Oryza Vol. 48 No. 3, 2011 (222-225)

Influence of nitrogen and weed management practices on productivity and nutrient uptake of wet direct seeded rice

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ABSTRACT

A field experiment was conducted at Pusa (Bihar) during wet season of 2005 and 2006 to evaluate the efficiency of weed management practices under different nitrogen scheduling on weed growth and yield of wet direct seeded rice Twenty five treatment combinations consisted of five weed management practices and five nitrogen scheduling practices. The various weed management treatments significantly decreased the density and dry weight of weed and increased the weed control efficiency, grain and straw yield compared with the unweeded check. Butachlor with Safener combined with one hand weeding, was at par with two hand weeding, recorded maximum values of the entire yield attributes and yield with lesser weed density and dry weight over weedy check. Application of N in 4-5 splits produced maximum grain yield and net return of wet seeded rice.

Key words: *direct-seeded rice, nitrogen scheduling, nutrient uptake, weed management*

Massive migration of labour, creating scarcity during the peak period of transplanting, and escalating labour wages are the new challenges facing rice farmers in the state. Transplanting often gets delayed due to non-availability of labour. The late planted crop has low productivity plant^{-1} due to restricted vegetative growth. Direct seeded rice (DSR) is often smothered by weeds. Heavy weed infestation, owing to non-competitiveness of DSR to weeds, is one of the major constraints in adoption and spread of direct seeding technique of rice cultivation. Direct sown rice on puddled soil faces a severe infestation of weeds which reduce the yield of rice to an extent of 78% (Pattar *et al*., 2005). Nitrogen is a key nutrient in promoting the plant growth and determining the yield level of rice. Recovery of applied nitrogen in rice is very low owing to various losses. Optimization of applied nitrogen at critical growth stage, coinciding with the period of efficient utilization are essential (Pandey *et al*., 2002) to meet the nitrogen requirement of crop throughout the growing season and to minimize N uptake by weeds. Thus, the present experiment was conducted to evaluate the performance of wet direct seeded rice under different nitrogen scheduling and weed management practices and to develop suitable combination of N scheduling and weed management practices.

MATERIALS AND METHODS

A field experiment was conducted during wet seasons of 2005 and 2006 at Rajendra Agricultural University, Pusa (Bihar) in silty loam alkaline soil having pH 8.4 with medium in organic carbon (0.53%) and low in available N (207.4 kg ha^{-1}), P_2O_5 (19.3 kg ha^{-1}) and K_2O (125.8 kg ha^{-1}) content. The experiment was laid out in randomized block design with three replication, comprising five methods of nitrogen scheduling, viz. N_1- Control, N_2- ½ at sowing(s) + ¼ Tillering (T) + ¼ panicle initiation (PI), N_3 – ½ Early tillering(20 days after sowing- ET) + ¼ Tillering + ¼ PI, N_4 – ¼ ET + ¼ Tillering + ¼ PI + ¼ panicle emergence (PE), N_5 – 1/5 sowing + 1/5 ET + 1/5 T + 1/5 PI + 1/5 PE and 5-weed management practices, viz. W_1 – Butachlor @ 1.5 kg a.i/ha with safener, W_2 – W_1 + 1 Hand weeding 30 days after sowing (DAS), W_3 – 2.Hand weeding (20 DAS & 40 DAS), W_4 – Hand weeding once (25 DAS), W_5 – Weedy check. The entire quantity of phosphorus as single superphosphate was applied as basal. Potassium (75% as Basal + 25% at PI) as muriate of potash and nitrogen as per treatment through urea along with 25 kg $ZnSO_4$ ha^{-1} were applied. Pre-germinated sprouted seeds of rice var. 'Rajendra kasturi' was sown in the second week of June during both the years with seed rate 80 kg ha^{-1}. Nitrogen, phosphorus and potassium contents of grain and straw of rice were estimated by standard methods. The yield parameters and yields were recorded and economics was worked out. Observation on weeds density and dry weight were recorded at 60 days after sowing by placing a quadrate of 1m x 1m randomly at two places in 23each plot. The data on number and dry weight of weeds were subjected to square-root transformation ("x + 0.5) before statistical analysis.

