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Growth attributes response of different doses of nitrogen on rice varieties in Vindhya region of Uttar Pradesh

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Abstract
Rice (*Oryza sativa* L.) is one of the most important staple food crops belonging to the grass family (poaceae). It is the most consumed cereal after wheat, and has the second largest area under production following maize crop worldwide. Water requirement is the most thrust area in rice. Owing this, a field experiment was conducted in Vindhyan soil during the 2016 in *Kharif*season at Agricultural Research Farm, Rajeev Gandhi South Campus, Barkachha Mirzapur. It is a campus of Banaras Hindu University, Varanasi. The experiment consisted 5 doses of nitrogen N_0, N_1, N_2, N_3 and N_4 (0, 60, 80, 100, 120 kg ha^{-1}) and selected 4 varieties of rice V_1, V_2, V_3, and V_4 (HUR-2-1, HUR-1-5, HUR-917, HUR-3022) laid out in a Factorial Randomized Block Design with three replications. In the experiment nitrogen treatment were used at three growth stages (vegetative growth stage at 40 DAT, reproductive stage at 70 DAT, maturity stage at harvesting), among three application of nitrogen, ½ of the total nitrogen applied at time of 23 DAT and remaining doses of nitrogen applied at reproductive stage (flowering stages) and maturity stage(grain filling stage), in these nitrogen application recorded significant growth on N_4 dose of nitrogen and N_2&N_3 doses of nitrogen no significance effect on rice growth and rice variety and V_1 given significant growth performance. Among the treatments and varieties, significant differences were observed in vegetative growth of rice at 70 day after transplanting (DAT) with maximum plant height (95 cm), at harvesting (109 cm) and number of tillers (19/hill) was recorded in HUBR-2-1& HUR-105 at N_4 kg Nha^{-1} while minimum plant height (65cm) and number of tillers (13/hill) was recorded in V_3 at N_4.(*A. Das., M. K. Singh)* The number of leaves (86 $hill^{-1}$) and leaf area index (38) were recorded maximum in HUBR-2-1 at N_4. Same trend were fallowed for root length and root volume. So this research result indicates that HUR-2-1 gives better vegetative growth at N_4 dose of nitrogen treatment in Vindhyan region of Uttar Pradesh. In controlled plot rice plant ware stunted growth and unable to multiplication of tillers and panicle initiation (*Choudhary, R. L. Kumar).*

Keywords: Rice,HUR-2-1, HUR-105, HUR-917, HUR-3022,and Growth attribute, Nitrogen, LGR, RGR

Introduction
Rice (Oryza sativa) is one of the world's most important staple foods. Rice (*Oryza sativa* L.) is one of the major staple food grains for more than 50% of the world population providing major sources of the food energy. If is grown in 144 country across the word on an area of 60 million hectare with annual production of 141.14 million tonnes. Rice belongs to the genus *Oryza.* Rice required high amount of nitrogenous fertilizers for their growth and development (tillering, chlorophyll content, height, panicles initiation flowering and grain filling). In this experiment all selected varieties developed by Banaras Hindu University, Varanasi UP. The highly scented HUR105 is an erect, semi dwarf (100–110 cm in height) variety with 125-130 days to maturity and a sturdy plant stature, which makes it tolerant of lodging. In addition, it has intermediate Amylose content and an alkali spreading value with high head rice recovery. Because of it medium maturity (130 days), it is a suitable crop for a rice-wheat rotation. (R.P. Singh and Chaitali Sen). Rice grown under high management requires large amounts of nitrogen (n) One crop consumes approximately 20-25 kg of nitrogen for every ton of yield, making nitrogen the single most important rice nutrient. Nitrogen's fundamental importance as a primary nutrient element is augmented by the fact that many improved rice varieties cultivated around the world have been bred to show a marked response to the application of nitrogenous fertilizers. Nitrogen increases the vigor and enhances the growth of the rice plant. *(Kaushal Kumar and S.K Prasad).* When absorbed during the vegetative phase, nitrogen: helps synthesize the chlorophyll necessary for photosynthesis (as evidenced by a marked "greening" of the leaves), promotes rapid leaf, stem, and root growth (as evidenced by an increase in the height, size, and number of tillers, as well as an increase in the size of leaves), speeds growth,

thus enabling seedlings to grow fast enough to avoid many seedling blights when absorbed during the reproductive and ripening phases, nitrogen, promotes development of the panicle (as evidenced by an increase in the number of spikelets), stimulates nutrient absorption and assimilation (as evidenced by an increase in size and number of filled grains - increases the protein content of the grains, thus improving the quality of the crop. Nitrogen deficiency in rice can be recognized by: yellowish, color of the leaves, particularly of younger leaves, small size of plants, low number of tillers, straightness, stiffness or upper leaves. Excessive application of this nutrient tends to cause yield reduction through the plant lodging, heavy mutual shading of leaves, or the damage by insect pests.

