



## Effect of weed management practices on nutrient uptake by direct seeded upland rice under Tripura condition

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### ABSTRACT

Direct-seeded rice (DSR) is a feasible alternative to mitigate methane emission, besides saving water and labour. The DSR crop can save 3-4 irrigations compared to the transplanted rice without any yield penalty. The yields are comparable with transplanted rice if crop is properly managed. Weeds are a major constraint to rice production in direct-seeded systems as they increase production costs and compete with the rice for light, water and nutrients. In this regard a field experiment was conducted during the *kharif* season of 2013 and 2014 to study the effect of weed management practices on nutrient uptake by direct seeded upland rice. The experiment consisted of twelve treatments laid out in randomized complete block design with three replication. The common weed flora found in the experimental field were *Amaranthus viridis*, *Oldenlandia corymbosa*, *Spilanthus acmella*, *Ludwigia parviflora*, *Cleome rutidosperma*, *Malvestrum coromondaliense* among the broad leaf weed, *Digitaria sanguinalis* among grasses and *Cyperus iria* among sedges. The highest uptake of NPK was recorded by the treatment hand weeding thrice at 15, 30 and 45 DAS, while weedy check registered the lowest uptake values for all the major nutrients. Among the other treatments, pendimethalin at 1.0 kg ha<sup>-1</sup> + one hand weeding at 30 DAS and pendimethalin at 1.0 kg ha<sup>-1</sup> at 2 DAS + bispyribac sodium at 25 g ha<sup>-1</sup> at 20 DAS were found more efficient with respect to nutrient uptake.

### 1. Introduction

Rice is the source of subsistence for more than one third of human population, especially poor. It is the main staple food in the Asia and the Pacific region, providing almost 39 % of calories (Yaduraju, 2013). Worldwide, 697.22 million tons of rice at an average yield of 4.4 tons ha<sup>-1</sup> is being harvested from 158.43 million ha annually producing 21% of world's food calorie supply (Jaladhar *et al.* 2018). Almost 90% of the total rice is produced and consumed in Asia. Rice plays a pivotal role in Indian agriculture and is staple food for more than 60% of the population. In India it is a means of livelihood for millions of rural households. The practice of direct seeding of rice is gaining importance at present and year by year its area is increasing. Conventional puddled transplanted rice is a major source of greenhouse gas (GHG), particularly methane,

causing global warming (Brye *et al.*, 2013). Direct-seeded rice (DSR) is a feasible alternative to mitigate methane emission, besides saving water and labour. The DSR crop can save 3-4 irrigations compared to the transplanted rice without any yield penalty (Bhushan *et al.*, 2007). Human labour use also reduced to 45% and tractor use to 58% in the DSR compared to transplanted rice. The yields are comparable with transplanted rice if crop is properly managed (Pathak *et al.*, 2013). Weeds are a major constraint to rice production in direct-seeded systems as they increase production costs and cause yield losses. Hence, in order to achieve maximum return from the supplied inputs weed management at critical stages of crop weed competition is important. Hence the present investigation was carried out to study the effect of weed management practices.

