Original Research Article

Influence of Post Emergence Application of Herbicides on Growth, Yield and Economics of Dry Direct Sown Rice

Abstract

The field trial was conducted on sandy clay loam soils of agricultural research station Ragolu, A.P. India during two consecutive *Kharif* seasons of 2015 and 2016 .The trial was conducted in Randomized Block Design with three replications and nine treatments Viz., T_1- 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; T_2- 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; T_3- post émergence application Bis-pyribac sodium @ 25 g ai/ha at 20 DAS fb Ethoxysulfuron @ 20 g ai/ha at 40DAS ; T_4- post emergence application Bis-pyribac sodium @ 25 g ai/ha at 20 DAS fb postemergence application of Fenoxaprop P ethyl with safenor (Rice star) @ 625ml/ha at 40 DAS ; T_5- post emergence application Bis-pyribac sodium @ 25 g ai/ha at 20 DAS fb postemergence application of Cyhalofopbutyl @100 g ai/ha + amine salt of 2,4, D @ 0.58 kg ai/ha at 40 DAS; T_6- post emergence application Bis-pyribac sodium @ 25 g ai/ha at 20 DAS fb Ethoxysulfuron @ 20 g ai/ha+ Fenoxaprop PEthyl with safenor (Rice star) @ 625ml/ha at 40 DAS; T_7- Post emergece application of Penoxulam@ 25g ai/ha at 20 DAS fb amine salt of 2,4, D @ 0.58 kg ai/ha at 40 DAS ;T_8- Two hand weedings at 20 & 40 DAS and T_9- Weedy Check. The study in dry direct sown rice on weed management by herbicides revealed that, uncontrolled weed growth in dry direct sown rice reduced the grain yield by 46 to 54 percent. 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 taller plants, maximum number of tillers/m^2, The highest dry matter production at harvest, more number of panicles/m2 filled grains/panicle, 1000 grain wt, higher grain yield (82-108 %t over weedy check) Straw yield besides higher gross returns net returns and B:C ratio among different herbicide treatments.

Key words: dry direct sown rice, post emergence herbicides, yield attributes, yield, economics.

INTRODUCTION

Rice is principal crop occupies more than 4 lakh hectares in north coastal districts of Andhra Pradesh where more than half of the area now under dry direct sown rice system of cultivation. In semi-dry system, seeds are sown in dry soil by broadcasting/line sowing or 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. The area under semi-dry rice is rapidly increasing in the north coastal districts of Andhra Pradesh due to scarcity of labor late availability of irrigation water. In north coastal Andhra Pradesh semi-dry system of establishment gaining momentum as it successfully exploits the pre monsoon showers ensuring high water use efficiency. However, uncontrolled weed growth is one of the major yield limiting factor in dry direct sown rice and the yield loss ranges usually up to 42 percent and even more in some cases (Shekhawat *et al*., 2020 and Nagargade *et al*., 2018). Therefore, "weeds present the main biological constraint to the success of DSR and failure to control weeds result in yield losses ranging from 50 to 90%" (Chauhan and Opena, 2012). The traditional methods of weed control in rice include Manual weeding in rice is labour-intensive and dry direct sown rice growers usually hand-weed their crops two or three times per season, investing up to 190 person-days $ha^{-1.}$ As human labour is becoming the very costly and unavailable for agriculture in the present day's stresses for other means of weed control and chemical weed control proved cost effective alternative to hand weeding in India.

Simultaneous germination of crop and weeds in direct sown system single application of either pre emergence or post emergence application in effective in controlling weeds and hence need sequential application of two or three pre and post emergence herbicides as tank mixture or in relay to ensure weed free condition especially during the period of critical crop weed competition (Shekhawat *et al*., 2020 and Nagargade *et al*., 2018). Weed flora also varies widely from place and time, method of land preparation and crop establishment needs usage of different herbicides due to variation in effectiveness of different herbicides. "Sequential application of herbicides were better compared to single application of either pre-emergence or post-emergence herbicides alone in controlling weeds in direct sown rice" (Singh et al.2016). Though some of the proven pre emergence herbicides are available for this system, information on post emergence herbicides and their combinations are patchy and needs immediate attention for reduce cost of production.