Methods and Material

The field experiment was carried out with 5 doses of nitrogen (0, 60, 80, 100, 120.) and 4 varieties of rice (HUR-2-1, HUR-1-5, HUR-917, HUR-3022) laid out in a Factorial Randomized Block Design with three replications (R_1, R_2& R_3). Total numbers of plots were 60. In the experiment nitrogen treatment used at three times (vegetative growth stage, reproductive stage, maturity stage), among three application of nitrogen, ½ of the total nitrogen applied at time of 23 DAT and remaining doses of nitrogen applied at reproductive stage (flowering stages 70 DAT) and maturity stage (grain filling stage) at Rajiv Gandhi South Campus, Barkachha, Mirzapur, campus of Banaras Hindu University, Varanasi Uttar Pradesh during kharif season 2016. In this experiment used recommended dose of Phosphorus, Potash and Zinc sulphate also. In data observation the different growth parameter such as plant height, number of tillers, number of leaves, leaf area index, root length and root volume were recorded at three times such as 40 DAS, 70 DAS & at the time of harvesting as manually. The LAI was calculated as square cm of leaf area per unit land area divided by square cm of unit land area (Pattuswamy *et al.*, 1976). During the experiment maximum temperature was 38.2 ^{0}C and minimum temperature was 21 ^{0}C. The average relative humidity was recorded 33.3 to 87%. The average annual rainfall is about 1073mm and out of which about 90 percent is received by south-west monsoon. Total number of days taken from day after transplanting to different phenophases of rice was recorded visually as to know the effect of various treatments on the phenophasic duration.

Linear Growth Rate (LGR): Linear growth rate was calculated by using following formula:

Linear Growth Rate (LGR) = L_2-L_1 / t_2-t_1

L_1 and L_2 are the length of plant height at time t_1 and t_2 respectively.

Crop Growth Rate (CGR): Crop growth rate represented total dry matter productivity of the community per unit land area over a certain time span. Thecrop growth rate calculated by the using following formula:

Crop Growth Rate = W_2-W_1 / t_1-t_2 X $_1$/L

W_1 and W_2 are plant dry weight of biomass at time t_1 and t_2, L is land area.

Table 1: Effect of doses of nitrogen on different varieties of rice

Treatment	Plant Height cm			Number of tillers		
Nitrogen Level	Growth stage (40 DAT)	Reproductive stage (70 DAT)	Maturity stage (Harvesting)	Growth stage (40 DAT)	Reproductive stage (70 DAT)	Maturity stage (Harvesting)
N0	56.61	65.89	90.1	13.0	15.9	12.24
N1	58.43	69.41	97.9	14.1	18.3	11.32
N2	64.12	75.74	104.8	17.4	16.4	15.07
N3	65.43	75.80	108.6	16.0	19.2	13.72
N4	65.56	77.42	109.9	18.4	20.5	17.10
SEm (±)	3.53	4.06	7.7	1.1	0.8	1.92
CD(P=0.05)	10.09	11.63	22.0	4.2	5.4	5.49
Variety						
V1	64.26	76.99	100.6	15.9	16.7	15.6
V2	68.24	74.29	107.4	16.7	17.6	12.7
V3	60.37	70.66	102.3	18.3	18.2	19.6
V4	64.92	74.68	92.5	16.2	17.2	15.3
SEm (±)	3.94	4.54	8.6	1.3	0.9	2.1
CD(P=0.05)	9.28	8.02	16.6	3.6	2.7	6.1