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## 2. Materials and method

A field experiment was conducted at Krishi Vigyan Kendra, South Tripura during the *kharij* (wet) season of 2013 and 2014 to study the influence of different weed management practices applied to direct seeded upland rice under Tripura condition. Twelve treatments *viz.* Pendimethalin @ 1.0 kg ha<sup>-1</sup> at 2 Days After Sowing (DAS), Bispyribac sodium @ 25 g ha<sup>-1</sup> at 25 DAS, Pendimethalin @ 1.0 kg ha<sup>-1</sup> at 2 DAS+ one hand weeding at 30 DAS, Pendimethalin @ 1.0 kg ha<sup>-1</sup> at 2 DAS + bispyribac sodium @ 25 g ha<sup>-1</sup> at 20 DAS, Metsulfuron methyl+ chlorimuron ethyl (Almix) @ 4 g at 10 DAS followed by Bispyribac sodium @ 25 g at 20 DAS, Pyrazosulfuron ethyl @ 25 g ha<sup>-1</sup> at 3 DAS followed by bispyribac sodium @ 25 g at 20 DAS, Fenoxaprop-p-ethyl @ 60 g ha<sup>-1</sup> + metsulfuron methyl+ chlorimuron ethyl (Almix) @ 4 g ha<sup>-1</sup> at 15 DAS, Stale seed bed + smother crop (cowpea) in between two rows of rice, Stale seed bed + one hand weeding at 30 DAS, Sesbania (broadcast) @ 25 kg ha<sup>-1</sup> during sowing of rice + 2,4-D @ 500 g ha<sup>-1</sup> at 25 DAS, Hand weeding at 15, 30 and 45 DAS, Weedy check were assigned in Randomized Block Design replicated thrice. Rice variety NDR-97 was used for the experimental purpose with recommended package of practices.

The upland rice was fertilized as per package of practices recommended. Five tonnes of Farm Yard Manure were applied at the time of field preparation for both the crop. Chemical fertilizers were applied to meet 60 kg nitrogen in the form of urea, 40 kg phosphorus (P<sub>2</sub>O<sub>5</sub>) in the form of single superphosphate and 40 kg potassium (K<sub>2</sub>O) in the form of muriate of potash in the rice.

Weed counts at different stages (15, 30, 60 and at harvest stage) was taken by placing quadrat at random three sites in each plot and calculating the average. Weed sample from any of the quadrat was taken, grouped into grasses, broad leaved weed and sedges, dried and weighed. Weed dry matter was expressed category wise in g m<sup>-2</sup>. Data on yield

attributes, grain yield, straw yield, plant dry matter and nutrient (N,P,K) content of rice were taken. Economics of different weed management practices was also studied. The data generated from the experiment were subject to analysis of variance (ANOVA) as applied to randomized block design describe by Cochran and Cox (1965).

## 3. Results and discussion

### Effect on weed

The experimental field was heavily infested with mixed flora of grassy, broad leaved and sedges. Predominant weeds in the experimental field were *Amaranthus viridis*, *Oldenlandia corymbosa*, *Spilanthes acmella*, *Ludwigia parviflora*, *Cleome ruidosperma*, *Malvestrum coromondalianeum* among the broad leaf weed, *Digitaria sanguinalis* among grasses and *Cyperus iria* among sedges. All the treatments resulted in significant reduction in weed density and dry weight of weeds over weedy check during both the years (Table 1). Hand weeding thrice at 15, 30 and 45 DAS resulted in the lowest weed density (19.3 no.m<sup>-2</sup> & 17.3 no.m<sup>-2</sup>), dry weight of weeds (49.0 g m<sup>-2</sup> & 38.5 g m<sup>-2</sup>) and highest weed control efficiency (80.5% & 84.5%) followed by pendimethalin @ 1.0 kg ha<sup>-1</sup> at 2 DAS+ one hand weeding at 30 DAS and pendimethalin @ 1.0 kg ha<sup>-1</sup> at 2 DAS + bispyribac sodium @ 25 g ha<sup>-1</sup> at 20 DAS for both the years. The highest weed density (112.3 no.m<sup>-2</sup> and 107.3 no.m<sup>-2</sup>), weed dry weight (251.5 g m<sup>-2</sup> & 241.4 g m<sup>-2</sup>) lowest weed control efficiency (0) was observed with weedy check plot during both the years. There was no remarkable changes in the weed density, dry weight and weed control efficiency between two years. Unchecked weed growth exploited the available nutrients and water, resulting in better growth and dry matter production. Similar observation have been made by Sunil *et.al* (2010) who reported that un weeded check recorded significantly higher weed population and weed dry weight.

