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Effect of Different Weed Management Practices and Wet Seeding Methods on Weed Control, Growth and Yield of Unpuddled Rice (*Oryza sativa* L.) in Tamirabarani Command Area

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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 growth and 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 growth and 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 POE bispyribac sodium at 25 g a.i ha^{-1} at 30 DAS not only significantly reduced the density of weeds but also increased the growth and yield of rice.

Keywords: Herbicides; Weed management; Growth and yield of Wet-seeded rice; Unpuddled rice

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 crop grown in India occupying an area of 43.49 mi ha with the production of 104.4 mi tonnes combined 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 with a productivity of 3758 kg ha^{-1} during 2015-16 (Indiastat, 2016).

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). At this time of water scarcity in order to save the water required for land

preparation, an alternate method of rice establishment should be established. 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.

Materials and Methods

An experiment was conducted at the wet land farm of our institute to study the effect of different weed management practices and wet seeding methods on growth and yield of 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.

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Result and Discussion

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

Weed flora

The weed flora noticed in the experimental field during the research period contained grasses, sedges and broad-leaved weeds. The chief category of weed in the experiment was broad-leaved weeds. The weed flora was mainly made up of *Echinochloa colona, Cynodon dactylon* under grasses, *Cyperus rotundus, Cyperus difformis* and *Fimbristylis miliacea* under sedges and *Ludwigia perennis, Eclipta alba, Sphaeranthus indicus, Bergia capensis, Monochoria vaginalis* and *Ammania baccifera* under broad-leaved weeds. In this study, broad leaved weeds dominated the weed flora. The next dominant weed category was grasses followed by sedges.

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, so that the weed density was decreased. This is in conformity with the findings of (Vijay Singh *et al*., 2016).

At 15 DAS, this treatment was followed by the 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 significantly reduced the weed density of 6.5 m^{-2}. 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 treatment which lowered the 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 at later growth stage as late germinating weeds were controlled 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).

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Weed control efficiency

Weed control efficiency 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 (Table1). 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 weed density and resulted in higher WCE (99.1 %). It was mainly due to the better control of weeds upto critical stage by the above treatment combination resulting in lower weed densities. Similar results have been reported by (Kumar *et al*., 2017).

Growth

Weed free check in rice intercropped with dhaincha had a positive effect on the growth parameters like plant height, number of tillers m^{-2} and dry matter production of unpuddled rice (Table 1). Highest plant height of 112.5 cm was registered with the weed free check and it was followed by PE pyrazosulfuron ethyl at 20 g a.i ha^{-1} on 8 DAS fb POE bispyribac sodium at 25 g a.i ha^{-1} as POE at 30 DAS (111.5 cm) in rice intercropped with dhaincha, at harvest stage. This might be due to the competition between the rice crop and dhaincha for natural resources such as light, moisture and space. Performance of a crop is said to be superior when the foliage of crop at ground surface utilizes maximum natural resources like light. This correlates with the findings of (Bhattarai *et al.*, 2016).

More number of tillers were observed with weed free check present at both drum seeded rice (465 m^{-2}) and paddy cum dhaincha seeder (445 m^{-2}). It was followed by application of PE pyrazosulfuron ethyl at 20 g a.i ha^{-1} on 8 DAS fb POE bispyribac sodium at 25 g a.i ha^{-1} in drum seeded rice (441 m^{-2}). Since the intercropping space is saved in drum seeded rice, plant population is comparably higher than the rice intercropped with dhaincha, which leads to higher number of total tillers in drum seeded rice. These results are in accordance with findings of (Marahatta *et al.*, 2017) and (Hassan *et al.*, 2010).

Also drymatter production was found to be higher with weed free treatment of rice intercropped with dhaincha (14122 kg ha^{-1}) and it was on par with weed free treatment of drum seeded rice (13435 kg ha^{-1}). This was followed by PE 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} at 30 DAS produced higher DMP of 12286 kg ha^{-1} in drum seeded rice. The combination of appropriate herbicides along with proper seeding methods, killed the weeds from their germination phase which ensured optimum plant stand and good growth of crop. This is in consistent with the findings of (Kumar *et al.*, 2017).

Yield

Weed free check in rice intercropped with dhaincha had a favourable effect on the grain and straw yield (Table 2). 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 with respective establishment method. 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. Generally the rice with green manure produces more yield than sole rice. However inversed result was found since the growth and establishment of dhaincha was affected by the action of herbicides. The increase in yield was mainly attributed to better control of weeds throughout the crop growth resulting in better availability of nutrients, moisture and light to the crop growth. This was 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 in rice sown with drum seeder was found to be the suitable wet seeding method with efficient weed management practice for achieving higher productivity of direct seeded rice under unpuddled condition in Tamirabarani command area.

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Table 1 : Effect of different weed management practices and wet seeding methods on total weed density (No. m^{-2}), weed control efficiency (%), plant height (cm), no. of tillers m^{-2} and DMP (kg ha^{-1}) of unpuddled rice

Treatments	Total weed density (No. m^{-2})			WCE* (%)	Plant height at harvest stage (cm)	No. of tillers m^{-2}	DMP at harvest stage (kg ha^{-1})
	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	109.6	441	12286
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	100.1	429	10820
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	97.6	426	9453
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	94.3	421	8893
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	106.2	435	11164
T_6 - Drum seeder + Weed free check	0.00 (0.72)	0.00 (0.72)	0.00 (0.72)	100.0	110.3	465	13435
T_7 - Drum seeder + Unweeded Control	37.70 (6.18)	80.26 (8.99)	96.41 (9.84)	-	86.7	352	6473
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	111.5	411	11812
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	102.9	404	10570
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	99.6	398	9899
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	96.1	391	9202
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	107.7	408	11507
T_{13} - Paddy cum Dhaincha seeder + Weed free check	0.00 (0.72)	0.00 (0.72)	0.00 (0.72)	100.0	112.5	445	14122

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T_{14} - Paddy cum Dhaincha seeder + Unweeded Control	35.40 (5.99)	76.78 (8.79)	90.68 (9.55)	-	89.5	331	7476
SEd	0.12	0.17	0.16	-	2.8	12.1	314
CD(P=0.05)	0.27	0.40	0.34	-	6.5	24	689

Figure in parenthesis are ($\sqrt{(0.5+x)}$) transformed values. *Data not statistically analyzed PE- Pre-emergence POE- Post-emergence fb- Followed by

Table 2 : Effect of different weed management practices and wet seeding methods on grain and straw yield (kg ha^{-1}) of unpuddled rice

Treatments	Grain yield	Straw yield
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

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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