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Nutrient Uptake and Yield of Direct Seeded Rice as Influenced by Nitrogen and Weed Management Practices

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ABSTRACT

A field experiment was conducted during the rainy (Kharif) season in 2015 and 2016 at Agricultural Research Farm, Department of Agronomy, Institute of Agricultural sciences, Banaras Hindu University, Varanasi, Uttar Pradesh, India to study nitrogen and weed management in direct seeded rice. The experiment consisted of four nitrogen splits in main-plots with six weed management practices in sub-plots in a split plot design with three replications. Result revealed that NPK content in grain and straw, their uptake and yield were significantly higher with the application of ¼ N at basal + ¼ at active tillering stage + ¼ N at panicle initiation stage + ¼ at heading stage and was at par with 1/3 N at basal + 1/3 N at active tillering stage + 1/3 N at panicle initiation stage than other nitrogen treatments. Whereas, harvest index was not significantly influenced by nitrogen and weed management treatments. Among weed management practices, application of bispyribac at 25 g a.i. ha^{-1} + azimsulfuron at 17.5 g a.i. ha^{-1} + NIS (0.25 %) at 15-20 DAS recorded maximum yield (grain and straw), NPK content in grain and straw and their uptake and was found at par with two hand weedings at 20 and 40 DAS during both the years of study.

Key words: *Nitrogen uptake, Direct seeded rice, Weed management, and Yield.*

INTRODUCTION

Direct-seeded rice is becoming more popular as an alternative to transplanted rice, as it is more remunerative if the crop is managed properly. Direct seeding of rice avoids the need for nursery preparation, uprooting of seedlings and transplanting. There has been a rapid shift to the direct seeding method of rice establishment in Asia with 21-22% of the total rice area being dry DSR. Weed is one of the major constraints for low productivity of direct seeded rice[2]. In direct-seeded rice, weeds pose serious competition to the crop in early stage and cause heavy reduction in rice yield. Uncontrolled weeds reduce the yield up to 80% in direct-seeded rice[11]. Weeds grow faster than the crop plants and thus absorb the available nutrients earlier, resulting in lack of nutrient for growth of the crop plants. Thus, an efficient and timely weed control is crucial for the success of DSR. In order to control weeds, farmers use both pre and post emergence herbicides[5].

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Split application is one of strategies for efficient use of N fertilizers throughout the growing season by synchronizing with plant demand, reducing denitrification losses and improved N uptake for maximum straw and grain yield, and harvest index in DSR. Hence, fractional application of nitrogen in right amount and proportion, and when it is needed the most seems to be a practical proposition. Weed control also facilitates higher absorption of applied nutrient, thus increases the efficiency of fertilizers application to the crops[1].

