Indian Journal of Weed Science **53**(1): 85–87, 2021

Print ISSN 0253-8040 Online ISSN 0974-8164

Weed management in aerobic rice with sequential application of pendimethalin and bispyribac-sodium under coastal deltaic ecosystem

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Article information

DOI: 10.5958/0974-8164.2021.00013.7

Type of article: Research note

Received : 21 November 2020
Revised : 26 January 2021
Accepted : 28 January 2021

Key words

Aerobic rice, Pendimethalin, Bispyribac-sodium, Weed management

ABSTRACT

A field experiment was conducted at Pandit Jawaharlal Nehru College of Agriculture and Research Institute (PAJANCOA&RI), Karaikal during September 2013 - January 2014 with ten treatments replicated thrice in a randomized block design to evaluate the weed management efficacy of sequential application of pendimethalin and bispyribac-sodium in aerobic rice. *Echinochloa colona* (28.1%), *Ludwigia abyssinica* (28%) and *Cyperus difformis* (19.8%) among grasses, broad-leaved weeds and sedges, respectively were the predominant in the experimental field. Among the weed control treatments, pendimethalin 1.0 kg/ha at 3 days after seeding (DAS) *fb* bispyribac-sodium 30 g/ha at 30 DAS was found to be effective recording lowest weed density and biomass and superior growth attributes, yield attributes and yield of rice (4.86 t/ha).

Rice is widely grown under flooded irrigated conditions for better establishment and easy weed control. The traditional rice cultivation requires about 3000-5000 litres of water for producing one kg rice (Thiyagarajan and Selvaraju 2001). It is no longer feasible to flood rice field to ensure better crop establishment and control weeds as well. In the present situation, aerobic rice system has huge potential as a water-wise technology, wherein the crop is established through direct seeding in non-puddled and non-flooded fields (Rao *et al.* 2007, 2017). Rice cultivation using this system can save about 50 to 60 per cent irrigation water and increase the water productivity by around 200 per cent as compared to lowland flooded system. In aerobic rice system, the dry tillage practices and aerobic soil conditions are highly conducive for germination and growth of weeds which results in higher weed pressure coupled with greater grain yield losses as compared to flooded rice (Mahajan *et al.*2009). Morphological similarity between grassy weeds and rice seedlings makes hand weeding difficult at early stages of growth. Over the years, chemical weed control has emerged as promising solution as it is easy, quick, economical and feasible. Application of pre-emergence herbicides mainly control weeds during the earlier stages of crop growth, but second flush of weeds at 25 to 30 days after sowing becomes a problem. Heavy infestation of weeds at later stages of rice growth are not controlled effectively by the pre-emergence herbicides alone. This situation warrants for initiating research efforts to evaluate and identify suitable early post-emergence herbicides for successful cultivation of aerobic rice which have wider applicability and weed control spectrum under coastal deltaic ecosystem.

Keeping these in view, a field experiment was conducted during September 2013-January 2014 at research farm of PAJANCOA&RI, Karaikal, Puducherry (11°56' N latitude, 79°53'E longitude, 4 m above mean sea level) India. The soil texture in the experimental site was loamy sand with alkaline pH (8.2). The soil was low in available nitrogen (60.6 kg/ha) and phosphorus (10.5 kg/ha) and medium in available potassium (184.4 kg/ha). A medium duration rice cv. '*ADT(R)46*' was sown and the recommended package of practices for aerobic rice was followed. The experiment was laid out in a randomized block design with ten treatments, replicated thrice (**Table 1**).

Observations on weeds were recorded with the help of quadrate 0.25 x 0.25 m placed randomly at four spots in each plot at specified period. Growth parameters, yield parameters and grain yield were recorded at harvest. The data on weed density and biomass was then analysed using square root transformation ($\sqrt{x+0.5}$) to normalize their distribution. The data collected from the experiments was subjected to the Fisher's method of Analysis of Variance (ANOVA).

Effect on weeds

The experimental field was infested with diverse weed flora comprising 35.7% grasses [*Echinochloa colona* (L.), *Echinochloa crus-galli* (L.) Beauv.], 21.8% sedges [*Cyperus difformis* (L)., *Cyperus iria* (L.)] and 42.5% broad-leaved weeds [*Ludwigia abyssinica* A. Rich., *Lindernia oppositifolia* (L.) Mukerjee]. Application of pendimethalin at 1.0 kg/ha at 3 DAS integrated with hand hoeing at 40 DAS recorded the lowest weed density (7.6/m^2) and was at par with application of pendimethalin at 1.0 kg/ha at 3 DAS *fb* bispyribac-sodium 30 g/ha at 30 DAS (9.5/m^2) and hand hoeing at 20 and 40 DAS (10.5/m^2). This may be attributed to the reason that pendimethalin was effective against *E. colona* and *L. chinensis* up to 30 DAS as reported earlier by Saravanane *et al*. (2016). When compared to application of bispyribac-sodium alone, application of pendimethalin at 3 DAS *fb* bispyribac-sodium at 30 DAS was observed to have less population of *L. chinensis* and *L. abyssinica*. The grasses and sedges started drying after application of bispyribac-sodium at 30 DAS. Brar and Bhullar (2012) also reported that bispyribac-sodium was effective in controlling complex weed flora of grasses like *E. colona, E. crus-galli*, sedges and broad-leaved weeds. Application of pendimethalin 1.0 kg/ha at 3 DAS integrated with hand hoeing at 40 DAS (4.2 g/plant) and hand hoeing at 20 and 40 DAS (5.2 g/plant) also recorded significant lower weed biomass due to effective reduction in weed density by pendimethalin during initial period and by hand hoeing at later periods. Highest weed control efficiency was recorded with application of pendimethalin 1.0 kg/ha at 3 DAS integrated with hand hoeing at 40 DAS (96.9%), which was followed by hand hoeing at 20 and 40 DAS (95.4%) and pendimethalin 1.0 kg/ha at 3 DAS *fb* bispyribac-sodium 30 g/ha at 30 DAS (86.5%).

