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Performance of rice cultivars with weed management practices in dry direct-seeded rice

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ABSTRACT

Weeds are the most important biotic constraint in direct-seeded rice (DSR) production. A field experiment was carried out in split plot design replicated thrice during September 2019 to evaluate the performance of different cultivars integrated with weed management practices under DSR at Pandit Jawaharlal Nehru College of Agriculture & Research Institute, Karaikal, Puducherry UT, India. The treatment combination consisted of three cultivars in main plot (*ADT 46*, *CO 52* and *White Ponni*) and five levels of weed management practices in the sub-plots (application of pendimethalin 1.0 kg/ha as pre-emergence herbicide at 3 DAS, bispyribac-sodium 0.02 kg/ha as post-emergence herbicide at 20 DAS, sequential application of pendimethalin 1.0 kg/ha followed by bispyribac-sodium 0.02 kg/ha, hand weeding twice at 20 and 40 days after sowing (DAS) and unweeded control. Results revealed that rice cultivar *ADT 46* integrated with sequential application of pendimethalin *fb* bispyribac-sodium (1.0 kg/ha *fb* 0.02 kg/ha) reduced the weed density and weed dry weight, and increased the growth, yield attributes and rice grain yield. Uncontrolled weeds caused 51.9 % yield loss in dry-DSR under coastal deltaic ecosystem.

Rice is an important cereal crop cultivated in India. Transplanting is the most common establishment method of rice in India. However, scenario of escalated resource costs in transplanting method forces the rice farmers to switch to a cheaper and alternative establishment method of direct seeding in India. DSR is practiced as wet seeding and dry seeding. Pre-germinated rice seeds are sown in the puddled soil under wet seeding whereas the dry seeds are sown in the unpuddled soil under dry seeding. Major bottleneck in the dry direct-seeding is weeds. Such weeds invite severe competition between weeds and rice thus reducing the crop yield on an average of 50-90% (Mahajan and Chauhan 2013).

Rice cultivars with weed-suppressing characters such as diverse morphological traits, canopy structure and relative growth rate are an important aspect of weed management in DSR (Mahajan *et al.* 2015). Herbicide use becomes more important when weeds and rice emerge simultaneously in DSR, and some of the weeds have morphological similarity to rice like *Echinochloa colona* and *Echinochloa crus-galli*, which are difficult to be differentiated at early stages of growth. So, evaluating the performance of promising rice cultivars of the region integrated with suitable weed management practices in dry-DSR is need of the hour.

Hence, a field experiment was conducted at Pandit Jawaharlal Nehru College of Agriculture & Research Institute, Karaikal, Puducherry UT, India during September 2019 (*Thaladi* season). The soil was sandy clay loam, pH 6.45, low in available N (82 kg/ha), high in available P (57 kg/ha) and medium in available K (254 kg/ha). The experiment comprised of three cultivars and five weed management practices (**Table 1**). Cultivars *viz. ADT 46*, *CO 52* and *White Ponni* (WP) were assigned to main plots, and five weed management practices, *viz.* pendimethalin at 1.0 kg/ha sprayed at 3 days after sowing (DAS), bispyribac-sodium 0.02 kg/ha sprayed at 20 DAS, sequential application of pendimethalin at 1.0 kg/ha followed by bispyribac-sodium at 0.02 kg/ha, hand weeding twice at 20 and 40 DAS and unweeded control were allotted to sub-plots, replicated three times in a split-plot design. Shallow and narrow furrows were opened at 20 cm interval with the help

of hand hoe. Dry rice seeds with seed rate of 75 kg/ha were manually sown in 10 cm gap between plants and covered with soil. Herbicides were sprayed using knap-sack sprayer fitted with flat-fan nozzle using spray fluid of 500 L/ha for pre-emergence and 375 L/ ha for post-emergence application. Data on weed density and dry matter accumulation were recorded at 60 DAS using four quadrates of size 0.5 x 0.5 m (Saravanane 2020). Data on weed density and dry weight were transformed with square root transformation ($\sqrt{x+0.5}$) before analyses. Grain yield and weed biomass relationships at harvest were assessed using linear regression analysis. Data were subjected to statistical scrutiny as per the procedures given by Panse and Sukhatme (1967).