MATERIAL AND METHODS

A field experiment was conducted during rainy (*kharif*) season of 2015 and 2016 at Agricultural Research Farm, Department of Agronomy, Institute of Agricultural sciences, Banaras Hindu University, Varanasi, Uttar Pradesh. The soil was Gangetic alluvial having Sandy clay loam in texture with *p*H 7.60. It was moderately fertile, being low in available organic carbon (0.40%), available N (198.38 kgha^{-1}), and medium in available P (17.78 kg ha^{-1}) and K (216.32 kg ha^{-1}). The experiment was laid out in split-plot design with three replications. The nitrogen management subjected to main plots while weed management in sub plots. A combination of 24 treatments consisting of 4 nitrogen management, viz. N_1 - ½ N basal + ¼ N at active tillering stage + ¼ N at panicle initiation stage, N_2 - ¼ N at basal + ½ N at active tillering stage + ¼ N at panicle initiation stage, N_3 - 1/3 N at basal + 1/3 N at active tillering stage + 1/3 N at panicle initiation stage and N_4 - ¼ N basal + ¼ N at active tillering stage + ¼ N at panicle initiation stage + ¼ N at heading stage and 6 weed management treatments, viz. W_0 - Weedy check, W_1- Two hand weedings at 20 and 40 DAS, W_2 - Pendimethalin 1.0 kg a.i ha^{-1} (PE) fb Bispyribac at 25 g a.i ha^{-1} + NIS (0.25%) at 15-20 DAS, W_3 - Bispyribac at 25 g a.i. ha^{-1} + Pyrazosulfuron at 20 g a.i. ha^{-1} + NIS (0.25%) at 15-20 DAS, W_4 - Oxadiargyl at 90 g a.i. ha^{-1} (PE) *fb* Bispyribac at 25g a.i. ha^{-1} + NIS (0.25%) at 15-20 DAS and W_5 - Bispyribac at 25 g a.i. ha^{-1} + Azimsulfuron at 17.5 g a.i. ha^{-1}) + NIS (0.25 %) at 15-20 DAS. A uniform dose of 150 kg N ha^{-1}, 60 kg P_2O_5 ha^{-1} and 60 kg K_2O ha^{-1} were applied in all the plots. Full dose of phosphorus and potash were applied as basal application and nitrogen was applied as treatment wise. 'HUR 105' variety of rice @ 35 kg ha^{-1} was used for seeding of rice. The required quantity of pre-emergence and post-emergence herbicides was sprayed as per treatment using spray volume of 600 litres of water ha^{-1} with the help of knap sack sprayer fitted with flat fan nozzle.

RESULTS AND DISCUSSION

Nitrogen content and uptake (kg ha^{-1}) by grain and straw

The maximum nitrogen content and uptake by grain and straw was recorded with the application of ¼ N at basal + ¼ N at active tillering stage + ¼ N at panicle initiation stage +¼ N at heading stage which was significantly superior to ½ N at basal + ¼ N at active tillering stage + ¼ N at panicle initiation stage and ¼ N at basal + ½ N at active tillering stage + ¼ N at panicle initiation stage, However, it was at par with 1/3 N at basal + 1/3 N at active tillering stage + 1/3 N at panicle initiation during both the years of experimentation. The minimum nitrogen content and uptake in grain and straw was recorded with ¼ N at basal + ½ N at active tillering stage + ¼ N at panicle initiation stage during both the years. Split application of N has been reported as the best method to improve N fertilizer use efficiency and nitrogen content and uptake[9].

Among the weed management treatments, maximum nitrogen content and uptake in grain was recorded with two hand weedings at 20 and 40 DAS followed by application of bispyribac at 25 g a.i. ha^{-1} + azimsulfuron at 17.5 g a.i. ha^{-1} + NIS (0.25 %) at 15-20 DAS during both the years, however, in straw two hand weedings at 20 and 40 DAS was at par with the bispyribac at 25 g a.i. ha^{-1} + azimsulfuron at 17.5 g a.i. ha^{-1} + NIS (0.25 %) at 15-20 DAS during both years. The next best treatment was the application of bispyribac at 25 g a.i. ha^{-1} +

pyrazosulfuron at 20 g a.i. ha^{-1} + NIS (0.25%) at 15-20 DAS in increasing the nitrogen uptake by grain and straw and was found significantly superior to rest of the treatments during both the years. These treatments increases the availability of nutrients by minimizing weed population, weed dry matter, crop weed competition as compared to remaining weed management and resulted higher dry matter accumulation in the crop, which ultimately reflected in higher nutrient uptake from the soil. The maximum nutrient uptake in crop was recorded under two hand weedings as reported by Singh and Singh (2010). Application of bispyribac at 25 g a.i. ha^{-1} + azimsulfuron at 17.5 g a.i. ha^{-1} + NIS (0.25 %) at 15-20 DAS recorded maximum nutrient uptake was given by Rana and Angiras[7]. The minimum nitrogen uptake in grain and straw was recorded under oxadiargyl at 90 g a.i. ha^{-1} (PE) fb bispyribac at 25g a.i. ha^{-1} + NIS (0.25%) at 15-20 DAS during both the years, however, it was found significantly superior to weedy check which had lowest nitrogen uptake by grain and straw during both the years of study.

