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Effect of different weed management practices on the weed population dynamics of direct seeded upland rice under Tripura condition

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ABSTRACT

A field experiment was conducted at Krishi Vigyan Kendra, South Tripura during the *kharif* (wet) season of 2013 and 2014 to study the influence of different weed management practices on weed population dynamics of direct seeded upland rice under Tripura condition. The experiment consisted of twelve treatments laid out in a randomized complete block design with three replication. Among the various treatments, pendimethalin @ 1.0 kg ha^{-1} at 2 Days After Sowing (DAS) + bispyribac sodium @ 25 g ha^{-1} at 20 DAS (T_4) recorded the lowest number of all weeds in both the years followed by pendimethalin @ 1.0 kg ha^{-1} at 2 DAS + one hand weeding at 30 DAS (T_3). At 60 and 90 DAS, lowest weeds population was recorded by hand weeding thrice at 15, 30 and 45 DAS (T_{11}). The highest net return and benefit cost ratio was observed with the treatment pendimethalin @ 1.0 kg ha^{-1} at 2 DAS + bispyribac sodium @ 25 g ha^{-1} at 20 DAS.

1. Introduction

Rice (*Oryza sativa* L.) is the most important staple food for more than half of the world's population, including regions of high population density and rapid growth. India has the largest area among rice growing countries and stands second in production. Expansion in the irrigated area, introduction of early maturing rice cultivars, availability of selective herbicides for weed management together with increasing transplanting cost and declining profitability of transplanted rice production system have encouraged rice farmers to shift from transplanting to direct seeding (Subbaiah *et al*. 1999). Globally, actual rice yield losses due to pests have been estimated at 40%, of which weeds have the highest loss potential (32%). The worldwide estimated loss in rice yield from weeds is around 10% of the total production (Oerke and Dehne 2004). However, for cultivation of direct-seeded rice, weeds are a major hurdle as nearly all *Kharif* season weeds depending upon seed bank in the field infest this crop.

2. Materials and Methods

A field experiment was conducted at Krishi Vigyan Kendra, South Tripura under ICAR(RC) for NEH Region during the *kharif* (wet) season of 2013 and 2014 to study the influence of different weed management practices on weed population dynamics of direct seeded upland rice under Tripura condition. Twelve treatments *viz.* pendimethalin @ 1.0 kg ha^{-1} at 2 Days After Sowing (DAS) (T_1), bispyribac sodium @ 25 g ha^{-1} at 25 DAS (T_2), pendimethalin @ 1.0 kg ha^{-1} at 2 DAS+ one hand weeding at 30 DAS (T_3), pendimethalin @ 1.0 kg ha^{-1} at 2 DAS + bispyribac sodium @ 25 g ha^{-1} at 20 DAS (T_4), metsulfuron methyl+ chlorimuron ethyl (Almix) @ 4 g at 10 DAS followed by bispyribac sodium @ 25 g at 20 DAS (T_5), pyrazosulfuron ethyl @ 25 g ha^{-1} at 3 DAS followed by bispyribac sodium @ 25 g at 20 DAS (T_6), fenoxaprop-p-ethyl @ 60 g ha^{-1} + metsulfuron methyl + chlorimuron ethyl (Almix) @ 4 g ha^{-1} at 15 DAS (T_7) , stale seed bed + smother crop (cowpea) in between two rows of rice (T_8), stale seed bed + one hand weeding at 30 DAS (T_9), sesbania (broadcast) @ 25 kg ha^{-1} during sowing of rice + 2,4-D @ 500 g ha^{-1} at 25 DAS (T_{10}), hand weeding at 15, 30 and 45 DAS (T_{11}),

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weedy check (T_{12}) were assigned in a 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 (80:40:40 NPK ha^{-1}). Five tonnes of 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 in the form of single superphosphate and 40 kg potassium 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. Data on yield attributes, grain yield, straw yield 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. Result and discussion

The experimental field was infested with different weed flora namely *Amaranthus viridis, Oldenlendia corymbosa, Spilanthes acmella, Ludwigia parviflora, Cleome rutidosperma, Malvestrum coromondalianeum* among the broad leaf weed, *Digitaria sanguinalis* among grasses and *Cyperus iria* among sedges. Similar weed flora in direct seeded rice was also reported by many workers like Duary *et al*. (2005), Maity and Mukherjee (2009), Chauhan and Opena (2012) and Kashid *et al*. (2015).

