



Influence of Establishment Methods and Weed Management Practices on Nutrient Removal by Weeds and Uptake by Rice in Puddled Lowland

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Field experiments were conducted at Tamil Nadu Agricultural University, Coimbatore, India during *kharif* 2008 and *rabi* 2008-09 to find out the nutrient removal by weeds and uptake by crop in puddled lowland rice under different rice establishment methods and weed management practices. The experiments were laid out in a strip plot design, replicated thrice. Four crop establishment methods (System of Rice Intensification (SRI), Transplanting, Direct Planting System (DPS) and Drum seeding) and four weed management practices (pre-emergence pyrazosulfuron ethyl 30 g ha⁻¹ at 3 DAT / 8 DAS + weeding with finger type double row rotary weeder at 40 DAT/DAS, weeding with conoweeder twice at 20 and 40 DAT/DAS, two hand weeding at 20 and 40 DAT/DAS and un-weeded control) were taken up for the experiments. Direct planting system recorded significantly lower N, P₂O₅ and K₂O removal by weeds due to lower weed density and dry weight and was followed by system of rice intensification during both the seasons. In weed management practices, conoweeder twice at 20 and 40 DAT/S registered conspicuously lesser nutrient removal by weeds than other treatments. SRI showed significantly higher uptake of N, P₂O₅ and K₂O by crop and consequently recorded significantly higher yield during both the seasons. In weed management practices, weeding with conoweeder twice at 20 and 40 DAT/DAS recorded significantly higher uptake of N, P₂O₅ and K₂O by crop and registered higher yield.

Key words: Crop establishment methods, weed management practices, nutrient removal, yield, rice.

Rice is a predominant food crop of India contributing 45 per cent of the total food grain production. Tamil Nadu alone contributes nearly eight per cent of the national rice production from an area of 2.07 million hectares, with a production of 7.15 million tonnes (Ministry of Agriculture, 2010). Rice crop suffers from various biotic and abiotic production stresses. Weed competition is one of the leading yield-limiting biotic stresses in rice cultivation. Weeds compete with crops for resources such as water, light, nutrients and space. Early emergence of weeds along with crop seedlings and their rapid growth results in a severe crop-weed competition for resources in low land rice. Singh *et al.* (2002) reported that weeds remove nutrients (N, P and K) eight times higher under direct seeded rice compared to that of puddled transplanting.

There is paucity of information on different weed management practices for different rice establishment methods on nutrient removal by weeds and uptake by crop. Hence a research work was conducted to study the effect of establishment methods and weed management practices on nutrient removal by weeds and uptake by crop in puddled lowland rice.

Materials and Methods

Field experiments were conducted during *kharif* 2008 and *rabi* 2008-09 at Tamil Nadu Agricultural University, Coimbatore. The soil was clay loam with pH 8.1 during *kharif* and 7.9 during *rabi*. The fertility status of the soil was low, medium and high in the available N, P₂O₅, and K₂O, respectively. Short duration rice cultivars ADT 43 and CO 43 were used during *kharif* 2008 and *rabi* 2008 -09, respectively. The experiments were laid out in strip plot design with three replications in both the seasons. The four crop establishment methods (System of Rice Intensification, Transplanting, Direct Planting System and Drum seeding) and four weed management practices (Pre-emergence pyrazosulfuron ethyl 30 g ha⁻¹ at 3 days after transplanting (DAT) / 8 days after sowing (DAS) + weeding with finger type double row rotary weeder at 40 DAT/DAS, weeding with conoweeder twice at 20 and 40 DAT/DAS, two hand weeding at 20 and 40 DAT/DAS and un-weeded control) were allotted to main and sub plot, respectively. The rice crop was raised with the seed rate of 5 kg, 60 kg, 30 kg and 86 kg ha⁻¹ for SRI, transplanting, DPS and drum seeding, respectively. Fertilizers were applied at the rate of 150: 50: 50 kg of N, P₂O₅ and K₂O ha⁻¹, respectively.

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Weed samples were taken in each plot at four randomly selected spots using a quadrant of 0.25 m² area and crop samples were taken from sampling row. These were air dried and then oven dried and ground in a Willey mill and analysed for nitrogen (Humphries, 1956), phosphorus (Jackson, 1973) and potassium (Jackson, 1973) content in weeds and crop and worked out nutrient removal by weeds and uptake by crop.