Phosphorus content and uptake (kg ha^{-1}) by grain and straw

The maximum phosphorus content and uptake by grain and straw was recorded with the application of ¼ N at basal + ¼ N at active tillering stage + ¼ N at panicle initiation stage +¼ N at heading stage which was significantly superior to ½ N at basal + ¼ N at active tillering stage + ¼ N at panicle initiation stage and ¼ N at basal + ½ N at active tillering stage + ¼ N at panicle initiation stage and it was found at par with 1/3 N at basal + 1/3 N at active tillering stage + 1/3 N at panicle initiation during both the years of experimentation. However, nitrogen application of 1/3 N at basal + 1/3 N at active tillering stage + 1/3 N at panicle initiation remained at par with ½ N at basal + ¼ N at active tillering stage + ¼ N at panicle initiation stage during both the years of study. Split application of N has been reported as the best method to improve N fertilizer use efficiency and nitrogen content and uptake (Singh *et al*., 2015).The minimum phosphorus content and uptake was noticed with ¼ N at basal + ½ N at active tillering stage + ¼ N at panicle initiation stage which was at par with the application of ½ N at basal + ¼ N at active tillering stage + ¼ N at panicle initiation stage during both the years of study.

Among the weed management treatments, maximum phosphorus content and uptake in grain was recorded with two hand weedings at 20 and 40 DAS followed by application of bispyribac at 25 g a.i. ha^{-1} + azimsulfuron at 17.5 g a.i. ha^{-1} + NIS (0.25 %) at 15-20 DAS during both the years, however, in straw two hand weedings at 20 and 40 DAS was at par with the bispyribac at 25 g a.i. ha^{-1} + azimsulfuron at 17.5 g a.i. ha^{-1} + NIS (0.25 %) at 15-20 DAS during both years. The next best treatment was the application of bispyribac at 25 g a.i. ha^{-1} + pyrazosulfuron at 20 g a.i. ha^{-1} + NIS (0.25%) at 15-20 DAS in increasing the phosphorus uptake by grain and straw and was found significantly superior to rest of the treatments during both the years. The maximum nutrient uptake in crop was recorded under two hand weedings as reported by Singh and Singh (2010). Application of bispyribac at 25 g a.i. ha^{-1} + azimsulfuron at 17.5 g a.i. ha^{-1} + NIS (0.25 %) at 15-20 DAS recorded maximum nutrient uptake was given by Rana and Angiras[7]. The minimum phosphorus uptake in grain and straw was recorded under Oxadiargyl at 90 g a.i. ha^{-1} (PE) fb Bispyribac at 25g a.i. ha^{-1} + NIS (0.25%) at 15-20 DAS during both the years, however, it was found significantly superior to weedy check which had lowest phosphorus uptake by grain and straw during both the years of study.

Potassium content and uptake by grain and straw

The potassium content and uptake recorded with nitrogen application of ¼ N at basal + ¼ N at active tillering stage + ¼ N at panicle initiation stage + ¼ N at heading stage which was significantly more than ½ N at basal + ¼ N at active tillering stage + ¼ N at panicle initiation stage and ¼ N at basal + ½ N at active tillering stage + ¼ N at panicle initiation

stage and it was found at par with 1/3 N at basal + 1/3 N at active tillering stage + 1/3 N at panicle initiation stage during both the years. The minimum potassium content and uptake was recorded under ¼ N at basal + ½ N at active tillering stage + ¼ N at panicle initiation stage which was at par with the application of ½ N at basal + ¼ N at active tillering stage + ¼ N at panicle initiation stage during both the years of study. Split application of N has been reported as the best method to improve N fertilizer use efficiency and nitrogen content and uptake[9].

