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RESEARCH ARTICLE

Impact of Different Weed Management Practices and Wet Seeding Methods on Weed Control and Yield Attributes of Rice (*Oryza sativa* L.) under Unpuddled Condition

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Abstract

Field experiment was conducted at Agricultural College and Research Institute, Killikulam (TNAU) during Late Pishanam (November 2017 – March 2018) to study the various wet seeding methods and weed management practices on yield of unpuddled rice in Tamirabarani command area. The experiment was laid out in randomized block design and replicated thrice with fourteen treatments. Treatments involving seven weed management practices were tested with two methods of wet seeding in rice by drum seeder and paddy cum dhaincha seeder. All the weed control treatments with seeding methods significantly reduced the density of weeds which resulted in significantly higher yield of rice over unweeded control. The results revealed that among the treatments, rice established through drum seeder along with the pre emergence application of pyrazosulfuron ethyl at 20 g a.i ha^{-1} on 8 DAS followed by post emergence application of bispyribac sodium at 25 g a.i ha^{-1} at 30 DAS significantly reduced the density of weeds and also increased the yield of rice.

Keywords*: Weed management, Rice cum Daincha seeder, Intercropping, Herbicides*

Introduction

Rice acts as the major food crop of the world which stands at the second place after wheat. It acts as the predominant food of around 2.7 billion people in the world which contains optimum nutritional value of 7-8% protein, 3% fiber and 3% fat (Kumar *et al*., 2017). Rice is the most important and extensively grown crop in India and occupying an area of 43.49 m ha with the production of 104.4 m tonnes with the average productivity of 2.4 t ha^{-1}. In Tamil Nadu, total area under rice is 20.0 lakh hectares with production of 75.17 lakh tonnes and productivity of 3758 kg ha^{-1} during 2015-16.

The health and productivity of agriculture is directly proportional to the availability of resources. Agriculture is one of the main activity which consumes larger portion of available water (UN-Water, 2006). Among the total water applied for rice cultivation in conventional method, 30 % of water is utilized for puddling process (Aslam *et al*., 2002). An alternate method of rice establishment should be identified to overcome the water crisis. Direct seeded rice cultivation helps us in this situation, which saves 12-35 % of irrigation water, 60 % of labour with high net profit. Although direct seeded rice is advantageous, it undergo a great threat caused by weeds (Sanusan *et al*., 2010).

Combination of pre and post emergence herbicides are needed to provide high economic return by reducing weed density with highly diversified weed flora (Chauhan, 2012). But all the herbicides cannot control the weeds effectively in direct seeded rice. In developed countries intercropping of dhaincha with rice is generally practiced to control weeds (Singh *et al.,* 2007). Moreover the weed population and weed flora under unpuddled condition would be highly varying.

This situation stimulated the initiation of research for evaluating suitable herbicide usage on different seeding methods for controlling the complex weed flora of direct wet seeded rice under unpuddled condition.

Material and Methods

An experiment was conducted at the wet land farm of Agricultural College and Research Institute, Killikulam to study the effect of different weed management practices and wet seeding methods on growth and yield of

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unpuddled rice (*Oryza sativa* L.) in Tamirabarani command area. The experiment was laid out in a Randomized Block Design with three replications.

It consist of two wet seeding methods (drum seeding and paddy cum dhaincha seeder) with seven weed management practices *viz.,* PE pyrazosulfuron ethyl 10% WP at 20 g a.i ha^{-1} on 8 DAS fb POE bispyribac sodium at 25 g a.i ha^{-1} on 30 DAS, PE pyrazosulfuron ethyl 10% WP at 20 g a.i ha^{-1} on 8 DAS fb POE ethoxy sulfuron ethyl at 30 g a.i ha^{-1} on 30 DAS, PE bensulfuron methyl 0.6% + pretilachlor 6% GR at 660 g a.i ha^{-1} on 8 DAS fb POE bispyribac sodium at 25 g a.i ha^{-1} on 30 DAS, PE bensulfuron methyl 0.6% + pretilachlor 6% GR at 660 g a.i ha^{-1} on 8 DAS fb POE ethoxy sulfuron ethyl at 30 g a.i ha^{-1} on 30 DAS, rotary weeding (twice at 35 and 45 DAS in rice intercropped with dhaincha and four times on 15 DAS at 10 days interval in drum seeded rice), weed free check and unweeded control.