RESULTS AND DISCUSSION

The dominant weed flora infesting the experimental plots consisted of grassy weeds, viz. *Echinochloa colona* (L.), *Echinochloa crus-galli* (L.), *Eleusine indica*(L.), Sedges *Cyperus rotundus* (L.), *Cyperus iria*(L.), *Fimbristylis miliacea* (L.); and broad-leaf weeds *Amaranthus viridis* (L.), *Amania baccifera* (L.), *Casularia axilaris* (L.). Analysis of weed flora revealed that grassy weeds, sedges and broad-leaf weeds constituted 34.7, 46.2 and 19.1 % of total weed flora, respectively. All the weed management practices significantly reduced the weed population and dry weight of weeds over weedy check. Butachlor at 1.5 kg a.i ha^{-1} with safener supplemented by one hand weeding (once at 30 DAS) recorded the lowest weed density and dry weight and was at par with the treatments hand weeding twice at 20 and 40 DAS. This might be owing to effective control of early as well as late-emerged weeds with the integrated use of herbicide combined with one hand weeding. Butachlor + one hand weeding recorded maximum WCE (73.29%) followed by hand weeding twice (71.71%). This may be ascribed to the reduced dry weight of weeds due to effective weed management practices (*Bayon* and *Kandasamy,* 2002; *Singh et al*., 2005). Split application of N resulted in significant variation on weed density and dry weight of weed. N-scheduling under N_2 (½ at sowing+¼ tillering + ¼P) recorded significantly higher values of weed density and dry weight of weed. Higher proportion of nitrogen in early stages of plant establishment when growth is slow with lower competitiveness boosted initial weed growth leading to increased weed density and dry weight (Singh *et al*, 2005).

Crop-weed competition may reduce rice yield by adversely affecting one or more yield attributes. The yield attributes (panicles m^{-2}, panicle length, panicle weight, filled grains panicle^{-1} etc.) increased significantly by all the weed management practices compared to weedy check, however, their efficacy varied depending upon their ability to control the composite population of weeds. The increase in yield was owing to significant reduction in density and dry weight of weeds which restrict their ability to compete with the crop for different growth factors resulting into better expression of yield components. The minimum grain yield was recorded under weedy check which was attributed to more weed growth and poor yield attributes formation (Maity and Mukherjce, 2008).

Significant improvement in yield attributes and yield due to N-sheduling was observed (Table-1). Splitting of N - 1/4 th each at early tillering, active tillering, PI and PE resulted in significant increase in yield over N splitting as ½ at sowing + ¼ of tillering + ¼ at PI and ½ at early tillering + ¼ active tillering + ¼ PI, while staying at par with 1/5th each at sowing, early tillering, active tillering, PI and PE. This might be ascribed to the adequate supply of nutrients and

Table 1. Effect of treatment on growth, yield attributes, yield and economics of direct seedeed rice (means of two years)

Treatment	Height (cm)	Panicles m^{-2}	Panicle Weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Net return (Rsha^{-1})
N-scheduling						
N_1	108	227	1.58	1.90	2.92	5365
N_2	116	246	1.85	2.51	3.82	11690
N_3	117	251	1.88	2.63	4.01	12937
N_4	118	262	1.97	2.94	4.44	16145
N_5	118	259	1.95	2.81	4.29	14807
CD(P=0.05)	1.4	11	0.09	0.27	0.29	-
W_1	115	247	1.86	2.52	3.83	12557
W_2	119	262	1.97	2.96	4.48	15620
W_3	117	258	1.95	2.89	4.38	14370
W_4	115	251	1.86	2.67	4.07	13217
W_5	111	227	1.60	1.79	2.72	5580
CD(P=0.05)	1.4	11	0.09	0.27	0.29	-

