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Effects of nitrogen levels and weed management in direct-seeded rice

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ABSTRACT

A field experiment was conducted at Agricultural Research Farm, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi to study effect of nitrogen level and weed management in direct-seeded rice. Treatment consisted of 12 treatment combinations which was laid out in the split-plot design having nitrogen levels (100, 120, 140 and 160 kg N/ha) in main plot and three weed management practices, *viz.* weedy, two hand weeding and bispyribac-sodium 25g/ha *fb* Cono-weeding in sub-plots replicated thrice. Two hand weeding recorded significantly lower weed biomass and density and better performance of crop growth and yield attributes and yield followed by bispyribac-Na 25 g/ha *fb* cono-weeding. In case of nitrogen application of 160 kg N/ha showed better performance of growth, yield attributes and yield as compared to other nitrogen treatments. It was observed that application of nitrogen 160 kg/ha and two hand weeding was found best treatment for higher grain yield and net returns.

Rice (*Oryza sativa*), the staple food of more than half of the population of the world, is an important target to provide food security and livelihoods for millions. Direct-seeding of rice (DSR) refers to the process of establishing the crop from seeds sown in the field and is an alternative to transplanting that can reduce the cost of rice establishment. Direct seeding of rice avoids the need for nursery preparation, uprooting of seedlings and transplanting. However, weeds are one of the major constraints in the success of DSR.

Crop fertilization is one important component of integrated weed management and it has been observed that nitrogen (N) fertilizer plays an important role in the competitive balance between weeds and rice (Raun and Johnson 1999, Camara *et al*. 2003). Therefore, manipulation of crop fertilization is a promising agronomic practice in reducing weed interference in crops (Cathcart *et al.* 2004, Blackshaw *et al.* 2005). Production potentiality of rice can be fully exploited with suitable nitrogen level and weed management practices.

Weeds usually grow faster than crop plants and thus absorb nutrient earlier resulting in lack of nutrients for growth of plant. Nitrogen fertilization has pronounced effect on the growth of weeds plant. Weeds not only reduce the amount of N available to the crops but also suppress the crop growth (Blackshaw 2003). Camara *et al.* (2003) reported that nitrogen is the major nutrient added to increase crop yield but it is not always recognized that altered soil nitrogen levels can influence crop-weed competitive interactions. Mahajan and Timsina (2011) reported that increasing N application rate up to 150 kg N/ha caused significant improvement in grain yield when the weeds were well controlled either by pendimethalin 1 kg/ha *fb* bispyribac-Na 25 g/ha or by pendimethalin 1 kg/ha *fb* bispyribac-Na 25 g/ha + 1 HW, respectively.

Therefore, in view of the above facts, the present investigation carried out during *Kharif* season of 2016 at Agricultural Research Farm, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, with the objectives of study the effect of nitrogen rate and weed management on growth and yield of direct seeded rice, effect of nitrogen rate and weed management on weed growth in direct seeded rice and work out economics of treatment under study.

A field experiment was conducted during *Kharif* season of 2016 at Agricultural Research Farm, Department of Agronomy, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh (India). The soil of the experimental field was sandy clay loam in texture with pH 7.20 low in organic matter (0.43%) , low in available nitrogen

(202.7 kg/ha), medium in available phosphorus (18.0 kg/ha) and potassium (209.2 kg/ha). The experiment comprised of 12 treatments which was laid out in the split plot design having nitrogen levels (100, 120, 140 and 160 kg N/ha) in main plot and three weed management practices, *viz.* weedy, two hand weeding and bispyribac sodium 25 g/ha *fb* Cono-weeding in subplots replicated thrice. Rice hybrid Arize 6444 was sown in the rows under dry condition with proper soil moisture condition with help of *Kudal* (local furrow maker) at spacing of 18.5 cm using seed rate of 30 kg/ ha. Half doses of nitrogen as per treatment was applied at the time of sowing and rest half was split in two equal splits and applied at tillering and panicle initiation stages. Full doses of phosphorus (60 kg/ha) and potassium (60 kg/ha) was applied as basal at the time of sowing.