Rice ASD 16 was used as a test variety. The recommended seed rate of 60 kg ha^{-1} of dry paddy seeds were soaked in water for 24 hours and incubated overnight to induce sprouting. Afterwards, the seeds were treated with biofertilizers. The recommended seed rate for intercropping dhaincha is 25 kg ha^{-1}. Sowing was done under slushy condition using paddy drum seeder with a spacing of 20 cm between rows and paddy cum dhaincha seed drill with a inter row spacing of 25 cm between rice rows and 12.5 cm between rice and dhaincha in the respective plots. Herbicides were applied at appropriate time as stated in the treatment schedule. The crop was irrigated as and when required. Weed density, growth and yield of rice were recorded.

Results and Discussion

The results obtained from the present study as well as discussions have been summarized under following headings

Table 1. Effect of different weed management practices and wet seeding methods on total weed density (No. m^{-2}) and weed control efficiency (%) of unpuddled rice

Treatments	Total weed density (No. m^{-2})			WCE* (%)
	15 DAS	30 DAS	45 DAS	
T_1 - Drum seeder + PE Pyrazosulfuron ethyl at 20 g a.i ha^{-1} fb PoE Bispyribac sodium at 25 g a.i ha^{-1}	6.50 (2.65)	25.48 (95.10)	0.91 (1.19)	99.1
T_2 - Drum seeder + PE Pyrazosulfuron ethyl at 20 g a.i ha^{-1} fb PoE Ethoxy Sulfuron ethyl at 30 g a.i ha^{-1}	7.41 (2.81)	27.87 (5.33)	6.16 (2.58)	93.6
T_3 - Drum seeder + PE Bensulfuron methyl 0.6% + Pretilachlor 6% GR at 660 g a.i ha^{-1} fb PoE Bispyribac sodium at 25 g a.i ha^{-1}	18.38 (4.35)	46.50 (6.86)	11.19 (3.42)	88.4
T_4 - Drum seeder + PE Bensulfuron methyl 0.6% + Pretilachlor 6% GR at 660 g a.i ha^{-1} fb PoE Ethoxy Sulfuron ethyl at 30 g a.i ha^{-1}	19.88 (4.51)	49.59 (7.08)	13.85 (3.78)	83.6
T_5 - Drum seeder + Rotary weeding four times on 15 DAS at 10 days interval	31.20 (5.63)	20.71 (4.61)	2.74 (1.80)	97.2
T_6 - Drum seeder + Weed free check	0.00 (0.72)	0.00 (0.72)	0.00 (0.72)	100.0
T_7 - Drum seeder + Unweeded Control	37.70 (6.18)	80.26 (8.99)	96.41 (9.84)	-
T_8 - Paddy cum Dhaincha seeder + PE Pyrazosulfuron ethyl at 20 g a.i ha^{-1} fb PoE Bispyribac sodium at 25 g a.i ha^{-1}	6.94 (2.73)	26.67 (5.21)	1.62 (1.46)	98.2
T_9 - Paddy cum Dhaincha seeder + PE Pyrazosulfuron ethyl at 20 g a.i ha^{-1} fb PoE Ethoxy Sulfuron ethyl at 30 g a.i ha^{-1}	8.02 (2.92)	29.51 (5.48)	6.71 (2.69)	92.6
T_{10} - Paddy cum Dhaincha seeder + PE Bensulfuron methyl 0.6% + Pretilachlor 6% GR at 660 g a.i ha^{-1} fb PoE Bispyribac sodium at 25 g a.i ha^{-1}	17.64 (4.26)	44.31 (6.69)	10.29 (3.28)	88.7
T_{11} - Paddy cum Dhaincha seeder + PE Bensulfuron methyl 0.6% + Pretilachlor 6% GR at 660 g a.i ha^{-1} fb PoE Ethoxy Sulfuron ethyl at 30 g a.i ha^{-1}	19.20 (4.44)	48.23 (6.98)	12.39 (3.59)	86.3
T_{12} - Paddy cum Dhaincha seeder + Rotary weeding twice on 35 DAS and 45 DAS	28.88 (5.42)	59.41 (7.74)	2.14 (1.63)	97.6
T_{13} - Paddy cum Dhaincha seeder + Weed free check	0.00 (0.72)	0.00 (0.72)	0.00 (0.72)	100.0
T_{14} - Paddy cum Dhaincha seeder + Unweeded Control	35.40 (5.99)	76.78 (8.79)	90.68 (9.55)	-
SEd	0.12	0.17	0.16	-
CD(P=0.05)	0.27	0.40	0.34	-