Table 2: Effect of doses of nitrogen on different varieties of rice

Treatment	Number of leaves		Leaf area Index		Root length (cm)		Root Volume(mm^3)	
Nitrogen Level	Growth stage(40 DAT)	Reproductive stage(70 DAT)	Growth stage(40 DAT)	Reproductive stage(70 DAT)	Growth stage(40 DAT)	Reproductive stage(70 DAT)	Growth stage(40 DAT)	Reproductive stage(70 DAT)
N_0	48.85	78.17	35.54	30.79	11.73	11.69	12.08	22.47
N_1	51.72	80.45	34.79	32.09	14.61	13.09	13.48	20.18
N_2	54.33	79.79	33.69	31.99	12.69	12.86	12.57	19.16
N_3	58.81	83.83	38.11	33.37	13.58	13.65	15.85	23.47
N_4	59.24	82.06	37.69	34.92	15.60	13.13	14.97	23.53
SEm (±)	6.73	2.05	1.00	1.43	1.28	0.92	1.27	1.49
CD(P=0.05)	11.25	5.85	2.87	4.99	3.67	2.64	3.63	4.27
Variety								
V_1	55.96	85.03	37.23	34.59	14.88	12.97	16.68	25.75
V_2	54.78	82.70	38.10	33.37	13.07	13.18	14.46	24.00
V_3	55.36	81.81	33.43	31.48	12.42	12.61	12.42	21.58
V_4	53.84	79.69	32.70	30.48	10.81	10.58	11.61	20.32
SEm (±)	7.52	2.29	1.12	1.60	1.44	1.03	1.42	1.67
CD(P=0.05)	3.52	6.54	6.21	4.57	4.11	2.95	5.32	4.77

N_0=0 Kg ha^{-1},N_1=60 Kg ha^{-1}, N_2=80 Kg ha^{-1}, N_3=100 Kg ha^{-1}, N_4=120 Kg ha^{-1}, V_1=HUR-2-1, V_2=HUR-105, V_3= HUR-917, V_4=HUR-3022.Avg= Average, DAT= Days After Transplanting.

Table 3: Interaction effect of Nitrogen doses and varieties of rice

Treatment	Plant Height (cm) 40 DAT					Plant Height (cm) 70 DAT					Plant Height (cm) at Harvest				
N X V	**V1**	**V2**	**V3**	**V4**	Avg	**V1**	**V2**	**V3**	**V4**	Avg	**V1**	**V2**	**V3**	**V4**	Avg
N0	53.8	58.9	57.3	56.4	56.6	68.0	69.2	71.1	71.3	69.9	85.3	92.4	98.2	84.5	90.1
N1	66.7	62.2	60.1	64.7	63.4	74.1	73.9	71.8	77.9	74.4	94.9	99.1	101.5	96.0	97.9
N2	67.1	64.3	55.6	69.4	64.1	79.0	74.8	69.6	79.6	75.7	106.7	100.8	109.9	101.7	104.8
N3	67.1	59.7	63.4	71.4	65.4	79.0	78.2	71.0	75.0	75.8	106.7	105.8	114.1	107.6	108.6
N4	66.5	66.0	65.4	62.6	65.2	85.0	75.4	79.8	69.6	77.4	104.3	113.8	112.8	72.7	100.9
Mean	64.3	62.2	60.4	64.9	62.9	77.0	74.3	72.7	74.7	74.7	99.6	102.4	107.3	92.5	100.5
SEm (±)	1.76					2.03					3.8				
CD (P=0.05)	5.04					5.81					11.0				
S X L	SIG					SIG					SIG				

Table 4: Interaction effect of Nitrogen doses and varieties of rice

Treatment	No. of tillers 40 DAT					No. of tillers 70 DAT					No. of tillers at Harvest				
N X V	**V1**	**V2**	**V3**	**V4**	Avg	**V1**	**V2**	**V3**	**V4**	Avg	**V1**	**V2**	**V3**	**V4**	Avg
N0	12.4	12.2	13.5	14.0	13.0	13.3	18.3	11.9	13.4	14.2	10.9	19.2	19.3	14.2	15.9
N1	17.9	16.1	12.9	17.3	16.1	16.8	18.8	13.6	16.2	16.3	19.5	20.0	16.6	17.1	18.3
N2	16.0	17.1	13.3	15.1	15.4	15.7	17.5	12.7	14.3	15.1	16.6	16.2	16.4	16.2	16.4
N3	16.0	17.2	12.9	17.8	16.0	15.7	12.3	11.8	15.1	13.7	16.6	15.3	16.3	20.4	17.2
N4	17.2	21.0	19.0	16.5	18.4	16.6	16.4	18.1	17.3	17.1	19.9	17.3	22.5	18.2	19.5
Mean	15.9	16.7	14.3	16.2	15.8	15.6	16.7	13.6	15.3	15.3	16.7	17.6	18.2	17.2	17.4
SEm (±)	0.6					0.96					0.41				
CD (P=0.05)	1.6					2.74					1.49				
S X L	SIG					SIG					SIG				