Effect on weed density

The effect of various weed management practices on weed density of grassy, broad leaved weed and sedges at different stages showed highly significant during both the years. Among the various treatment tested, all weed management practices resulted in significant reduction in weed density as compared to weedy check. At 30 DAS, the highest number of grassy, broad leaved and sedges were recorded with weedy check treatment. Among the other treatments, pendimethalin @ 1.0 kg ha^{-1} at 2 DAS + bispyribac sodium @ 25 g ha^{-1} at 20 DAS recorded the lowest number of all weed in both the years but in the second year this particular treatment was at par with pendimethalin @ 1.0 kg ha^{-1} + one hand weeding at 30 DAS (Table 1). There was no remarkable changes in the weed density between two years.

Table 1. Effect of treatments on weed density at 30 DAS

Treatment	Weed density (No. m^{-2}) at 60 DAS							
	2013				2014			
	Grasses	BLW	Sedges	Total	Grasses	BLW	Sedges	Total
Pendimethalin @ 1.0 kg ha^{-1} at 2 Days After Sowing (DAS)	3.29 (10.33)	2.47 (5.66)	3.93 (15.00)	5.61 (31.00)	3.08 (9.00)	2.18 (4.33)	3.71 (13.33)	5.20 (26.66)
Bispyribac sodium @ 25 g ha^{-1} at 25 DAS	4.38 (18.66)	3.72 (13.33)	2.90 (8.00)	6.36 (40.00)	4.18 (17.00)	3.53 (12.00)	2.67 (6.66)	6.01 (35.67)
Pendimethalin @ 1.0 kg ha^{-1} at 2 DAS+ one hand weeding at 30 DAS	3.17 (9.66)	2.48 (5.66)	3.53 (12.00)	5.27 (27.33)	2.02 (3.66)	1.95 (3.33)	3.28 (10.33)	4.22 (17.33)
Pendimethalin @ 1.0 kg ha^{-1} at 2 DAS + bispyribac sodium @ 25 g ha^{-1} at 20 DAS	2.47 (5.66)	2.60 (6.33)	3.07 (9.00)	4.62 (21.00)	2.18 (4.33)	2.26 (4.66)	2.84 (7.66)	4.12 (16.66)
Metsulfuron methyl + chlorimuron ethyl (Almix) @ 4 g at 10 DAS followed by bispyribac sodium @ 25 g at 20 DAS	3.97 (15.33)	2.85 (7.66)	2.47 (5.66)	5.40 (28.66)	3.75 (13.66)	2.73 (7.00)	2.26 (4.66)	5.08 (25.33)
Pyrazosulfuron ethyl @ 25 g ha^{-1} at 3 DAS followed by bispyribac sodium @ 25 g at 20 DAS	3.07 (9.00)	2.96 (8.33)	3.18 (9.66)	5.24 (27.00)	2.79 (7.33)	2.79 (7.33)	2.91 (8.00)	4.80 (22.66)
Fenoxaprop-p-ethyl @ 60 g ha^{-1} + metsulfuron methyl + chlorimuron ethyl (Almix) @ 4 g ha^{-1} at 15 DAS	2.72 (7.00)	3.62 (12.66)	2.47 (5.66)	5.08 (25.33)	2.53 (6.00)	3.34 (10.66)	2.11 (4.00)	4.60 (20.66)
Stale seed bed + smother crop (cowpea) in between two rows of rice	3.29 (10.33)	3.58 (12.33)	3.33 (10.66)	5.81 (33.33)	2.96 (8.33)	3.33 (10.66)	3.18 (9.66)	5.40 (28.66)
Stale seed bed + one hand weeding at 30 DAS	3.22 (10.00)	3.33 (10.66)	3.58 (12.33)	5.79 (33.00)	3.01 (8.66)	3.06 (9.00)	3.33 (10.66)	5.37 (28.33)