Effect on rice

Application of pendimethalin 1.0 kg/ha at 3 DAS *fb* bispyribac-sodium 30 g/ha at 30 DAS recorded the tallest rice plants (72.9 cm). Whereas 70.2% reduction in plant height, resulting in stunted rice plants was observed under unweeded control. Plant height had a significant positive correlation (r = 0.764**) (**Table 2**) with weed control efficiency and significant negative correlation with weed density (r = - 0.805**) and biomass (r = - 0.752**). When bispyribac-sodium was applied earlier at 15 DAS, slight yellowing was observed on the rice leaves, but later the rice plants recovered from this symptom. Pendimethalin 1.0 kg/ha at 3 DAS *fb* bispyribac-sodium 30 g/ha at 30 DAS recorded maximum LAI (7.69), dry matter production (30.07 g/plant), number of tillers/m^2 (546.7), number of productive tillers/m^2 (508.0), test weight (27.3 g) and grain yield (4.86 t/ha). Baloch *et al*. (2005) also found that rice without weed competition recorded higher number of productive tillers due to greater space use by rice and earlier canopy closure due to better competitive ability and nutrient use efficiency. The increase in panicle production occurred due to the increase in tillers

Table 1. Effect of weed control treatments on weed and crop attributes of aerobic rice

Treatment	Weed density (no./m^2)	Weed biomass (g/m^2)	Weed control efficiency (%)	Plant height (cm)	Rice DMP (g/plant)	Rice LAI	No. of productive tillers/m^2	No. of spikelets/ panicle	No. of grains/ panicle	Grain yield (t/ha)
Pendimethalin 1.0 kg/ha at 3 DAS *fb* bispyribac-Na20 g/ha at 30 DAS	13.5(184)	11.0(127)	78.2	69.3	5.41	4.50	404.0	98.0	87.1	4.00
Pendimethalin 1.0 kg/ha at 3 DAS *fb* bispyribac-Na 25 g/ha at 30 DAS	12.9(165)	9.3(87)	85.1	69.4	5.55	5.16	410.7	99.4	89.0	4.20
Pendimethalin 1.0 kg/ha at 3 DAS *fb* bispyribac-Na 30 g/ha at 30 DAS	9.5(99)	8.8(79)	86.5	72.9	6.87	7.62	510.7	102.1	92.7	4.86
Bispyribac-sodium 20 g/ha at 15 DAS	21.5(467)	14.0(199)	65.8	64.4	4.08	3.66	393.3	86.5	74.2	2.58
Bispyribac-sodium 25 g/ha at 15 DAS	19.8 391)	11.4(130)	77.7	69.0	5.34	4.71	425.3	98.2	86.4	3.56
Bispyribac-sodium 30 g/ha at 15 DAS	20.4(416)	12.8(166)	71.6	64.7	4.54	3.52	352.0	88.0	76.0	2.63
Pendimethalin 1.0 kg/ha at 3 DAS *fb* 2,4-D Na salt 1.0 kg/ha at 40 DAS	17.1(291)	15.9(256)	56.1	60.9	3.29	3.11	260.0	82.1	69.2	1.71
Pendimethalin 1.0 kg/ha at 3 DAS and hand hoeing at 40 DAS	7.6(61)	4.2(18)	96.9	69.9	5.71	5.82	433.3	99.5	89.6	4.49
Hand hoeing at 20 and 40 DAS	10.5(113)	5.2(27)	95.4	70.3	6.04	6.16	441.3	100.7	90.6	4.67
Unweeded control	35.9(1291)	24.0(583)	-	52.2	1.98	1.47	157.3	50.0	37.3	0.33
LSD (p=0.05)	4.5	3.7	NA	8.3	1.12	1.27	89.7	8.5	5.6	0.57

Table 2. Correlation coefficient (r) values for rice growth and yield parameters with weed parameters

Parameters	Weed density	Weed dry matter production	Weed control efficiency
Plant height	-0.805	-0.752	0.764
Leaf area index	-0.760	-0.747	0.741
Number of tillers/ m^2	-0.738	-0.698	0.670
Dry matter production of rice	-0.730	-0.768	0.755
Number of productive tillers/m^2	-0.753	-0.737	0.750
Panicle length	-0.741	-0.719	0.751
Panicle weight	-0.772	-0.729	0.770
Test weight	-0.535	-0.456	0.531
Number of spikelets/panicle	-0.841	-0.814	0.834
Number of grains/panicle	-0.852	-0.836	0.853
Grain yield	-0.789	-0.816	0.843

Significant at 1%

number. The weed control efficiency had a significant and positive correlation with grain yield (r = 0.843**). Unweeded control recorded the lowest growth, yield attributes and yield might be due to higher physical suppression and competition with increasing weed density.

It was concluded that application of pendimethalin at 1.0 kg/ha at 3 DAS *fb* bispyribac-sodium at 30 g/ha at 30 DAS is the most suitable weed management option for achieving higher yield in aerobic rice under coastal deltaic ecosystem.

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