MATERIAL AND METHODS

The Field trial was conducted on sandy clay loam soils of agricultural research station Ragolu, A.P. India during two consecutive *Kharif* seasons of 2015 and 2016. The soil was sandy loam in texture with a pH of 6.5 and EC of 0.15 dSm^{-1}, low in organic carbon (0.33%) and available nitrogen (174 kg ha^{-1}), medium in available phosphorus (38 kg ha^{-1}) and potassium (264 kg $ha^{-1)}$. Total rainfall received during both the year of experimentation, 2016 and 2017 was 1189.8 mm and 724 mm, during field experimentation respectively The trial was conducted in Randomized Block Design with three replications and nine treatments *Viz.*, T_1- 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; T_2- 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; T_3- post emergence application Bis-pyribac sodium @ 25 g ai/ha at 20 DAS fb Ethoxysulfuron @ 20 g ai/ha at 40DAS ; T_4- post emergence application Bis-pyribac sodium @ 25 g ai/ha at 20 DAS fb postemergence application of Fenoxaprop P ethyl with safenor (Rice star) @ 625ml/ha at 40 DAS ; T_5- post emergence application Bis-pyribac sodium @ 25 g ai/ha at 20 DAS fb postemergence application of Cyhalofopbutyl @100 g ai/ha + amine salt of 2,4, D @ 0.58 kg ai/ha at 40 DAS; T_6- post emergence application Bis-pyribac sodium @ 25 g ai/ha at 20 DAS fb Ethoxysulfuron @ 20 g ai/ha+ Fenoxaprop PEthyl with safenor (Rice star) @ 625ml/ha at 40 DAS; T_7- Post emergece application of Penoxulam@ 25g ai/ha at 20 DAS fb amine salt of 2,4, D @ 0.58 kg ai/ha at 40 DAS ;T_8- Two hand weedings at 20 & 40 DAS and T_9- Weedy Check

Experimental Details:

The seed of rice was directly sown in lines on dry soil@ 2-3 seeds $hill^{-1}$ with a spacing of 20 x 10 cm. RGL2332 was the cultivar. Seed treatment done with fungicide Carbendazim @ 1g/kg seed. Gap filling, thinning done at 10 DAS to maintain the uniform population in all the plots. N, P2O5, K2O applied @ 120 - 60 - 50 kg per hectare as urea, single super phosphate and murate of potash, respectively. Standard package recommended by Acharya N.G. Ranga Agricultural university for *kharif* direct sown rice was followed for this crop except weed control. Spay fluid applied uniformly @ 500 L

ha^{-1} by knapsack sprayer fitted with flat fan nozzle. Data on plant height, tillers m^{-2}, panicles/m^2, filled grains/panicle, test weight, grain and straw yields were recorded following standard procedure from 10 hills selected at random. Cost of cultivation was computed considering the local market price of inputs used and returns were calculated by adopting standard procedures. Data subjected to ANOVA and the significance was tested by Fisher's least significance difference (p= 0.05).

RESULTS AND DISCUSSION

Uncontrolled weed growth in dry direct sown rice reduced the grain yield by 54 percent during 2015 and 46 percent during 2016 .Singh *et al*.(2005) also reported that "uncontrolled weed growth in direct-seeded rice resulted in reduction in grain yield by 75.8%." All the weed control treatments exerted noticeable influence on different growth parameters, yield attributes, grain and straw yield and economic parameters of dry direct sown rice during both the years of study. Among all weed management treatments two hand weedings done at 20 & 40 DAS was recorded higher growth parameters, yield attributes, grain and straw yield of dry direct sown rice. This might be due to less competition between plants for growth factors such as water, nutrients, solar radiation and space. Whereas among 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 resulted into taller plants, maximum number of tillers/m2, The highest dry matter production at harvest, more number of panicles/m2 filled grains/panicle 1000 grain wt(g) Grain yield Straw yield and it was found at par in these parameters with two hand weedings during both the years. 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 increased the grain yield by 108 percent during 2015 and 82 percent during 2016 shows the effectiveness of treatment in reducing weed competition and resulted in to better growth structure, higher yield contributing characters there by realized higher grain yield. This might be due to the reason that the sequential application of two herbicides having distinct mode of actions created a rather weed free environment by effectively