Among weed management practices, two hand weedings at 20 and 40 DAS recorded significantly higher potassium content and uptake by grain and straw which was at par with the application of bispyribac at 25 g a.i. ha^{-1} + azimsulfuron at 17.5 g a.i. ha^{-1} + NIS (0.25 %) at 15-20 DAS during both years. The next best treatment was the application of bispyribac at 25 g a.i. ha^{-1} + pyrazosulfuron at 20 g a.i. ha^{-1} + NIS (0.25%) at 15-20 DAS in increasing the phosphorus uptake by grain and straw during both the years. The maximum nutrient content and uptake in crop was recorded under two hand weedings as reported by Sanjay *et al*. (2006). Application of bispyribac at 25 g a.i. ha^{-1} + azimsulfuron at 17.5 g a.i. ha^{-1} + NIS (0.25 %) at 15-20 DAS recorded maximum nutrient uptake was given by Prakash *et al*.[6]. The minimum potassium content and uptake was recorded under weedy check. The minimum potassium content and uptake in grain and straw was recorded under oxadiargyl at 90 g a.i. ha^{-1} (PE) fb bispyribac at 25g a.i. ha^{-1} + NIS (0.25%) at 15-20 DAS during both the years, which was found significantly superior to weedy check which had lowest potassium uptake by grain and straw during both the years of study.

Crop yield

Application of ¼ N at basal + ¼ N at active tillering stage + ¼ N at panicle initiation stage +¼ N at heading stage was recorded maximum grain and straw yield followed by 1/3 N at basal + 1/3 N at active tillering stage + 1/3 N at panicle initiation stage than other nitrogen treatments and was on par to each other (Table 3). The increased grain and straw yield was perhaps the result of reduced weed density and their dry weight, better weed control efficiency. These findings were in conformity with the results of Kumawat *et al*.[4]. The minimum grain and straw yield was recorded under nitrogen application of ¼ N at basal + ½ at N active tillering stage + ¼ N at panicle initiation stage and ½ N at basal + ¼ at N active tillering stage + ¼ N at panicle initiation stage. Amongst various weed management treatments, hand weeding twice at 20 and 40 DAS and the application of Bispyribac at 25 g a.i. ha^{-1} + Azimsulfuron at 17.5 g a.i. ha^{-1} + NIS (0.25 %) at 15-20 DAS resulted in significantly higher grain and straw yield (Table 3) than other weed management treatments. The increased yield in these treatments might be due to cumulative effect of lower weed density, dry weight, higher weed control efficiency. The maximum grain and straw yield was recorded under Bispyribac at 25 g a.i. ha^{-1} + Azimsulfuron at 17.5 g a.i. ha^{-1} + NIS (0.25 %) at 15-20 DAS as given by Ghosh *et al*.[3].

Table 1: Effect of nitrogen management and weed management practices on nitrogen, phosphorus and potassium content (%) in grain and straw

Treatments	Nitrogen (%)				Phosphorus (%)				Potassium (%)			
	2015		2016		2015		2016		2015		2016	
	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw
Nitrogen management												
N_1- ½ N at basal + ¼ N at active tillering stage + ¼ N at panicle initiation stage	1.156	0.582	1.072	0.538	0.264	0.234	0.230	0.179	0.428	1.489	0.315	1.446
N_2- ¼ N at basal + ½ N at active tillering stage + ¼ N at panicle initiation stage	1.116	0.524	1.032	0.498	0.255	0.224	0.219	0.175	0.416	1.480	0.305	1.436
N_3- 1/3 N at basal + 1/3 N at active tillering stage + 1/3 N at panicle initiation stage	1.291	0.625	1.174	0.589	0.276	0.238	0.235	0.187	0.433	1.504	0.382	1.453
N_4- ¼ N at basal + ¼ N at active tillering stage + ¼ N at panicle initiation stage +¼ N	1.327	0.703	1.206	0.691	0.288	0.253	0.247	0.194	0.472	1.521	0.411	1.462