Sesbania (broadcast) @ 25 kg ha^{-1} during sowing of rice + 2,4-D @ 500 g ha^{-1} at 25 DAS	4.98 (24.33)	3.44 (11.33)	3.85 (14.33)	7.11 (50.00)	4.77 (22.33)	3.13 (9.33)	3.58 (12.33)	6.67 (44.00)
Hand weeding at 15, 30 and 45 DAS	0.71 (0)	0.71 (0)	0.71 (0)	0.71 (0)	0.71 (0)	0.71 (0)	0.71 (0)	0.71 (0)
Weedy Check	5.34 (28.00)	5.30 (27.66)	4.52 (20.00)	8.73 (75.66)	5.24 (27.00)	5.18 (26.33)	4.34 (18.33)	8.49 (71.66)
S. Em (±)	0.17	0.14	0.15	0.14	0.18	0.15	0.16	0.15
CD(P=0.05)	0.50	0.42	0.46	0.43	0.53	0.46	0.47	0.44
CV (%)	8.75	8.11	8.68	4.66	10.14	9.67	9.73	5.18

At 60 DAS, hand weeding thrice at 15, 30 and 45 DAS recorded the lowest population of total weed. Among the other treatments, pendimethalin @ 1.0 kg ha^{-1} + one hand weeding at 30 DAS registered the lowest population of total weed and was statistically at par with pendimethalin @ 1.0 kg ha^{-1} at 2 DAS + bispyribac sodium @ 25 g ha^{-1} at 20 DAS treatment during both the years. All the treatments were significantly superior to the weedy check (Table 2).

Table 2. Effect of treatments on weed density at 60 DAS

Treatment	**Weed density (No. m^{-2}) at 60 DAS**							
	2013				**2014**			
	Grasses	**BLW**	**Sedges**	**Total**	**Grasses**	**BLW**	**Sedges**	**Total**
Pendimethalin @ 1.0 kg ha^{-1} at 2 Days After Sowing (DAS)	16.33	18.00	25.67	60.00	15.00	16.67	24.33	56.00
Bispyribac sodium @ 25 g ha^{-1} at 25 DAS	22.33	22.67	12.33	57.33	20.67	21.00	10.67	52.33
Pendimethalin @ 1.0 kg ha^{-1} at 2 DAS+ one hand weeding at 30 DAS	10.33	9.00	13.00	32.33	8.67	7.67	11.33	27.67
Pendimethalin @ 1.0 kg ha^{-1} at 2 DAS + bispyribac sodium @ 25 g ha^{-1} at 20 DAS	10.33	10.00	13.33	33.67	10.00	8.67	12.67	31.33
Metsulfuron methyl + chlorimuron ethyl (Almix) @ 4 g at 10 DAS followed by bispyribac sodium @ 25 g at 20 DAS	21.00	21.67	12.67	55.33	19.33	20.00	11.00	50.33
Pyrazosulfuron ethyl @ 25 g ha^{-1} at 3 DAS followed by bispyribac sodium @ 25 g at 20 DAS	13.00	17.67	18.33	49.00	11.33	16.00	16.33	43.67
Fenoxaprop-p-ethyl @ 60 g ha^{-1} + metsulfuron methyl + chlorimuron ethyl (Almix) @ 4 g ha^{-1} at 15 DAS	18.33	19.67	17.67	55.67	16.33	17.67	15.67	49.67
Stale seed bed + smother crop (cowpea) in between two rows of rice	30.33	20.00	28.00	78.33	28.33	18.33	26.33	73.00
Stale seed bed + one hand weeding at 30 DAS	22.33	21.67	22.00	66.00	20.33	20.33	20.33	61.00
Sesbania (broadcast) @ 25 kg ha^{-1} during sowing of rice + 2,4-D @ 500 g ha^{-1} at 25 DAS	32.00	17.00	28.00	77.00	29.67	15.33	26.33	71.33
Hand weeding at 15, 30 and 45 DAS	8.00	6.67	4.67	19.33	7.00	7.00	3.33	17.33
Weedy Check	42.33	34.33	35.67	112.33	40.67	32.33	34.33	107.33