Table 1. Effect of crop establishment methods and weed management practices on N, P₂O₅ and K₂O removal (kg ha⁻¹) on 60 DAT/DAS by weeds in rice during *kharif* 2008

Treatment	N					P ₂ O ₅					K ₂ O						
	M ₁	M ₂	M ₃	M ₄	Mean	M ₁	M ₂	M ₃	M ₄	Mean	M ₁	M ₂	M ₃	M ₄	Mean		
W ₁	1.31	2.00	1.90	2.38	1.90	0.50	0.79	0.66	1.00	0.73	0.48	0.68	0.56	0.82	0.63		
W ₂	1.60	1.70	1.28	2.27	1.71	0.61	0.70	0.50	0.98	0.69	0.58	0.63	0.47	0.75	0.60		
W ₃	1.66	2.10	1.62	2.43	1.95	0.67	0.74	0.58	0.92	0.72	0.59	0.65	0.50	0.70	0.61		
W ₄	81.66	85.30	80.26	87.50	83.68	9.95	10.30	9.76	11.16	10.29	52.10	59.41	46.03	64.80	55.58		
Mean	21.56	22.77	21.26	23.64		2.93	3.13	2.87	3.51		13.43	15.34	11.89	16.76			
Interaction effect																	
	SEd	CD (P = 0.05)					SEd	CD (P = 0.05)					SEd	CD (P = 0.05)			
M	1.33	NS				M	0.09	0.28				M	0.51	1.61			
W	0.68	2.15				W	0.04	0.13				W	0.30	0.95			
M at W	2.91	NS				M at W	0.29	NS				M at W	1.02	3.26			
W at M	2.67	NS				W at M	0.19	NS				W at M	0.94	2.99			

M₁ - SRI W₁ - Pyrazosulfuron-ethyl 30 g ha⁻¹ at 3 DAT / 8 DAS + Finger type double row rotary weeder weeding at 40 DAT/S

M₂ - Transplanted W₂ - Conoweeder weeding at 20 and 40 DAT/S

M₃ - DPS W₃ - Two hand weeding at 20 and 40 DAT/S

M₄ - Drum seeded W₄ - Un-weeded control

the experimental fields were *Echinochloa crus-galli*, (L.) Beauv. among grasses, *Cyperus difformis* (L.) and *Fimbristylis miliacea* (L.) among sedges and *Eclipta alba* (L.) and *Ammania baccifera* among broad leaved weeds.

Table 2. Effect of crop establishment methods and weed management practices on N, P₂O₅ and K₂O removal (kg ha⁻¹) on 60 DAT/DAS by weeds in rice during *rabi* 2008 - 09

Treatment	N					P ₂ O ₅					K ₂ O						
	M ₁	M ₂	M ₃	M ₄	Mean	M ₁	M ₂	M ₃	M ₄	Mean	M ₁	M ₂	M ₃	M ₄	Mean		
W ₁	1.73	2.55	1.82	2.81	2.22	0.30	0.83	0.57	1.58	0.82	0.36	0.64	0.54	0.91	0.61		
W ₂	2.00	2.17	1.59	2.50	2.06	0.49	0.64	0.40	1.13	0.66	0.41	0.56	0.39	0.69	0.51		
W ₃	2.10	2.23	1.65	2.62	2.15	0.58	0.67	0.46	1.40	0.77	0.58	0.60	0.43	0.76	0.59		
W ₄	70.51	79.20	67.74	84.12	75.39	8.15	9.00	7.91	9.66	8.68	50.57	57.09	45.11	62.59	53.84		
Mean	19.08	21.53	18.20	23.01		2.38	2.78	2.33	3.44		12.98	14.72	11.61	16.24			
Interaction effect																	
	SEd	CD (P = 0.05)					SEd	CD (P = 0.05)					SEd	CD (P = 0.05)			
M	0.80	2.54				M	0.10	0.33				M	0.54	1.70			
W	0.46	1.47				W	0.09	0.28				W	0.45	1.42			
M at W	1.68	5.34				M at W	0.23	NS				M at W	1.08	3.44			
W at M	1.55	4.92				W at M	0.22	NS				W at M	1.04	3.30			