Twelve weed species (*Echinochloa colona* L., *Echinochloa crus-galli* L. and *Leptochloa chinensis* L. among grasses; *Cyperus iria* L., *Cyperus difformis* L. and *Fimbristylis miliacea* L. among sedges; *Bergia capensis* L., *Eclipta alba* (L.) Hassk, *Ludwigia perennis* L., *Marsilea quadrifolia* L., *Sphaeranthus indicus* L. and *Aeschynomene indica* L. among broad -leaved weeds) were observed in experimental field.

Cultivars significantly reduced the weed density and weed dry weight except grass weed density at 60 DAS (**Table 1**). Sedges, broad-leaved weeds and total weed density and dry weight were significantly lower under cultivar *ADT 46* which was comparable to *CO 52*. High productive tillers with improved plant height under cultivar *ADT 46* might have helped to register low density and dry weight of weeds compared to other cultivars. Caton *et al*. (2003) indicated that plants with high tillering ability and taller stature is essential for weed competitiveness. Further, cultivars differ in their weed competitiveness by virtue of their genotypic differences (Mahajan *et al*. 2015). Higher total weed density (213.6 no./m^2) and dry weight (59.5 g/m^2) was recorded under IWP, which resulted in lower weed control efficiency of 58.1% as compared to all other cultivars.

Weed management practices significantly reduced the weed density and weed dry weight at 60 DAS. Sequential application of pendimethalin 1.0 kg/ha followed by bispyribac-sodium 0.02 kg/ha has recorded lower total weed density (113.5 no./m^2) and weed dry weight (21.1 g/m^2), resulted in higher weed control efficiency (78.3%). However, it was followed by hand weeding twice (74.6%). It is earlier reported that single use of either pre-emergence or post-emergence herbicide was not effective against complex weed flora in DSR (Mahajan and Chauhan 2013). However, sequential application of pre-emergence (pendimethalin) and post-emergence herbicides (bispyribac-sodium) found to be effective against wide spectrum of weeds (Saravanane 2020). Early control of weeds by pendimethalin herbicide was due to its persistence nature, which has half-life period of 10.5 to 44 days depending upon soil temperature and moisture (Ramirez and Plaza 2015) and late emergence weed control by bispyribac-sodium due to its ALS (acetolacto synthase) enzyme inhibition. Unweeded control recorded higher total weed density (241.3 no./m^2) and total weed dry weight (92.4 g/m^2).

Cultivars and weed management influenced the growth, yield parameters and yield except plant height under cultivars (**Table 2**). *ADT 46* has recorded better growth, yield parameters and in turn, resulted in 19 and 31% higher rice yield compared to *Co 52* and WP. This might be due to better weed competitive

Table 1. Effect of cultivars and varying weed management treatments on weed density, weed dry weight and weed control efficiency in dry-DSR

Treatment	Weed density (no./ m^2)				Weed dry weight (g/m^2)				Weed control efficiency (%)
	Grasses	Sedges	BLW	Total weed density	Grasses	Sedges	BLW	Total weed dry weight	
Cultivars									
ADT 46	4.77(26.2)	3.22(16.9)	9.13(83.7)	11.03(126.9)	3.04(13.6)	1.57(3.4)	3.95(15.6)	5.37(32.8)	69.9
Co 52	5.31(29.1)	4.00(22.0)	9.34(88.1)	11.68(139.3)	3.35(13.9)	1.98(5.1)	4.18(17.4)	5.77(36.3)	69.8
White Ponni	5.61(32.8)	4.83(28.7)	12.26(152.1)	14.43(213.6)	4.64(25.0)	2.08(5.3)	5.42(29.5)	7.52(59.5)	58.1
LSD (p=0.05)	NS	0.96	2.44	2.07	0.73	0.38	1.15	1.44	
Weed management									
Pendimethalin 1.0 kg /ha	5.34(28.8)	4.67(25.6)	10.53(112.9)	12.78(167.3)	3.64(13.4)	1.98(4.3)	4.68(21.9)	6.24(39.6)	57.5
Bispyribac-sodium 0.02 kg /ha	4.82(23.3)	3.01(17.8)	10.30(109.1)	12.05(150.2)	3.28(11.4)	1.73(3.9)	4.56(21.2)	5.89(36.4)	61.4
Pendimethalin 1.0 kg/ha *fb* bispyribac-sodium 0.02 kg/ha	4.07(16.8)	2.45(8.2)	9.28(88.4)	10.48(113.5)	1.92(3.7)	1.32(1.4)	3.96(15.9)	4.52(21.1)	78.3
Hand weeding twice (20 & 40 DAS)	4.30(20.0)	2.87(11.1)	9.69(96.2)	11.13(127.3)	2.22(5.0)	1.47(2.5)	4.15(17.5)	4.91(24.9)	74.6
Unweeded control	7.62(58.0)	7.09(50.0)	11.42(133.3)	15.47(241.3)	7.32(54.1)	2.87(10.8)	5.24(27.5)	9.55(92.4)	-
LSD(p=0.05)	0.42	1.47	0.62	0.79	0.50	0.79	0.37	0.59	