Figure in parenthesis are () transformed values, *Data not statistically analysed, PE- Pre-emergence, POE- Post-emergence, fb- Followed by

Total weed density

Significant variation on the total weed density were observed due to the adoption of different seeding methods and weed management practices at all stages of observation viz., 15, 30 and 45 DAS (Table 1). Among the various seeding methods and weed management practices, weed free check in both method of seeding recorded zero weed density at all stages of observation. This might be due to effective destruction of weeds, and it is in conformity with the findings of Vijay Singh *et al*. (2016).

Table 2. Effect of different weed management practices and wet seeding methods on no. of productive tillers m^{-2}, panicle length (cm), 1000 grain weight (g), total no. of grains $panicle^{-1}$, no. of sterile grains $panicle^{-1}$ and sterility % of unpuddled rice

Treatments	No. of productive tillers m^{-2}	Panicle length (cm)	1000 grain weight (g)	Total no. of grains $panicle^{-1}$	No. of sterile grains $panicle^{-1}$	Sterility %
T_1 - Drum seeder + PE Pyrazosulfuron ethyl at 20 g a.i ha^{-1} fb PoE Bispyribac sodium at 25 g a.i ha^{-1}	374	24.6	24.10	161	36	22.10
T_2 - Drum seeder + PE Pyrazosulfuron ethyl at 20 g a.i ha^{-1} fb PoE Ethoxy Sulfuron ethyl at 30 g a.i ha^{-1}	358	23.4	23.78	156	36	23.30
T_3 - Drum seeder + PE Bensulfuron methyl 0.6% + Pretilachlor 6% GR at 660 g a.i ha^{-1} fb PoE Bispyribac sodium at 25 g a.i ha^{-1}	351	21.6	23.64	153	38	24.60
T_4 - Drum seeder + PE Bensulfuron methyl 0.6% + Pretilachlor 6% GR at 660 g a.i ha^{-1} fb PoE Ethoxy Sulfuron ethyl at 30 g a.i ha^{-1}	346	20.9	23.56	151	39	25.50
T_5 - Drum seeder + Rotary weeding four times on 15 DAS at 10 days interval	366	23.7	23.79	159	35	22.30
T_6 - Drum seeder + Weed free check	398	25.1	24.12	164	36	21.80
T_7 - Drum seeder + Unweeded Control	269	17.9	22.34	132	46	35.10
T_8 - Paddy cum Dhaincha seeder + PE Pyrazosulfuron ethyl at 20 g a.i ha^{-1} fb PoE Bispyribac sodium at 25 g a.i ha^{-1}	381	24.3	24.08	172	30	17.30
T_9 - Paddy cum Dhaincha seeder + PE Pyrazosulfuron ethyl at 20 g a.i ha^{-1} fb PoE Ethoxy Sulfuron ethyl at 30 g a.i ha^{-1}	368	22.4	23.78	163	31	19.20
T_{10} - Paddy cum Dhaincha seeder + PE Bensulfuron methyl 0.6% + Pretilachlor 6% GR at 660 g a.i ha^{-1} fb PoE Bispyribac sodium at 25 g a.i ha^{-1}	359	22.1	23.76	164	34	20.80
T_{11} - Paddy cum Dhaincha seeder + PE Bensulfuron methyl 0.6% + Pretilachlor 6% GR at 660 g a.i ha^{-1} fb PoE Ethoxy Sulfuron ethyl at 30 g a.i ha^{-1}	353	21.3	23.57	162	35	21.30
T_{12} - Paddy cum Dhaincha seeder + Rotary weeding twice on 35 DAS and 45 DAS	373	24.2	24.03	167	30	17.70
T_{13} - Paddy cum Dhaincha seeder + Weed free check	408	25.4	24.26	176	27	15.40
T_{14} - Paddy cum Dhaincha seeder + Unweeded Control	282	19.4	22.54	149	52	34.90
SEd	7.7	0.85	0.76	4.5	0.89	0.8
CD(P=0.05)	16	1.6	NS	9	2	1.4