Table 5: Interaction effect of Nitrogen doses and varieties of rice

Treatment	Number of leaves 40 DAT					Number of leaves 70 DAT					Leaf area Index 40 DAT				
N X V	**V1**	**V2**	**V3**	**V4**	Avg	**V1**	**V2**	**V3**	**V4**	Avg	**V1**	**V2**	**V3**	**V4**	Avg
N0	48.8	49.4	48.4	48.8	48.8	77.2	75.5	80.1	79.9	78.2	37.9	38.3	39.4	38.6	38.5
N1	51.9	51.8	52.1	51.1	51.7	78.0	80.1	80.8	83.0	80.5	35.8	40.4	40.5	38.3	38.8
N2	60.2	55.1	56.1	53.9	56.3	84.4	81.4	83.8	81.4	82.8	37.3	36.8	40.2	40.4	38.7
N3	60.2	59.4	59.2	56.4	58.8	84.4	84.4	86.5	80.0	83.8	37.3	36.9	39.5	38.7	38.1
N4	58.8	58.2	60.9	59.0	59.2	81.1	82.1	82.9	74.2	80.1	37.8	38.1	37.4	37.4	37.7
Mean	56.0	54.8	55.4	53.8	55.0	81.0	80.7	82.8	79.7	81.1	37.2	38.1	39.4	38.7	38.4
SEm (±)	3.37					1.02					0.50				
CD (P=0.05)	9.63					2.93					1.44				
S X L	SIG					SIG					SIG				

Table 6: Interaction effect of Nitrogen doses and varieties of rice

Treatment	Leaf area Index 70 DAT					Root length(cm) 40 DAT					Root length(cm) 70 DAT				
N X V	V_1	V_2	V_3	V_4	Avg	V_1	V_2	V_3	V_4	Avg	V_1	V_2	V_3	V_4	Avg
N_0	31.9	33.9	31.1	30.3	31.8	14.0	12.3	12.6	12.0	12.7	11.4	11.8	11.6	12.0	11.7
N_1	32.2	35.1	30.0	31.1	32.1	16.9	13.9	13.8	13.9	14.6	12.3	13.9	12.3	13.9	13.1
N_2	33.6	30.8	31.7	31.9	32.0	12.8	13.0	12.5	12.4	12.7	14.2	14.0	13.1	14.2	13.9
N_3	33.6	35.5	32.9	31.4	33.4	12.8	12.9	11.3	13.3	12.6	14.2	12.3	13.1	15.0	13.7
N_4	31.7	31.5	31.8	32.7	31.9	12.8	13.3	11.9	12.4	12.6	12.8	14.0	12.9	12.8	13.1
Mean	32.6	33.4	31.5	31.5	32.2	13.9	13.1	12.4	12.8	13.0	13.0	13.2	12.6	13.6	13.1
SEm (±)	0.71					0.64					0.46				
CD (P=0.05)	2.05					1.84					1.32				
S X L	SIG					SIG					SIG				

Table 7: Relative growth rate (RGR) of rice cultivars at different doses of nitrogen

Treatment	Relative Growth Rate(cm/day)		
Nitrogen Level	**Growth stage (40 DAT)**	**Reproductive stage (70 DAT)**	**Maturity stage (Harvesting)**
N0	55.95	33.44	20.49
N1	62.59	34.77	31.88
N2	63.27	35.99	25.97
N3	64.54	39.00	32.04
N4	64.28	35.47	27.56
SEm (±)	3.44	3.01	9.23
CD(P=0.05)	9.84	8.61	26.40
Variety			
V1	63.40	36.97	27.03
V2	61.43	32.35	23.10
V3	59.61	34.03	31.29
V4	64.05	39.59	28.92
SEm (±)	3.85	3.37	10.32
CD(P=0.05)	11.00	9.63	29.52