Two hand weeding was done as per the need of the treatment; one hand weeding was done at 20 days after sowing (DAS) and second was done at 40 DAS of the crop. Post-emergence application of bispyribac sodium 25 g/ha was applied as per treatment with Knapsack sprayer filled with flat fan nozzle using 300 lt. of water/ ha .The data on yield attributes and yield of rice were recorded at the time of harvesting. Weed species within the area of quadrate were cut close to the ground surface and air dried in hot air oven maintained at 70 to 75 ºC temperature. Crop was harvested when most of the panicles turned golden yellow. Harvesting was done manually by using sickle. The yields, thus obtained, were converted in kg/ha for presentation of results.

Effect on weed

Weed density recorded on 60 DAS (**Table 1**) revealed that amongst the nitrogen level, the minimum density of *Echinochloa colona, Echinochloa crus-galli, Cyperus difformis, Fimbristylis maliacea, Caesulia axillaris* and *Ammania baccifera* were observed in 100 kg N/ha. However, the maximum density of *E.colona, E.crus-galli* were recorded in 160 kg N/ha followed by 140 kg N/ha and 120 kg N/ ha. Weed population increased with higher rate of nitrogen, which may be due to more nitrogen supply and relatively higher absorbing capacity of weeds in comparison to crop. Similar findings have also been reported by Pysek and Leps (1991). The weed density of grasses and sedges increased significantly with increasing nitrogen rates whereas density of broad leaf weeds was not significantly increased with increasing the nitrogen rates. Amongst different weed management treatments, two hand weeding recorded significantly minimum population of weeds (grasses, sedges and broad leaf weeds) followed by bispyribac-Na *fb* cono-weeding and weedy. However, data revealed that bispyribac-Na *fb* cono-weeding recorded lesser population of weeds (grasses, sedges and broad leaf weeds) as compared to weedy. Similar results were also observed for weed biomass in case of grasses, sedges and broad-leaved weeds. Higher doses of nitrogen enhanced vigorous weed growth because weeds are capable to absorbing relatively higher amount of nitrogen than crop and flourished quickly than the crop. The findings have also been supported by Iqwal and Wright (1997). This may be due to reduced competition between weeds and crops for the light, space and nutrient which reduced the total biomass of weed. Similar findings are also reported by the Vaishya *et al.* (1992).

Effect on crop growth and yield

The significantly higher plant height, dry matter accumulation/m, total tillers/running row was obtained with nitrogen level 160 N/kg compared to 100 kg N/ha, 120 kg N/ha, 140 kg N kg/ha and statistically higher based on the observations recorded **(Table 2)**. The taller plant in 160 kg N/ha might be due to better use of available growth resources like light and temperature which may result in higher nitrogen absorption for the synthesis of

Table 1. Effect of nitrogen rates and weed management on weed density and weed biomass at 60 DAS in dry direct-seeded rice

Treatment	Density of weeds (no./ m^2)										Weed biomass (g/ m^2)			
	Grasses			Sedges			Broad-leaf weeds			Total weeds	Grasses	Sedges	Broad-leaf weeds	Total
	E. colona	*E. crus-galli*	Total	*C. difformis*	*F. maliaceae*	Total	*C. axillaris*	*A. baccifera*	Total					
Nitrogen level														
100 kg/ha	3.0(9)	2.2(5)	3.1(15)	3.5(14)	2.2(4)	4.0(18)	4.5(23)	2.6(8)	5.3(32)	8.1(65)	4.3(21)	4.6(23)	7.1(59)	10.2(103)
120 kg/ha	3.1(10)	2.3(5)	3.8(16)	3.7(15)	2.3(5)	4.2(19)	4.8(25)	2.9(9)	5.7(35)	8.4(69)	4.5(22)	4.8(25)	7.4(63)	10.6(111)
140 kg/ha	3.4(12)	2.4(6)	4.2(18)	4.0(17)	2.3(5)	4.6(22)	5.1(29)	3.1(10)	6.0(40)	9.0(80)	4.9(26)	5.2(29)	8.1(72)	11.3(127)
160 kg/ha	3.6(13)	2.5(7)	4.4(20)	4.3(19)	2.5(6)	4.9(25)	5.5(32)	3.4(12)	6.4(45)	9.5(89)	5.3(29)	5.6(33)	8.6(81)	12.0(143)
LSD (p=0.05)	0.19	0.17	0.24	0.23	NS	0.26	0.32	0.38	0.41	0.20	0.35	0.35	0.53	0.33
Weed management														
Weedy	4.6(20)	3.3(10)	5.6(31)	5.4(29)	3.1(9)	6.2(37)	7.1(49)	4.3(18)	8.3(68)	11.7(136)	6.7(44)	7.1(50)	11.2(124)	14.8(218)
Two hand weeding	1.9(3)	1.4(1)	2.2(4)	2.2(4)	1.6(2)	2.5(5)	2.7(7)	1.6(2)	3.2(9)	4.5(19)	2.6(6)	2.8(7)	4.2(17)	5.6(30)
Bispyribac-Na 25g/ha *fb* conoweeding	3.4(11)	2.3(5)	4.2(16)	4.0(15)	2.4(5)	4.5(20)	5.2(26)	3.1(9)	6.0(36)	8.6(72)	4.9(23)	5.2(26)	8.1(65)	10.8(115)
LSD (p=0.05)	0.93	0.13	0.12	012	0.25	0.13	0.16	0.18	0.20	0.89	0.15	0.17	0.27	0.23