M₁ - SRI W₁ - Pyrazosulfuron-ethyl 30 g ha⁻¹ at 3 DAT / 8 DAS + Finger type double row rotary weeder weeding at 40 DAT/S

M₂ - Transplanted W₂ - Conoweeder weeding at 20 and 40 DAT/S

M₃ - DPS W₃ - Two hand weeding at 20 and 40 DAT/S

M₄ - Drum seeded W₄ - Un-weeded control

K₂O removal by weeds at 60 DAT/DAS in both the seasons (Table 1 and 2) due to the reason that weed growth was faster than crop in direct seeded rice and absorb added nutrients more rapidly and in larger quantities than by crops. Singh *et al.* (2002) reported that weeds remove nutrients (N, P and K) eight times higher under direct seeded rice compared to that of puddled transplanting.

Direct planting system recorded distinctly lower removal of N, P₂O₅ and K₂O at 60 DAT/DAS in both

Results and Discussion

Weed flora

Broad-spectrum of weed flora consisting of two species of grass weeds, four species of sedge weeds and five species of broad leaved weeds were found in the experimental fields during *kharif* 2008 and *rabi* 2008-09. Predominant weeds found in both

Nutrient removal by weeds

Crop establishment techniques

Among crop establishment methods, drum seeding recorded significantly higher N, P₂O₅ and

the seasons by weeds due to lower weed density and dry weight (Table 4 and 5).

Weed management practices

The nutrient removal by weeds varied significantly among weed management practices. Conoweeder twice at 20 and 40 DAT/DAS registered lesser nutrient removal by weeds which might be owing to the reason that conoweeder operation destroyed the weeds considerably, so that the nutrient uptake by crop was increased than that by

Table 3. Effect of crop establishment methods and weed management practices on N, P₂O₅ and K₂O uptake (kg ha⁻¹) on 60 DAT/DAS by rice during *kharif* 2008 and *rabi* 2008-09

Treatment	Kharif 2008			Rabi 2008-09		
	N	P ₂ O ₅	K ₂ O	N	P ₂ O ₅	K ₂ O
Establishment techniques						
M ₁ - System of Rice Intensification (SRI)	65.9	23.27	110.3	63.5	21.3	110.1
M ₂ - Transplanting (Conventional)	64.2	22.59	108.4	61.8	20.3	106.4
M ₃ - Direct Planting System (DPS)	65.0	23.03	109.8	63.2	21.1	108.8
M ₄ - Drum seeded rice (Sprouted seeds)	59.9	20.00	103.5	57.6	18.5	101.3
SEd	1.6	0.80	1.7	1.5	0.6	2.2
CD (P = 0.05)	5.1	2.56	5.5	4.8	1.9	6.9
Weed management practices						
W ₁ - Pre-emergence pyrazosulfuron ethyl + Finger type double row rotary weeder weeding on 40 DAT/S.	74.5	26.56	120.0	72.6	24.3	118.9
W ₂ - Conoweeder weeding on 20 and 40 DAT/S.	76.8	28.19	122.7	74.6	25.9	121.4
W ₃ - Two hand weeding at 20 and 40 DAT/S.	74.9	27.21	121.1	72.7	24.6	119.2
W ₄ - Un-weeded control	28.9	6.93	68.1	26.3	6.2	66.9
SEd	1.9	0.71	2.7	1.5	0.5	4.1
CD (P = 0.05)	6.3	2.25	8.6	4.9	1.7	12.9

Interaction effect was not significant at 5 per cent probability level.

weeds. Higher nutrient removal by weeds was observed in application of pyrazosulfuron-ethyl 30 g ha⁻¹ at 3 DAT/8 DAS + weeding with finger type double row rotary weeder at 40 DAT/DAS among other weed management practices except un- weeded control might be due to the reason that the pyrazosulfuron-ethyl 30 g ha⁻¹ at 3 DAT/8 DAS controlled weeds at early stage. After that the weeds were removed only at 40 DAT/DAS with finger type double row rotary weeder which revealed that weeds were not

controlled effectively. The pattern of nutrient removal by weeds showed that wherever effective weed control was possible the nutrient loss due to weeds was less.