N_1-Control, N_2- ½ at sowing + ¼ Tillering (T) + ¼ panicle initiation (PI), N_3 – ½ Early tillering (20 days after sowing- ET) + ¼ Tillering + ¼ PI, N_4 – ¼ ET + ¼ Tillering + ¼ PI + ¼ panicle emergence (PE), N_5 – 1/5 sowing + 1/5 ET + 1/5 T + 1/5 PI + 1/5 PE, W_1 – Butachlor @ 1.5 kg a.i ha^{-1} with safener, W_2 – W_1 + 1 Hand weeding 30 days after sowing (DAS), W_3 – 2.Hand weeding (20 DAS and 40 DAS), W_4 – Hand weeding once (25 DAS), W_5 – Weedy check metabolites for growth and development of plants. Nitrogen efficiency get enhanced, as evident from higher yield attributes and yield, when it is congruent with crop requirement (Cassman, *et al,* 1998). Higher value of yield attributes and yield under these treatment might be due to better synchronization between crop N demand and supply at critical physiological stages crucial for better assimilation and translocation of photosynthates towards grain (Avasthe, 2009).

Nitrogen management practices significantly increased the crop uptake of NPK. Application of N at four splits viz. 1/4th N each at early tillering, active tillering, panicles initiation and panicle emergence recorded maximum N, P and K (kg ha^{-1}) which was significantly superior over other practices (Table 2). The improvement in NPK uptake was reflected in higher grain and straw yield. This might be ascribed to the adequate supply of nutrients and metabolites for growth and development (Dixit and Gupta, 2000). Among weed management practices, Butachlor @ 1.5 kg a.i ha^{-1} with safener plus 1 Hand weeding 30 days after sowing (W_2) and two hand weedings (20 DAS and 40 DAS) (W_3) recorded significantly higher NPK uptake over other weed management practices while staying at par with each other. Weedy check resulted in the highest uptake of nutrients (NPK) by weeds, whereas the lowest uptake was recorded by Butachlor with safenor supplemented with one hand weeding at 30 DAS and was closely followed by two hand weeding. Low uptake of nutrients by weeds under these treatments might be ascribed to the minimum dry weight of weed recorded under these treatments.

The highest net return of Rs. 16145 ha^{-1} was recorded with N applied at four splits viz. 1/4th each ET, AT, PI and PE because of the higher grain and straw yield. Weed management practices appreciably increased the net return. The maximum (Rs. 15620 ha^{-1}) was obtained from the treatment with herbicide supplemented with hand weeding followed by two hand weeding (Rs. 14370 ha^{-1}). This could be due to high weed control efficiency and higher grain yield.

The grain quality parameters like hulling percentage milling percentage, head rice recovery, L/

Table 2. Effect of treatment on weed growth and NPK uptake by crop and weeds (means of two years)

Treatment	Weed density (No m^{-2})	Weed dry weight (g m^{-2})	Weed control efficiency (%)	Uptake by Crop N	P	K	Uptake by Weed N	P	K
N-scheduling									
N1	12.0 (144)	7.9 (62.61)	53.6	41.39	9.66	49.98	8.58	1.82	12.20
N2	11.8 (138)	7.3 (53.10)	56.7	60.62	12.52	64.61	7.36	1.49	10.29
N3	10.9 (119)	6.6 (42.50)	58.8	63.31	13.17	66.98	5.88	1.15	8.20
N4	8.6 (74)	5.6 (30.83)	65.3	68.33	14.42	72.41	4.26	0.83	5.94
N5	9.2 (85)	6.0 (35.42)	61.6	65.98	13.94	71.72	4.90	0.96	6.83
CD-(P=0.05)	0.9	0.7	-	3.62	1.57	4.1	1.03	0.4	1.12
Weed management									
W1	11.4 (130)	7.0 (49.15)	43.2	59.75	12.6	65.27	6.80	1.39	9.55
W2	7.2 (51)	4.8 (22.25)	73.2	67.44	14.25	72.46	3.06	0.67	4.35
W3	8.2 (66)	5.0 (24.57)	71.7	68.74	14.55	73.24	3.40	0.73	4.79
W4	9.7 (94)	6.5 (41.87)	48.8	63.69	13.32	68.04	5.74	1.14	8.04
W5	14.8 (219)	9.3 (85.23)	-	39.92	9.03	46.12	11.68	2.31	16.36
CD(P=0.05)	0.9	0.7	-	3.62	1.57	4.1		0.4	1.12