Table 2. Effect of nitrogen rates and weed management on growth attributes (60 DAS), yield attributes, yield and economics in dry direct-seeded rice

Treatment	Plant height (cm)	Dry matter (g/ running m)	Leaf area index	Chlorophyll content (%)	Tillers (no./ running m)	Panicle length (cm)	Panicle weight (g)	Effective tillers (no./m^2)	No of grains/ panicle	Test weight (g)	Grain yield (t/ha)
Nitrogen level											
100 kg/ha	63.2	349.6	2.65	38.8	271	23.0	6.15	408.8	159	24.6	5.4
120 kg/ha	64.5	356.9	2.70	39.6	276	23.5	6.28	417.3	162	25.2	5.6
140 kg/ha	66.0	364.8	2.76	40.5	282	24.0	6.42	426.6	166	25.7	5.7
160 kg/ha	67.4	372.6	2.82	41.3	288	24.5	6.55	435.8	169	26.3	5.9
LSD (p=0.05)	0.58	3.10	0.027	0.34	2.5	0.21	0.06	3.76	1.44	NS	.05
Weed management											
Weedy	62.1	343.7	2.60	38.1	266	22.6	6.05	401.9	156	24.2	5.4
Two hand weeding	67.4	373.0	2.82	41.4	289	24.5	6.56	436.2	169	26.2	5.9
Bispyribac-Na 25 g/ha *fb* conoweeding	66.2	366.2	2.77	40.6	283	24.1	6.44	428.2	166	25.8	5.8
LSD (p=0.05)	NS	3.70	0.028	0.41	2.87	0.25	0.07	4.34	1.69	NS	0.058

protoplasm responsible for rapid cell division subsequently increasing the plant in shape and size. The higher dry matter accumulation running row/m in 160 kg N/ha might be due better growth. The higher number of total tillers/ running m in 160 kg N/ ha might be due to ability of effective utilization of plant growth resources with advancement of life cycle. The findings have also been supported by Sharief *et al.* (2006). The higher LAI recorded in 160 kg N/ha might be due to more number of leaves/m^2. The higher chlorophyll content in 160 kg N/ha was due to more uptake of nitrogen as compared to remaining level of nitrogen. Also higher chlorophyll content may be due to more accumulation of nitrogen from the soil and chlorophyll content in leaves is directly associated with nitrogen uptake. The higher number of effective tillers/m^2 recorded in 160 kg N/ha and 140 kg N/ha might be due to better growth and early initiation of tillers before start of reproductive growth. The findings have been also supported by Ramamoorty *et al.* (2007). Panicle weight (g), panicle length (cm), number of grains/ panicle and 1000-grain weight were significantly higher in 160 kg N /ha than the 100 kg N/ha, 120 kg N/ ha and 140 kg N kg/ha which might be due to ability of hybrid rice cultivar of better growth which may result in the better development of yield attributing characters. The higher values of growth and yield attributes recorded by 160 kg N/ha might be due to higher plant height, number of leaves, leaf area, total tillers.