S. Em (±)	1.27	1.11	1.22	1.41	1.21	1.04	1.19	1.41
CD(P=0.05)	3.74	3.26	3.58	4.14	3.57	3.06	3.49	4.14
CV (%)	10.75	10.59	10.98	4.22	11.13	10.81	11.63	4.58

At 90 DAS, weed density varied significantly with different treatments as evident from the data presented in Table 3. The highest population of weeds was recorded with weedy check. The lowest population of weeds was recorded in the treatment hand weeding at 15, 30 and 45 DAS in both the years. Among the other treatments, pendimethalin @ 1.0 kg ha^{-1} + one hand weeding at 30 DAS registered the lowest number of total weed and was at par with pendimethalin @ 1.0 kg ha^{-1} at 2 DAS + bispyribac sodium @ 25 g ha^{-1} at 20 DAS during both the years (Table 3).

Table 3. Effect of treatments on weed density at 90 DAS

Treatment	**Weed density (No. m^{-2}) at 60 DAS**							
	2013				**2014**			
	Grasses	**BLW**	**Sedges**	**Total**	**Grasses**	**BLW**	**Sedges**	**Total**
Pendimethalin @ 1.0 kg ha^{-1} at 2 Days After Sowing (DAS)	16.67	17.67	26.67	61.00	15.00	16.33	25.00	56.33
Bispyribac sodium @ 25 g ha^{-1} at 25 DAS	22.67	22.67	16.67	62.00	21.33	21.00	15.00	57.33
Pendimethalin @ 1.0 kg ha^{-1} at 2 DAS+ one hand weeding at 30 DAS	9.67	10.00	12.33	32.00	7.67	9.00	11.33	28.00
Pendimethalin @ 1.0 kg ha^{-1} at 2 DAS + bispyribac sodium @ 25 g ha^{-1} at 20 DAS	9.33	11.67	13.00	34.00	9.33	9.67	11.43	30.33
Metsulfuron methyl + chlorimuron ethyl (Almix) @ 4 g at 10 DAS followed by bispyribac sodium @ 25 g at 20 DAS	20.67	19.33	12.00	52.00	19.33	17.33	10.33	47.00
Pyrazosulfuron ethyl @ 25 g ha^{-1} at 3 DAS followed by bispyribac sodium @ 25 g at 20 DAS	18.33	18.67	20.67	57.67	17.67	17.00	19.00	53.67
Fenoxaprop-p-ethyl @ 60 g ha^{-1} + metsulfuron methyl + chlorimuron ethyl (Almix) @ 4 g ha^{-1} at 15 DAS	21.00	20.67	18.00	59.67	19.33	19.00	16.33	54.67
Stale seed bed + smother crop (cowpea) in between two rows of rice	32.00	22.67	29.33	84.00	30.33	21.00	27.33	78.67
Stale seed bed + one hand weeding at 30 DAS	29.00	23.67	23.67	76.33	27.33	22.00	21.67	71.00
Sesbania (broadcast) @ 25 kg ha^{-1} during sowing of rice + 2,4-D @ 500 g ha^{-1} at 25 DAS	35.33	20.67	29.33	85.33	34.00	19.00	27.33	80.33
Hand weeding at 15, 30 and 45 DAS	8.33	8.33	4.33	21.00	7.33	7.00	4.00	18.33
Weedy Check	41.67	35.33	37.33	114.33	40.67	34.00	35.33	110.00
S. Em (±)	1.25	1.04	1.05	1.95	1.04	1.05	1.08	1.76
CD(P=0.05)	3.68	3.06	3.09	5.73	3.07	3.09	3.19	5.18
CV (%)	9.85	9.40	9.02	5.49	8.73	10.33	10.09	5.35