Interaction effect

In a given establishment method, direct planting system recorded significantly lower nutrient removal with conoweeder twice at 20 and 40 DAT/DAS and was comparable with other treatments except in un-

Table 4. Effect of crop establishment methods and weed management practices on total weed density (No.m⁻²) on 60 DAT/DAS in rice during *kharif* 2008 and *rabi* 2008-09

Treatment	Kharif 2008					Rabi 2008 - 09				
	M ₁	M ₂	M ₃	M ₄	Mean	M ₁	M ₂	M ₃	M ₄	Mean
W ₁	4.42 (19.57)	5.96 (35.53)	4.80 (23.05)	7.55 (57.03)	5.68 (33.80)	6.27 (21.83)	6.27 (39.30)	4.84 (23.40)	7.43 (55.19)	5.80 (34.93)
W ₂	5.81 (33.91)	6.64 (44.13)	5.26 (27.67)	7.81 (60.93)	6.38 (41.66)	6.19 (38.39)	7.10 (50.40)	5.67 (32.17)	7.94 (63.17)	6.72 (46.03)
W ₃	5.26 (27.67)	6.21 (38.62)	4.96 (24.60)	7.39 (55.37)	5.96 (36.57)	5.39 (29.10)	6.24 (39.00)	4.95 (24.53)	7.27 (53.60)	5.97 (36.56)
W ₄	11.22 (126.01)	11.37 (129.30)	10.60 (112.31)	12.66 (160.34)	11.46 (131.99)	11.55 (133.45)	12.95 (167.63)	10.53 (110.93)	13.82 (191.34)	12.21 (150.84)
Mean	6.68 (51.79)	7.55 (61.90)	6.40 (46.91)	8.85 (83.42)		6.95 (55.69)	8.14 (74.08)	6.50 (47.76)	9.12 (90.82)	
	SEd		CD (P = 0.05)			SEd		CD (P = 0.05)		
M	0.08		0.26			M		0.06		
W	0.13		0.40			W		0.13		
M at W	0.29		NS			M at W		0.32		
W at M	0.31		NS			W at M		0.34		

M₁ - SRI W- Pyrazosulfuron-ethyl 30 g ha⁻¹ at 3 DAT / 8 DAS + Finger type double row rotary weeder weeding at 40 DAT/S

M₂ - Transplanted W₂- Conoweeder weeding at 20 and 40 DAT/S

M₃ - DPS W₃- Two hand weeding at 20 and 40 DAT/S

M₄ - Drum seeded W₄- Un-weeded control

weeded control for all the establishment methods in both the seasons.

In a given weed management practice, for un-weeded control, drum seeding recorded significantly higher nutrient removal and was comparable with transplanting. For weeding with conoweeder twice at 20 and 40 DAT/DAS and hand weeding twice at 20 and 40 DAT/DAS, direct planting system recorded significantly lower nutrient removal and was

comparable with other treatments in both the seasons.

Nutrient uptake by crops

Crop establishment methods

Among the establishment methods, system of rice intensification showed significantly higher uptake of N, P₂O₅ and K₂O by crop at 60 DAT/DAS in both the seasons due to deeper and proliferate root

Table 5. Effect of crop establishment methods and weed management practices on total weed dry weight (kg ha⁻¹) on 60 DAT/DAS in rice during *kharif* 2008 and *rabi* 2008-09