at heading stage												
SEm±	0.011	0.025	0.010	0.029	0.004	0.005	0.004	0.009	0.016	0.005	0.010	0.012
CD (P=0.05)	0.038	0.087	0.033	0.100	0.013	0.019	0.013	0.031	NS	0.018	0.036	0.040
Weed management practices												
W_0 - Weedy check	0.897	0.418	0.849	0.404	0.166	0.139	0.159	0.112	0.303	1.322	0.222	1.270
W_1- Two hand weedings at 20 and 40 DAS	1.376	0.748	1.315	0.708	0.364	0.313	0.306	0.256	0.516	1.572	0.413	1.525
W_2 - Pendimethalin at 1.0 kg a.i. ha^{-1} (PE) fb Bispyribac at 25 g a.i. ha^{-1} + NIS (0.25%) at 15-20 DAS	1.212	0.590	1.100	0.560	0.248	0.218	0.213	0.175	0.432	1.503	0.326	1.453
W_3 - Bispyribac at 25 g a.i. ha^{-1} + Pyrazosulfuron at 20 g a.i. ha^{-1} + NIS (0.25%) at 15-20 DAS	1.273	0.650	1.163	0.602	0.288	0.264	0.239	0.190	0.481	1.554	0.379	1.510
W_4- Oxadiargyl at 90 g a.i. ha^{-1} (PE) *fb* Bispyribac at 25g a.i. ha^{-1} + NIS (0.25%) at 15-20 DAS	1.133	0.530	1.049	0.500	0.225	0.202	0.188	0.148	0.388	1.473	0.298	1.419
W_5- Bispyribac at 25 g a.i. ha^{-1} + Azimsulfuron at 17.5 g a.i. ha^{-1} + NIS (0.25 %) at 15-20 DAS	1.339	0.717	1.279	0.668	0.332	0.288	0.292	0.222	0.505	1.567	0.390	1.517
SEm±	0.017	0.020	0.013	0.023	0.005	0.014	0.005	0.014	0.015	0.014	0.012	0.022
CD (P=0.05)	0.049	0.057	0.037	0.065	0.016	0.040	0.015	0.039	0.044	0.039	0.033	0.063

Table 2: Effect of nitrogen management and weed management practices on nitrogen, phosphorus and potassium uptake (kg ha^{-1}) by crop