PE- Pre-emergence POE- Post-emergence fb- Followed by

Application of pyrazosulfuron ethyl at 20 g a.i ha^{-1} on 8 DAS fb POE bispyribac sodium at 25 g a.i ha^{-1} on 30 DAS in drum seeded rice which recorded significantly lesser weed density of 6.5 m^{-2} at 15 DAS. At 30 DAS, adoption of four rotary weeding on 15 DAS at 10 days interval in drum seeded rice was found to be the best with minimum total weed density of 20.7 m^{-2}. At 45 DAS also apart from weed free check, application of pyrazosulfuron ethyl at 20 g a.i ha^{-1} on 8 DAS fb POE bispyribac sodium at 25 g a.i ha^{-1} on 30 DAS in drum seeded rice significantly reduced the total weed density (0.9 m^{-2}) compared to other treatment combinations.

This might be due to the control of weeds at germination phase by the application of pre-emergence herbicides and significant reduction of late germinating weeds at later growth stages by post-emergence application of herbicides. Also the weed suppression of dhaincha was found to be low since it was affected by the pre emergence herbicides belonging to the sulfonyl urea herbicide family. Similar findings were reported by Bhattarai *et al.* (2016) and Boutin *et al.*(2000).

Weed control efficiency

Weed control efficiency (WCE) indicates the level of effective reduction of weed density by seeding methods and weed control treatments over weedy check. This was highly influenced by different seeding methods and weed control treatments (Table 1). Among the seeding methods and weed management practices, application of pyrazosulfuron ethyl at 20 g a.i ha^{-1} on 8 DAS fb POE bispyribac sodium at 25 g a.i ha^{-1} on 30 DAS in drum seeded rice registered more reduction of weeds and inturn resulted in higher WCE (99.1 %). It was mainly due to the better control of weeds upto critical stage by the above treatment combination. Similar results have also been reported by Kumar *et al*. (2017).

Table 3. Effect of different weed management practices and wet seeding methods on grain and straw yield (kg ha^{-1}) of unpuddled rice