suppressing a broad spectrum of weed population and consequently weed dry matter. Prevalence of weed free crop growing environment might have enabled congenial conditions for production of higher growth stature and better yield structure The findings of the present study are in corroborating with those of Pattar *et al*. (2005) in direct-seeded rice. Walia *et al.* (2008) reported "pre emergence application of pendimethalin 0.75 kg ha1 fb post emergence application of bispyribac-sodium 25 g ha^{-1} resulted in 372% increase in rice grain yield compared to weedy check owing to better weed control".

However Post emergence application of Bis-pyribac sodium @ 25 g ai/ha and Penoxulam@ 25g ai/ha at 20 DAS were at par in growth parameters, yield attributes, grain and straw yield of dry direct sown rice. Similarly, there was no measurable difference in growth parameters, yield attributes, grain and straw yield of dry direct sown rice with respect to postemergence application of Ethoxysulfuron @ 20 g ai/ha+ Fenoxaprop P Ethyl with safenor (Rice star) @ 625 ml/ha and Cyhalofopbutyl @100 g ai/ha + amine salt of 2,4, D @ 0.58 kg ai/ha, metsulfuron methyl + chlorimuron ethyl (Almix) 4 g ai/ha, at 40 DAS and all inturn proved very effective over un weeded check established the need of sequential ap[plication of post emergence herbicides for weed control in dry direct sown rice. Application of 2,4 D amine salt @ 0.58 kg ai/ha at only 40 DAS was found to be inferior among other postemergence herbicides application. Postemergence application of these hebicides augmented the growth, improved the yield structure thre by yield of dry direct sown rice might be due to reduced competetion from weeds for prolonged period of crop growth facilitated avaialability of ample resources as per the crop needs.These results are in line to (McCauley *et al.,* 2005) who reported that "without the application of post emergence herbicides, the rice yield may reduce by 9 to 60%."

Among different weed management treatments two hand weedings at 20 & 40 DAS was recorded higher gross returns, and Cost of cultivation also., Whereas 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 among different herbicide treatments. However, Net Returns and B:C ratio was higher 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 all the weed management practices. All the sequential application of herbicide treatments yielded better returns over two hand weedings. “Higher rice grain yield and economic returns with post emergence application of bispyribac-sodium” was reported earlier by Khaliq *et al.* (2012). Two hand weedings at 20 & 40 DAS recorded lowest Net Returns and B: C ratio due to higher Cost of cultivation involved.

CONCLUSION: Two years field study in dry direct sown rice on weed management by herbicides revealed that, Uncontrolled weed growth in dry direct sown rice reduced the grain yield by 46 to 54 percent. 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 taller plants, maximum number of tillers/m2, The highest dry matter production at harvest, more number of panicles/m2 filled grains/panicle, 1000 grain wt, higher grain yield (82-108 percent over weedy check) Straw yield besides higher gross returns net returns and B:C ratio among different herbicide treatments.

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Table.1: Effect of post emergence application of herbicides on growth parameters of dry direct sown rice.