Treatments	Nitrogen uptake (Kg ha^{-1})				Phosphorus uptake (Kg ha^{-1})				Potassium uptake (Kg ha^{-1})			
	2015		2016		2015		2016		2015		2016	
	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw
Nitrogen management												
N_1- ½ N at basal + ¼ N at active tillering stage + ¼ N at panicle initiation stage	46.63	34.16	40.33	30.38	10.94	13.96	8.81	10.24	17.33	85.94	11.97	79.65
N_2- ¼ N at basal + ½ N at active tillering stage + ¼ N at panicle initiation stage	43.02	30.47	36.95	27.34	10.03	13.07	8.02	9.80	16.07	83.00	11.02	76.52
N_3- 1/3 N at basal + 1/3 N at active tillering stage + 1/3 N at panicle initiation stage	51.92	39.29	45.85	35.77	11.73	15.21	9.28	11.20	18.11	91.72	12.42	84.69
N_4- ¼ N at basal + ¼ N at active tillering stage + ¼ N at panicle initiation stage + ¼ N at heading stage	54.94	43.41	48.03	40.29	12.54	16.10	10.22	12.03	20.34	94.18	16.92	86.99
SEm±	0.89	1.22	0.68	1.33	0.26	0.53	0.29	0.61	0.68	1.57	0.41	1.88
CD (P=0.05)	3.10	4.23	2.35	4.60	0.90	1.85	0.99	2.10	2.34	5.43	1.41	6.50
Weed management practices												
W_0 - Weedy check	17.71	13.66	14.53	11.89	3.27	4.81	2.73	3.55	5.76	44.05	4.66	38.56
W_1- Two hand weedings at 20 and 40 DAS	68.51	51.80	61.08	47.03	18.11	21.69	14.20	17.04	25.71	108.62	19.29	100.91
W_2 - Pendimethalin at 1.0 kg a.i. ha^{-1} (PE) fb Bispyribac at 25 g a.i. ha^{-1} + NIS (0.25%) at 15-20 DAS	49.04	36.66	41.14	33.53	10.02	13.46	8.00	10.43	17.49	92.49	12.23	86.21
W_3 - Bispyribac at 25 g a.i. ha^{-1} + Pyrazosulfuron at 20 g a.i. ha^{-1} + NIS (0.25%) at 15-20 DAS	56.14	40.35	47.96	36.50	12.72	16.35	9.82	11.42	21.23	95.92	15.68	90.30
W_4- Oxadiargyl at 90 g a.i. ha^{-1} (PE) fb Bispyribac at 25g a.i. ha^{-1} + NIS (0.25%) at 15-20 DAS	41.93	30.99	35.03	27.85	8.23	11.79	6.24	8.21	14.30	85.82	9.97	78.59
W_5- Bispyribac at 25 g a.i. ha^{-1} + Azimsulfuron at 17.5 g a.i. ha^{-1} + NIS (0.25 %) at 15-20 DAS	62.48	48.27	57.65	43.03	15.51	19.43	13.20	14.75	23.59	105.37	17.68	97.21
SEm±	1.33	1.34	1.18	1.40	0.33	0.98	0.29	0.84	0.79	2.13	0.57	2.20
CD (P=0.05)	3.80	3.84	3.36	4.01	0.95	2.79	0.83	2.39	2.26	6.10	1.63	6.28

Table 3: Effect of nitrogen and weed management practices on Yield (t ha^{-1}) in direct seeded rice

Treatments	Grain yield (t/ha)		Straw yield (t/ha)	
	2015	2016	2015	2016
Nitrogen management				
N_1- ½ N at basal + ¼ Nat active tillering stage + ¼ N at panicle initiation stage	3.65	3.30	5.53	5.25
N_2- ¼ N at basal + ½ N at active tillering stage + ¼ N at panicle initiation stage	3.84	3.48	5.69	5.44
l/3 N at basal + 1/3 N at active tillering stage + 1/3 N at panicle initiation stage	3.99	3.62	6.03	5.74
¼ N at basal + ¼ N at active tillering stage + ¼ N at panicle initiation stage +¼ N at heading stage	4.09	3.77	6.14	5.87
SEm±	0.08	0.09	0.10	0.11
CD (P=0.05)	0.29	0.31	0.33	0.37
Weed management practices				
W_0 - Weedy check	1.97	1.70	3.32	2.99
W_1- Two hand weedings at 20 and 40 DAS	4.77	4.38	6.90	6.61
Pendimethalin at 1.0 kg a.i. ha^{-1} (PE) fb Bispyribac at 25 g a.i. ha^{-1} + NIS (0.25%) at 15-20 DAS	4.04	3.72	6.05	5.83
Bispyribac at 25 g a.i. ha^{-1} + Pyrazosulfuron at 20 g a.i. ha^{-1} + NIS (0.25%) at 15-20 DAS	4.36	3.91	6.17	5.98
Oxadiargyl at 90 g a.i. ha^{-1} (PE) *fb* Bispyribac at 25g a.i. ha^{-1} + NIS (0.25%) at 15-20 DAS	3.67	3.32	5.73	5.54
Bispyribac at 25 g a.i. ha^{-1} + Azimsulfuron at 17.5 g a.i. ha^{-1}) + NIS (0.25 %) at 15-20 DAS	4.56	4.21	6.72	6.40
SEm±	0.13	0.15	0.15	0.13
CD (P=0.05)	0.36	0.42	0.44	0.37

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