The data on grain yield and straw yield of rice varied significantly among the treatments in both the years (Table 4). There was a drastic reduction in grain yield in the weedy check plot and it was to the tune of 83.19% in the first year and 79.44% in the second year. Similar results were observed by Naresh *et al*. (2011) and Mathew *et al*. (2013). Among the various treatment, hand weeding at 15, 30 and 45 DAS recorded the highest grain and straw yield of upland rice and it was statistically at par with pendimethalin @ 1.0 kg ha^{-1} + one hand weeding at 30 DAS and pendimethalin @ 1.0 kg ha^{-1} at 2 DAS + bispyribac sodium @ 25 g ha^{-1} at 20 DAS during both the years (Table 4). The competition between rice and weed for nutrient, water, light and space was less under the above treatments, which facilitated greater utilization of sun light, higher synthesis of carbohydrate and better partitioning of photosynthates towards grain formation and ultimately leading to higher grain yield of rice. Sardana *et al*.(2004) reported that integrated weed management resulted in lower weed dry matter and higher number of panicles, panicle length and more number of grains panicle^{-1}, 1000 grain weight and grain yield. All other treatments were significantly superior than the weedy check .

Table 4. Effect of weed management practices on grain yield, straw yield and harvest index of direct seeded upland rice

Treatment	Grain yield (t ha^{-1})		Straw yield (t ha^{-1})		Economics			
					Net return		Return Rupee^{-1} invested	
	2013	2014	2013	2014	2013	2014	2013	2014
Pendimethalin @ 1.0 kg ha^{-1} at 2 Days After Sowing (DAS)	2.15	2.36	3.89	4.21	11337	14297	1.55	1.70
Bispyribac sodium @ 25 g ha^{-1} at 25 DAS	2.21	2.26	3.65	4.22	10650	11830	1.49	1.54
Pendimethalin @ 1.0 kg ha^{-1} at 2 DAS+ one hand weeding at 30 DAS	3.30	3.59	5.03	5.28	21427	25573	1.81	1.96
Pendimethalin @ 1.0 kg ha^{-1} at 2 DAS + bispyribac sodium @ 25 g ha^{-1} at 20 DAS	3.26	3.41	4.87	5.17	23847	26010	2.02	2.11
Metsulfuron methyl + chlorimuron ethyl (Almix) @ 4 g at 10 DAS followed by bispyribac sodium @ 25 g at 20 DAS	2.49	2.65	3.72	4.65	13488	16542	1.60	1.73
Pyrazosulfuron ethyl @ 25 g ha^{-1} at 3 DAS followed by bispyribac sodium @ 25 g at 20 DAS	2.71	2.80	4.04	4.81	16637	18490	1.73	1.82
Fenoxaprop-p-ethyl @ 60 g ha^{-1} + metsulfuron methyl + chlorimuron ethyl (Almix) @ 4 g ha^{-1} at 15 DAS	1.89	1.98	3.82	3.98	7908	9188	1.39	1.45
Stale seed bed + smother crop (cowpea) in between two rows of rice	1.86	2.01	3.79	4.01	4493	6613	1.19	1.28
Stale seed bed + one hand weeding at 30 DAS	1.86	2.10	3.71	3.89	1857	5203	1.07	1.20
Sesbania (broadcast) @ 25 kg ha^{-1} during sowing of rice + 2,4-D @ 500 g ha^{-1} at 25 DAS	1.81	1.93	3.75	3.74	7490	9083	1.38	1.46
Hand weeding at 15, 30 and 45 DAS	3.45	3.60	5.16	5.43	17620	19713	1.54	1.61
Weedy Check	0.58	0.74	2.90	2.80	-5347	-3450	0.66	0.78
S. Em (±)	0.11	0.13	0.22	0.17	1609	1783	0.07	0.08
CD(P=0.05)	0.34	0.37	0.64	0.49	4719	5230	0.22	0.23
CV (%)	8.62	8.93	9.40	6.70	25.45	23.29	8.39	8.95

The data on net return and return per rupee invested expressed that pendimethalin @ 1.0 kg ha^{-1} at 2 DAS + bispyribac sodium @ 25 g ha^{-1} 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 (2.02 and 2.11) in both the years and was found to be the most remunerative weed management practices (Table 4). The herbicide pendimethalin @ 1.0 kg ha^{-1} + 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 and comparatively lower cost involved in the cultivation of crop under these treatments. Similar result was reported by Yakadri *et al.* (2016). Weedy check fetched the negative net return. This is due to greater competition between rice and weed which led to poor growth of the crop, lower grain and straw yield. This again emphasized the importance of weed management for profitable rice production.

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