**Table 1.** Effect of weed management practices on weed density, weed dry weight and weed control efficiency at 60 DAS

Treatments	Weed density (no.m <sup>-2</sup> )		Weed dry weight (g m <sup>-2</sup> )		Weed control efficiency (%)	
	2013	2014	2013	2014	2013	2014
Pendimethalin @ 1.0 kg/ha at 2 DAS	60.0	56.0	145.5	134.6	42.1	46.1
Bispyribac sodium @ 25 g/ha at 25 DAS	57.3	52.3	148.6	140.2	40.9	43.8
Pendimethalin @ 1.0 kg/ha at 2 DAS+ one hand weeding at 30 DAS	32.3	27.6	61.3	50.1	75.6	79.9
Pendimethalin @ 1.0 kg/ha at 2 DAS + bispyribac sodium at 25 g/ha at 20 DAS	33.6	31.3	65.4	51.8	73.9	79.2
Metsulfuron methyl+ chlorimuron ethyl (Almix) @ 4 g at 10 DAS followed by bispyribac sodium at 25 g at 20 DAS	55.3	50.3	141.0	132.5	43.9	46.9

Pyrazosulfuron ethyl @ 25 g/ha at 3 DAS followed by bispyribac sodium at 25 g at 20 DAS	49.0	43.6	132.8	122.6	47.1	50.9
Fenoxaprop-p-ethyl @ 60 g/ha + metsulfuron methyl+ chlorimuron ethyl (Almix) at 4 g/ha at 15 DAS	55.6	49.6	139.1	128.1	44.7	48.7
Stale seed bed + smother crop (cowpea) in between two rows of rice	78.3	73.0	188.0	176.1	25.2	29.5
Stale seed bed + one hand weeding at 30 DAS	66.0	61.0	158.6	147.6	36.9	40.9
Sesbania (broadcast) @ 25 kg/ha during sowing of rice + 2,4-D at 500 g/ha at 25 DAS	77.0	71.3	180.0	170.0	28.4	31.9
Hand weeding at 15, 30 and 45 DAS	19.3	17.3	49.0	38.5	80.5	84.5
Weedy check	112.3	107.3	251.5	241.4	0.0	0.0
S. Em (±)	1.4	1.4	2.8	3.	-	-
CD(P=0.05)	4.1	4.1	8.2	8.9	-	-
CV (%)	4.2	4.5	3.5	4.1	-	-

#### Effect on the performance of rice crops

Grain yield, straw yield, net return and return per rupee invested was highly influenced by different weed management practices. Among the different treatments, hand weeding thrice at 15, 30 and 45 DAS recorded the highest grain yield (3.4 & 3.6 t/ha) and straw yield (5.1 & 5.4 t/ha) and this treatment was at par with pendimethalin @ 1.0 kg ha<sup>-1</sup> at 2 DAS+ one hand weeding at 30 DAS and pendimethalin @ 1.0 kg ha<sup>-1</sup> at 2 DAS + bispyribac sodium @ 25 g ha<sup>-1</sup> at 20 DAS during both the season (Table 2). Effective and timely weed management under these treatments reduced the dry weight of weeds which facilitated the crop to have sufficient space, light, nutrient and moisture and ultimately results in increased grain and straw yield. Pendimethalin @ 1.0 kg ha<sup>-1</sup> at 2 DAS + bispyribac sodium @ 25 g ha<sup>-1</sup> at 20 DAS recorded the highest net return (Rs. 23847/- in the first year and Rs. 26010/- in the second year) and return per rupee invested (2.0 and 2.1) in both the years and was found to be the most remunerative weed management practices. The herbicide pendimethalin @ 1.0