Treatment	Kharif 2008					Rabi 2008 - 09				
	M ₁	M ₂	M ₃	M ₄	Mean	M ₁	M ₂	M ₃	M ₄	Mean
W ₁	9.5 (92.0)	12.0 (146.0)	10.4 (109.0)	13.7 (189.0)	11.4 (134.0)	8.8 (77.0)	11.7 (137.3)	8.6 (74.0)	13.0 (169.7)	10.5 (114.5)
W ₂	11.8 (142.0)	12.9 (167.0)	10.6 (114.0)	14.5 (211.3)	12.5 (158.5)	10.8 (117.1)	12.1 (147.3)	9.1 (83.7)	14.0 (197.4)	11.5 (136.4)
W ₃	10.8 (117.6)	12.1 (148.0)	9.9 (100.0)	13.4 (182.0)	11.6 (136.9)	9.8 (96.4)	11.5 (132.0)	8.5 (72.7)	13.0 (170.1)	10.7 (117.8)
W ₄	40.4 (1637.0)	43.0 (1857.3)	37.6 (1416.0)	51.2 (2628.0)	43.1 (1884.6)	36.9 (1361.9)	39.4 (1553.8)	34.8 (1214.3)	41.9 (1754.7)	38.3 (1471.2)
Mean	18.1 (497.1)	20.0 (579.5)	17.1 (434.7)	23.2 (802.5)		16.6 (413.1)	18.7 (492.6)	15.3 (361.2)	20.5 (573.0)	
	SEd		CD (P = 0. 05)			SEd		CD (P = 0. 05)		
M	0.3		0.9			M		0.2		
W	0.3		0.8			W		0.2		
M at W	0.7		2.1			M at W		0.7		
W at M	0.7		2.1			W at M		0.7		

M₁ - SRI W₁ - Pyrazosulfuron-ethyl 30 g ha⁻¹ at 3 DAT / 8 DAS + Finger type double row rotary weeder weeding at 40 DAT/S

M₂ - Transplanted W₂ - Conoweeder weeding at 20 and 40 DAT/S

M₃ - DPS W₃ - Two hand weeding at 20 and 40 DAT/S

M₄ - Drum seeded W₄ - Un-weeded control

system enabling them to uptake more nutrients (Table 3). Jayashree Beura and Reddy (2003) has reported better control of weeds and favourable conditions for crop growth resulted in higher nutrient uptake by crop. It was comparable with both transplanting and direct planting system. Drum seeding recorded significantly lower nutrient uptake by crop during both the seasons.

Table 6. Effect of crop establishment methods and weed management practices on Grain yield (kg ha⁻¹) of rice during *kharif* 2008 & *rabi* 2008-09

Treatment	Grain yield (kg ha ⁻¹)	
	Kharif 2008	Rabi 2008-09
Establishment techniques		
M ₁ - System of Rice Intensification (SRI)	5062	4475
M ₂ - Transplanting (Conventional)	4523	4291
M ₃ - Direct Planting System (DPS)	4410	4094
M ₄ - Drum seeded rice (Sprouted seeds)	4225	3967
SEd	84	45
CD (P = 0.05)	267	142
Weed management practices		
W ₁ - Pre-emergence pyrazosulfuron ethyl + Finger type double row rotary weeder weeding on 40 DAT/S.	4996	4645
W ₂ - Conoweeder weeding on 20 and 40 DAT/S.	5271	4947
W ₃ - Two hand weeding at 20 and 40 DAT/S.	5106	4803
W ₄ - Un-weeded control	2847	2432
SEd	112	75
CD (P = 0.05)	358	237

Interaction effect was not significant at 5 per cent probability level.

Weed management practices

Among the weed management practices, weeding with conoweeder twice at 20 and 40 DAT/DAS recorded significantly higher uptake of N, P₂O₅ and K₂O by crop which might be due to the reason that the conoweeding primarily facilitated higher availability of plant nutrients and also incorporation of weeds into soil serves supplemental nutrients to crop throughout the crop growth period. This result was in accordance with the findings of Uphoff (2006) who reported that weeding with rotating hoe actively aerates the soil and at the same time churns weeds back in to the soil to decompose, thereby conserving nutrients.

Conclusion

Among establishment methods, direct planting system recorded significantly lower N, P₂O₅ and K₂O removal by weeds followed by system of rice intensification during both the seasons. In weed management practices, conoweeder twice registered lesser nutrient removal by weeds.

SRI showed higher uptake of N, P₂O₅ and K₂O by crop and recorded significantly higher yield during both the seasons. Drum seeding registered lower uptake of N, P₂O₅ and K₂O by crop during both the seasons. In weed management practices, weeding with conoweeder twice at 20 and 40 DAT/DAS recorded significantly higher uptake of N, P₂O₅ and K₂O by crop and obtained higher yield.

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