The grain yield was significantly higher in 160 kg N/ha as compared to other nitrogen levels. Also significantly higher grain yield in 160 kg N/ha might be due to synchronization of tillers that help in early emergence of productive panicles and panicle weight possibly due to better utilization capacity of available nutrients which helped in determining the relatively more yield. Higher dose of nitrogen might have increased number of panicles/m^2 as well as number of grains per panicle and 1000-grain weight. The findings have also been supported by Srinivasan and Angayarkanni (2008).

Plant height at all the stages of observations was not influenced significantly due to different weed management practices but two hand weedings recorded higher plant height as compared to bispyribac-Na *fb* cono-weeding and weedy. It might be due to less competition for space, sunlight and other inputs. The dry matter accumulation/ m running row recorded at all the stages of observations of the crop was significantly higher in two hand weedings compared to bispyribac-Na *fb* cono-weeding **(Table 2)**. Hand weeding twice (20 and 40 DAS) was found most promising to reduce the weed dry matter as compared to other treatments. The results are in agreement with Vaishya *et al.* (1992). The crop treated with two hand weeding recorded higher number of total tillers/m^2 whereas bispyribac-sodium *fb* cono-weeding had significantly higher number of tillers/m^2 as compared to weedy. The panicle length, numbers of effective tillers/m^2, number of grains/ panicle and test weight were found significantly higher in two hand weedings than bispyribac-Na *fb* cono-weeding. The grain yield was also significantly higher in two hand weedings than bispyribac-Na *fb* cono-weeding. The higher grain yield in weed management might be due to higher number of effective tillers/m^2 and number of filled grains/ panicle. Nitrogen level 160 kg N/ha obtained maximum gross return at two hand weeding plot followed by 140 kg N/ha with two hand weeding, 120

Table 3. Effect of nitrogen rates and weed management on cost of cultivation, gross return, net return and B: C ratio of direct-seeded rice

Treatment	Cost of cultivation (x10^3 `/ha)	Gross return (x10^3 `/ha)	Net return (x10^3 `/ha)	B: C ratio
Nitrogen 100 kg/ha + weedy	34.14	85.87	51.72	2.4
Nitrogen 100 kg/ha with two hand weeding	41.34	101.79	60.44	2.5
Nitrogen 100 kg/ha with bispyribac-Na 25g/ ha *fb* cono weeding	37.29	100.66	63.36	2.7
Nitrogen 120 kg/ha + weedy	34.59	97.50	62.91	2.8
Nitrogen 120 kg/ha with two hand weeding	41.79	104.83	63.03	2.5
Nitrogen 120 kg/ha with bispyribac-Na 25 g/ha *fb* cono weeding	37.74	102.39	64.65	2.7
Nitrogen 140 kg/ha + weedy	35.04	98.64	63.60	2.8
Nitrogen 140 kg/ha with two hand weeding	42.24	106.45	64.21	2.5
Nitrogen 140 kg/ha with bispyribac-Na 25 g/ha *fb* cono weeding	38.19	105.67	67.48	2.8
Nitrogen 160 kg/ha + weedy	35.49	99.79	64.30	2.7
Nitrogen 160 kg/ha with two hand weeding	42.69	121.41	78.72	2.9
Nitrogen 160 kg/ha with bispyribac-Na 25 g/ha *fb* cono weeder	38.64	107.25	68.61	2.8

N kg/ha with two hand weeding and100 N kg/ha with two hand weeding, respectively **(Table 3)**. It was revealed that nitrogen level 160 kg N/ha obtained maximum net return as compared to other nitrogen level and weed management combinations followed by nitrogen level 140 kg N/ha and 120 kg N/ha, respectively. The nitrogen level 160 kg N/ha at two hand weeding recorded maximum benefit cost ratio as compared to other nitrogen level and weed management combinations followed by nitrogen level 140 kg N/ha with bispyribac-Na *fb* cono-weeder weeding and 120 kg N/ha with two hand weeding as compared to rest of the treatment combinations, respectively.

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