kg ha<sup>-1</sup> + one hand weeding at 30 DAS registered net return of Rs. 21427/- and 25573/- in the first year and second year respectively and was the next best treatment. This is simply due to higher grain and straw yield of the crop obtained from these treatments. Similar result was reported by Yakadri *et al.* (2016). Though the rice yield and gross return were the highest under hand weeding at 15, 30 and 45 DAS, the data on net income and return per rupee invested showed that it was less remunerative than pendimethalin @ 1.0 kg ha<sup>-1</sup> at 2 DAS + bispyribac sodium @ 25 g ha<sup>-1</sup> at 20 DAS and pendimethalin @ 1.0 kg ha<sup>-1</sup> + one manual weeding at 30 DAS which implied that it was uneconomic and unnecessary to give three hand weeding during the entire crop growth. The net income was found negative under weedy check due to greater competition between rice and weed which led to poor growth of the crop, lower grain and straw yield. This is in conformity with the study conducted by Prashanth *et al.* (2016) who reported that the lowest net returns and B:C ratio was obtained in unweeded check in transplanted rice.

**Table 2.** Effect of weed control measures on yield performance and economics of direct seeded rice

Treatment	Grain yield (t ha <sup>-1</sup> )		Straw yield (t ha <sup>-1</sup> )		Net return (Rs. ha <sup>-1</sup> )		Return per Rupee invested	
	2013	2014	2013	2014	2013	2014	2013	2014
Pendimethalin @ 1.0 kg/ha at 2 DAS	2.2	2.4	3.9	4.2	11337	14297	1.5	1.7
Bispyribac sodium @ 25 g/ha at 25 DAS	2.2	2.3	3.7	4.2	10650	11830	1.4	1.5
Pendimethalin @ 1.0 kg/ha at 2 DAS+ one hand weeding at 30 DAS	3.3	3.6	5.0	5.3	21427	25573	1.8	1.9
Pendimethalin @ 1.0 kg/ha at 2 DAS + bispyribac sodium @ 25 g/ha at 20 DAS	3.3	3.4	4.8	5.2	23847	26010	2.0	2.1

Metsulfuron methyl+ chlorimuron ethyl (Almix) @ 4 g at 10 DAS followed by bispyribac sodium @ 25 g at 20 DAS	2.5	2.7	3.7	4.7	13488	16542	1.6	1.7
Pyrazosulfuron ethyl @ 25 g/ha at 3 DAS followed by bispyribac sodium @ 25 g at 20 DAS	2.7	2.8	4.0	4.8	16637	18490	1.7	1.8
Fenoxaprop-p-ethyl @ 60 g/ha + metsulfuron methyl+ chlorimuron ethyl (Almix) @ 4 g/ha at 15 DAS	1.8	1.9	3.8	3.9	7908	9188	1.3	1.4
Stale seed bed + smother crop (cowpea) in between two rows of rice	1.8	2.0	3.7	4.0	4493	6613	1.1	1.2
Stale seed bed + one hand weeding at 30 DAS	1.8	2.1	3.7	3.8	1857	5203	1.0	1.2
Sesbania (broadcast) @ 25 kg/ha during sowing of rice + 2,4-D @ 500 g/ha at 25 DAS	1.8	1.9	3.7	3.7	7490	9083	1.3	1.4
Hand weeding at 15, 30 and 45 DAS	3.4	3.6	5.1	5.4	17620	19713	1.5	1.6
Weedy check	0.6	0.7	2.9	2.8	-5347	-3450	0.6	0.8
<b>S. Em (±)</b>	0.1	0.1	0.2	0.2	1609	1783	0.1	0.1
<b>CD(P=0.05)</b>	0.3	0.3	0.6	0.5	4719	5230	0.2	0.2
<b>CV (%)</b>	8.6	8.9	9.4	6.7	25.45	23.29	8.3	8.9