Treatments	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})
T_1 - Drum seeder + PE Pyrazosulfuron ethyl at 20 g a.i ha^{-1} fb PoE Bispyribac sodium at 25 g a.i ha^{-1}	5784	6473
T_2 - Drum seeder + PE Pyrazosulfuron ethyl at 20 g a.i ha^{-1} fb PoE Ethoxy Sulfuron ethyl at 30 g a.i ha^{-1}	5120	5645
T_3 - Drum seeder + PE Bensulfuron methyl 0.6% + Pretilachlor 6% GR at 660 g a.i ha^{-1} fb PoE Bispyribac sodium at 25 g a.i ha^{-1}	4374	5041
T_4 - Drum seeder + PE Bensulfuron methyl 0.6% + Pretilachlor 6% GR at 660 g a.i ha^{-1} fb PoE Ethoxy Sulfuron ethyl at 30 g a.i ha^{-1}	4067	4792
T_5 - Drum seeder + Rotary weeding four times on 15 DAS at 10 days interval	5305	5825
T_6 - Drum seeder + Weed free check	6183	7137
T_7 - Drum seeder + Unweeded Control	2829	3618
T_8 - Paddy cum Dhaincha seeder + PE Pyrazosulfuron ethyl at 20 g a.i ha^{-1} fb PoE Bispyribac sodium at 25 g a.i ha^{-1}	5627	6150
T_9 - Paddy cum Dhaincha seeder + PE Pyrazosulfuron ethyl at 20 g a.i ha^{-1} fb PoE Ethoxy Sulfuron ethyl at 30 g a.i ha^{-1}	5028	5515
T_{10} - Paddy cum Dhaincha seeder + PE Bensulfuron methyl 0.6% + Pretilachlor 6% GR at 660 g a.i ha^{-1} fb PoE Bispyribac sodium at 25 g a.i ha^{-1}	4578	5291
T_{11} - Paddy cum Dhaincha seeder + PE Bensulfuron methyl 0.6% + Pretilachlor 6% GR at 660 g a.i ha^{-1} fb PoE Ethoxy Sulfuron ethyl at 30 g a.i ha^{-1}	4223	4946
T_{12} - Paddy cum Dhaincha seeder + Rotary weeding twice on 35 DAS and 45 DAS	5432	6048
T_{13} - Paddy cum Dhaincha seeder + Weed free check	6540	7550
T_{14} - Paddy cum Dhaincha seeder + Unweeded Control	3310	4120
SEd	166	192
CD(P=0.05)	360	421

PE- Pre-emergence POE- Post-emergence fb- Followed by

Yield attributes

Weed free check in both method of seeding had a favourable effect on the yield components (Table 2), grain and straw yield (Table 3). Apart from weed free check, pyrazosulfuron ethyl at 20 g a.i ha^{-1} applied as PE on 8 DAS fb POE bispyribac sodium at 25 g a.i ha^{-1} on 30 DAS in rice intercropped with dhaincha recorded higher number of productive tillers (381 m^{-2}) and lower sterility percentage (17.3 %). It might be due to the smothering effect of dhaincha and application of effective herbicide combination which provided a competition free environment for the crop. This had increased the capacity of NPK uptake and enhanced the source and sink sizes which inturn increased the entire yield attributes. Similar, observations were also made by Kumar *et al.* (2017).

Yield

The economic yield in the weed free treatment was found superior over all other treatments. This result was supported by Singh *et al*., (2016). Highest grain yield and straw yield was found with the weed free check in rice with 6540 and 7550 kg ha^{-1}, respectively and without intercropped dhaincha (6183 and 7137 kg ha^{-1}, respectively). Among the different herbicides used, application of pyrazosulfuron ethyl at 20 g a.i ha^{-1} on 8 DAS fb POE bispyribac sodium at 25 g a.i ha^{-1} on 30 DAS in drum seeded rice recorded maximum grain yield (5784 kg ha^{-1}) and straw yield (6473 kg ha^{-1}) apart from weed free check in both methods of seeding. The weed free check in dhaincha intercropped rice and application of pyrazosulfuron ethyl at 20 g a.i ha^{-1} on 8 DAS fb POE bispyribac sodium at 25 g a.i ha^{-1} on 30 DAS in drum seeded rice recorded additional yield of 3230 kg ha^{-1} and 2955 kg ha^{-1} over unweeded control. This was achieved by the way of effective early and later weed control through pre and post-emergence herbicides which prevented the crop-weed competition. The increase in yield was mainly reflected through increased leaf area, DMP, which contributed to more number of productive tillers m^{-2}, number of filled grains $panicle^{-1}$, test weight and higher yield. Earlier findings by Kumar *et al*., (2017) and Brown, (1990) agreed with the present findings.

Conclusion

From the above results, it could be concluded that application of pyrazosulfuron ethyl at 20 g a.i ha^{-1} as pre emergence herbicide on 8 DAS followed by POE bispyribac sodium at 25 g a.i ha^{-1} at 30 DAS was found to be the suitable wet seeding method with efficient weed management practice for achieving higher productivity of drum seeded rice under unpuddled condition in Tamirabarani command area.

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