LSD, least significant difference; BLW- Broad- leaved weeds; NS- Non-significant; figures in parentheses were original values; *fb*-followed by

Table 2. Effect of cultivars and varying weed management treatments on growth, yield parameters, yield and weed index in dry DSR

Treatment	Plant height (cm)	Productive tiller/m^2	Panicle weight (g)	1000 seed weight (g)	Grain yield (t/ha)	Weed index
Cultivars						
ADT 46	123.3	362.6	3.37	23.65	3.76	18.2
Co 52	119.9	359.2	3.11	16.80	3.05	33.6
White Ponni	116.9	342.2	2.45	14.76	2.58	43.9
LSD (p=0.05)	NS	15.78	0.52	2.36	0.30	
Weed management						
Pendimethalin 1.0 kg/ha	117.8	360.8	2.93	18.07	2.98	35.2
Bispyribac-sodium 0.02 kg/ha	120.2	367.3	3.08	18.41	3.19	30.7
Pendimethalin 1.0 kg/ha *fb* bispyribac-sodium 0.02 kg/ha	124.7	378.1	3.58	19.05	3.73	18.8
Hand weeding twice (20 and 40 DAS)	122.4	376.0	3.23	19.24	3.54	23.0
Unweeded control	115.2	291.2	2.07	17.24	2.21	51.9
LSD (p=0.05)	2.78	12.01	0.23	NS	0.23	

LSD, least significant difference; NS- Non-significant; *fb*- followed by

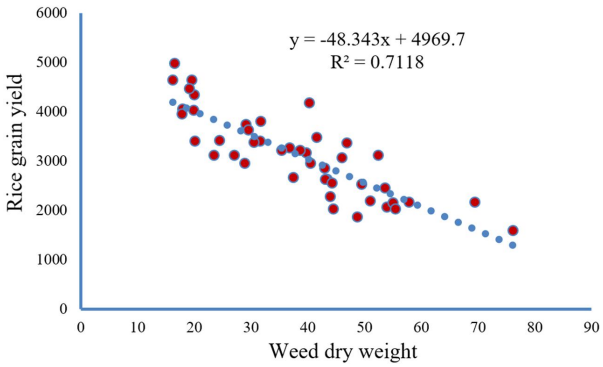

Figure 1. The relationship between grain yield and total weed dry weight at harvest

environment prevailed under *ADT 46*. Sequential application of pendimethalin 1.0 kg/ha followed by bispyribac-sodium 0.02 kg/ha has recorded higher plant height (124.7 cm), productive tillers (378.1 tillers), panicle weight (3.58 g) and grain yield (3.73 t/ha) of rice. The increase in grain yields under sequential application of herbicides due to effective control of weeds was earlier reported by Mahajan and Chauhan (2013) and Saravanane (2020). Grain yield was statistically comparable with hand weeding twice (3.54 t/ha). Shorter rice plants, lesser number tillers, poor filling of grains and less panicle weight due to the vigorous crop-weed competition for growth factors like nutrient, space, light and carbon dioxide (Tindall *et al*. 2005) under unweeded control resulted in lesser grain yield (2.21 t/ha). Rice grain yield and total weed dry weight at harvest stage showed negative linear relationship with co-efficient of determination of 0.712 (**Figure 1**).

Current study clearly indicated that weed interference contributed to the negative influence on the growth and yield attributes of the crop, which cumulatively reduced the grain yield of DSR. Uncontrolled weeds resulted in 51.9% yield reduction in DSR.

It was concluded that farmers can cultivate *ADT 46* integrated with sequential application of pendimethalin 1.0 kg/ha followed by bispyribac-sodium 0.02 kg/ha in labour scarcity areas or hand weeding twice at 20 and 40 DAS in labour sufficient areas to effectively manage the diverse weed flora, enhance rice yield of dry DSR in the coastal deltaic ecosystem.

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