N_1-Control, N_2- ½ at sowing + ¼ Tillering (T) + ¼ panicle initiation (PI), N_3 – ½ Early tillering (20 days after sowing- ET) + ¼ Tillering + ¼ PI, N_4 – ¼ ET + ¼ Tillering + ¼ PI + ¼ panicle emergence (PE), N_5 – 1/5 sowing + 1/5 ET + 1/5 T + 1/5 PI + 1/5 PE, W_1 – Butachlor @ 1.5 kg a.i ha^{-1} with safener, W_2 – W_1 + 1 Hand weeding 30 days after sowing (DAS), W_3 – 2.Hand weeding (20 DAS and 40 DAS), W_4 – Hand weeding once (25 DAS), W_5 – Weedy check

Values in parentheses are original

Table 3. Effect of treatment on quality of direct seeded rice(means of two years)

Treatment	Hulling(%)	Milling(%)	Head rice	L/B ratio	Alkali value	Amylose content
N-scheduling						
N1	74.96	66.13	57.67	4.32	3.47	15.03
N2	74.99	66.89	57.91	4.31	3.49	15.07
N3	75.07	67.34	57.89	4.32	3.49	15.09
N4	75.13	68.09	58.38	4.35	3.52	15.14
N5	75.11	68.02	58.14	4.35	3.51	15.13
CD(P=0.5)	NS	0.69	0.64	NS	NS	NS
Weed management						
W1	75.03	67.42	57.93	4.33	3.48	15.08
W2	75.08	67.35	58.09	4.32	3.47	15.09
W3	75.17	67.24	58.13	4.32	3.52	15.11
W4	75.14	67.38	57.96	4.36	3.52	15.11
W5	74.78	67.09	57.83	4.33	3.50	15.09
CD (P=0.5)	NS	NS	NS	NS	NS	NS

N_1-Control, N_2- ½ at sowing + ¼ Tillering (T) + ¼ panicle initiation (PI), N_3 – ½ Early tillering (20 days after sowing- ET) + ¼ Tillering + ¼ PI, N_4 – ¼ ET + ¼ Tillering + ¼ PI + ¼ panicle emergence (PE), N_5 – 1/5 sowing + 1/5 ET + 1/5 T + 1/5 PI + 1/5 PE, W_1 – Butachlor @ 1.5 kg a.i ha^{-1} with safener, W_2 – W_1 + 1 Hand weeding 30 days after sowing (DAS), W_3 – 2.Hand weeding (20 DAS and 40 DAS), W_4 – Hand weeding once (25 DAS), W_5 – Weedy check

B ratio, Alkali value and amylose content were analysed and most of the characters were found to be remained unaffected due to nitrogen and weed management-practices, except milling percentage and head rice recovery which were found to be statistically superior (Table 3) when N was applied in four equal amount at early tillering, active tillering, panicle initiation and panicle emergence. Thus, It may be concluded that application of N at early tillering, active tillering, panicle initiation and panicle emergence along with pre-emergence application of Butachlor with safener followed by 1 hand weeding is crucial for enhancing grain yield of quality rice under existing agro-climatic condition of north Bihar plains.

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