Treatment	Plant height (cm)		Tillers^{-2}		Dry matter (kg ha^{-1})		Panicles^{-2}	
	2015	2016	2015	2016	2015	2016	2015	2016
T_1- Bis-pyribac sodium *fb* Amine salt of 2,4 D	130	127	518	534	13576	13745	371	372
T_2- Bis-pyribac sodium *fb* Almix	129	129	523	559	14285	14190	377	381
T_3- Bis-pyribac sodium *fb* Ethoxysulfuron	129	127	539	538	14060	14055	398	382
T_4- Bis-pyribac sodium *fb* Rice star	130	128	501	556	14233	14528	390	389
T_5- Bis-pyribac sodium *fb* Cyhalofopbutyl+2,4,D amine	130	129	494	563	14539	14682	387	395
T_6- Bis-pyribac sodium *fb* Ethoxysulfuron + Rice star	139	136	590	581	14776	14791	403	398
T_7- Penoxulam *fb* 2,4, D amine	136	135	445	569	14094	14214	370	384
T_8- Two hand weedings	141	139	634	621	15260	15250	410	414
T_9- Weedy Check	117	114	313	302	8562	8782	249	236
SEm+/-	3.70	4.02	18.1	16.5	431	409	9.11	8.95
CD (0.05)	11	12	54	49	1280	1215	27	26

Table.2: Effect of post emergence application of herbicides on yield parameters and yield of dry direct sown rice.

Treatment	filled grains panicle^{-1}		1000 grain wt(g)		Grain yield (kg ha^{-1})		Straw yield (kg ha^{-1})	
	2015	2016	2015	2016	2015	2016	2015	2016
T_1- Bis-pyribac sodium *fb* Amine salt of 2,4 D	114	129	22.77	22.52	5900	6014	7116	7185
T_2- Bis-pyribac sodium *fb* Almix	119	131	23.17	22.71	6326	6246	7409	7390
T_3- Bis-pyribac sodium *fb* Ethoxysulfuron	122	127	23.32	22.91	6211	6202	7303	7298
T_4- Bis-pyribac sodium *fb* Rice star	124	135	23.24	22.78	6338	6469	7411	7504
T_5- Bis-pyribac sodium *fb* Cyhalofopbutyl+2,4,D amine	126	139	23.10	22.64	6431	6549	7556	7591
T_6- Bis-pyribac sodium *fb* Ethoxysulfuron + Rice star	129	143	23.41	23.06	6578	6567	7638	7682
T_7- Penoxulam *fb* 2,4, D amine	104	133	22.58	22.23	6184	6333	7249	7401
T_8- Two hand weedings	133	149	23.56	23.11	6878	6715	7934	7882
T_9- Weedy Check	87	82	21.40	21.05	3158	3612	4659	4720
SEm+/-	4.38	3.72	0.18	0.17	186	157	203	219
CD (0.05)	13	11	0.55	0.50	553	465	603	650

Table.3: Effect of post emergence application of herbicides on economics of dry direct sown rice.

Treatment	Cost of cultivation (Rs ha^{-1})		Gross Returns (Rs ha^{-1})		Net Returns (Rs ha^{-1})		Rupee returned per rupee invested (Rs^{-1})	
	2015	2016	2015	2016	2015	2016	2015	2016
T_1- Bis-pyribac sodium *fb* Amine salt of 2,4 D	34050	35753	89757	94218	55707	58465	1.64	1.64
T_2- Bis-pyribac sodium *fb* Almix	33950	35648	95779	97750	61829	62102	1.82	1.74
T_3- Bis-pyribac sodium *fb* Ethoxysulfuron	33800	35490	94333	97160	60533	61670	1.79	1.74
T_4- Bis-pyribac sodium fb Rice star	34050	35753	96141	101240	62091	65487	1.82	1.83
T_5- Bis-pyribac sodium *fb* Cyhalofopbutyl+ 2,4,D amine	36225	38036	97451	102492	61226	64456	1.69	1.69
T_6- Bis-pyribac sodium *fb* Ethoxysulfuron + Rice star	34300	36015	99648	102774	65348	66759	1.91	1.85
T_7- Penoxulam *fb* 2,4, D amine	34100	35805	93823	98984	59723	63179	1.75	1.76
T_8- Two hand weedings	39050	41003	104206	105164	65156	64161	1.67	1.56
T_9- Weedy Check	31550	33128	49552	57528	18002	24400	0.57	0.74
SEm+/-	715	776	1930	2027	1375	1323	0.08	0.06
CD (0.05)	2117	2314	5736	6018	4085	3921	0.23	0.19