaprop P Ethyl with safenor (Rice star) @ 625 ml/ha at 40 DAS among different chemical weed control treatments as this treatment reduced the weed germination and suppressed the consequent growth impressively compared to other herbicide treatments due to their broad spectrum of action on different weed flora for prolonged periods. Significantly lesser weed density and weed dry weight was noticed due to application of bispyribac sodium fb. 2, 4-D amine salt + fenoxyp-ethyl with safener in Dry direct sown rice (VijayaLakshmi *et al.* 2020). Similar results of

effectiveness of sequential application of post emergence herbicides on weed growth in direct seeded rice by Rao *et al.* (2020).

CONCLUSION

The study can be concluded that, post emergence application of Bis-pyribac sodium @ 25 g ai/ha at 20 DAS followed by Ethoxysulfuron @ 20 g ai/ha+ Fenoxaprop P Ethyl with safenor (Rice star) @ 625 ml/ha at 40 DAS recorded maximum plant height, higher number of tillers m⁻², higher dry matter production, greater number of panicles m⁻² with higher number of filled grains panicle⁻¹ with higher test weight ultimately resulted in to the 94 % higher grain yield, 63 % higher straw yield over weedy check with lowest values of weed index and higher weed control efficiency and found at par to hand weeding twice.

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