#### Nutrient uptake by Rice crop

All weed control treatments recorded significant increase in N, P and K uptake by the crops (Table 3). The highest uptake of NPK was recorded by the hand weeding at 15, 30 and 45 DAS (90.5 & 95.2 kg/ha N, 13.4 & 13.9 kg/ha P, 100.6 & 105.8 kg/ha K) while weedy check (32.1 & 32.6 kg/ha N, 4.9 & 4.8 kg/ha P, 51.0 & 50.1 kg/ha K) registered the lowest uptake values for all the major nutrients for both the years. This was in congruity with the result of Mandal *et al.* (2011). Among the other treatments, pendimethalin @ 1.0 kg ha<sup>-1</sup> + one hand weeding at 30 DAS and pendimethalin @ 1.0 kg ha<sup>-1</sup> at 2 DAS + bispyribac sodium @ 25 g ha<sup>-1</sup> at 20

DAS were found more efficient with respect to nutrient uptake by direct seeded rice. The enhanced growth characters in these treatments contributed to high dry matter production and nutrient uptake being a product of dry matter production and nutrient content, it was enhanced under such situations. Gupta *et al.* (2015) reported that all weed control treatments recorded significant increase in N, P and K uptake by the crop compared to weedy check. They also reported that the highest nutrient uptake was obtained in weed free treatment followed by pre-emergence herbicide integrated with one hand weeding or another herbicide.

**Table 3.** Effect of weed management practices on nutrient uptake by direct seeded rice

Treatment	N uptake (kg ha <sup>-1</sup> )		P uptake (kg ha <sup>-1</sup> )		K uptake (kg ha <sup>-1</sup> )	
	2013	2014	2013	2014	2013	2014
Pendimethalin @ 1.0 kg/ha at 2 DAS	61.8	66.9	8.9	9.6	71.6	82.1
Bispyribac sodium @ 25 g/ha at 25 DAS	60.7	65.7	8.7	9.1	69.2	79.1
Pendimethalin @ 1.0 kg/ha at 2 DAS+ one hand weeding at 30 DAS	87.4	94.5	13.0	13.5	96.9	99.9
Pendimethalin @ 1.0 kg/ha at 2 DAS + bispyribac sodium @ 25 g/ha at 20 DAS	86.1	90.2	12.5	12.8	93.4	100.9
Metsulfuron methyl+ chlorimuron ethyl (Almix) @ 4 g at 10 DAS followed by bispyribac sodium @ 25 g at 20 DAS	65.5	74.6	9.5	10.6	71.4	87.6
Pyrazosulfuron ethyl @ 25 g/ha at 3 DAS followed by bispyribac sodium @ 25 g at 20 DAS	70.8	78.4	10.2	11.2	77.7	92.2

Fenoxaprop-p-ethyl @ 60 g/ha + metsulfuron methyl+ chlorimuron ethyl (Almix) @ 4 g/ha at 15 DAS	58.1	59.5	8.9	8.8	71.1	75.2
Stale seed bed + smother crop (cowpea) in between two rows of rice	57.9	59.9	8.5	8.8	70.6	74.6
Stale seed bed + one hand weeding at 30 DAS	56.3	61.1	8.1	8.5	68.9	73.0
Sesbania (broadcast) @ 25 kg/ha during sowing of rice + 2,4-D @ 500 g/ha at 25 DAS	55.9	57.3	8.1	8.4	71.0	69.9
Hand weeding at 15, 30 and 45 DAS	90.5	95.2	13.4	13.9	100.6	105.8
Weedy check	32.1	32.6	4.9	4.8	51.0	50.1
<b>S. Em (±)</b>	2.8	3.0	0.6	0.5	4.0	3.5
<b>CD(P=0.05)</b>	8.4	8.9	1.7	1.5	11.8	10.4
<b>CV (%)</b>	7.6	7.5	11.1	9.1	9.2	7.5

It was evident that with minimum weeds to compete with, and share resources, the uptake of nutrients by the crop was facilitated, resulting in more vigorous crop growth and better yield under such treatments. Higher nutrient uptake of crop in these treatments was mainly attributed to lower weed population and weed dry weight and this helped the crop to grow well and absorb more nutrients from the soil. These results are in line with Sunil *et al.* (2011).

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