Table 8: Crop growth rate (CGR) of rice cultivars at different doses of nitrogen

Treatment	Crop Growth Rate(CGR) (gm^{-2} d^{-1})		
Nitrogen Level	**Growth stage (40 DAT)**	**Reproductive stage (70 DAT)**	**Maturity stage (Harvesting)**
N0	6.83	17.84	37.48
N1	6.25	17.87	37.50
N2	7.10	18.94	39.13
N3	7.22	19.61	40.18
N4	6.82	18.54	39.67
SEm (±)	1.45	4.21	5.69
CD(P=0.05)	4.15	12.04	16.29
Variety			
V1	6.39	18.34	38.19
V2	7.28	18.46	38.42
V3	6.69	18.06	37.82
V4	7.01	19.38	40.74
SEm (±)	1.62	4.70	6.37
CD(P=0.05)	4.64	13.46	18.21

Result and Discussion

Days taken to attain different phenophases of rice cultivars at different days of transplanting have been depicted in table 1. From table 1 it was revealed that days taken to attain maximum plant height 30 days after transplanting, 70 days after transplanting and at the time of harvesting of N_3& N_4 doses of nitrogen given significant effect on plant height and remaining doses have no significant effect. Among two doses N_3 & N_4, N_4 dose is superior. Among the varieties variety for (V_1) HUR-2-1 the days taken to attain maximum plant height (68.76 cm) and remaining varieties (V_2, V_3 and V_4) are at par. The interaction effect recorded V_1 and N_4 is the superior in case of plant height (table 3). From table 1 it was revealed that days taken to attain maximum number of tillers(17 $hill^{-1}$) 30

days after transplanting (18 hill^{-1}), 70 days after transplanting (20 hill^{-1}) and at the time of harvesting (17 hill^{-1}) of N_3& N_4 doses of nitrogen given significant effect on number of tillers and remaining doses have no significant effect. Among two doses N_3 & N_4, N_4 dose is superior. Among the varieties variety for (V_1) HUR-2-1 the days taken to attain maximum number of tillers (18 hill^{-1}) and remaining varieties (V_2, V_3 and V_4) are at par. The interaction effect recorded V_1 and N_4 is the superior in case of number of tillers (table 4). From table 2 it was revealed that days taken to attain maximum number of leaves 30 days after transplanting (59 hill^{-1}), 70 days after transplanting (82 hill^{-1}) of N_3& N_4 doses of nitrogen given significant effect on number of leaves and remaining doses have no significant effect. Among two doses N_3 & N_4, N_4 dose is superior. Among the varieties, variety for (V_1) HUR-2-1 the days taken to attain maximum number of leaves 30 DAT 59 hill^{-1} and 70 DAT recorded highest leaves (82hill^{-1}) and remaining varieties (V_2, V_3 and V_4) are at par. The interaction effect recorded V_1 and N_4 is the superior in case of number of leaves (table 5).From table 2 it was revealed that days taken to attain maximum leaf area index at 30 days after transplanting (37 hill^{-1}), 70 days after transplanting (34 hill^{-1}) of N_3& N_4 doses of nitrogen given significant effect on leaf area index and remaining doses have no significant effect. Among two doses N_3 & N_4, N_4 dose is superior. Among the varieties, variety for (V_1) HUR-2-1 the days taken to attain maximum leaf area index at 30 DAT recorded (34 hill^{-1})and 70 DAT recorded highest leaf area index (33 hill^{-1}) and remaining varieties (V_2, V_3 and V_4) are at par. The interaction effect recorded V_1 and N_4 is the superior in case of leaf area index (table 5).From table 2 it was revealed that days taken to attain maximum root length at 30 days after transplanting (13 hill^{-1}), 70 days after transplanting (15 hill^{-1}) of N_3& N_4 doses of nitrogen given significant effect on root length and remaining doses have no significant effect. Among two doses N_3 & N_4, N_4 dose is superior. Among the varieties, variety for (V_1) HUR-2-1 the days taken to attain maximum root length at 30 DAT recorded (16hill^{-1}) and 70 DAT recorded highest root length (25 hill^{-1}) and remaining varieties (V_2, V_3 and V_4) are at par. The interaction effect recorded V_1 and N_4 is the superior in case of root length (table 6).From table 2 it was revealed that days taken to attain maximum root volume at 30 days after transplanting (14 hill^{-1}), 70 days after transplanting (23 hill^{-1}) of N_3& N_4 doses of nitrogen given significant effect on root volume and remaining doses have no significant effect. Among two doses N_3 & N_4, N_4 dose is superior. Among the varieties, variety for (V_1) HUR-2-1 the days taken to attain maximum root volume at 30 DAT recorded (16 hill^{-1}) and 70 DAT recorded highest root volume (25 hill^{-1}) and remaining varieties (V_2, V_3 and V_4) are at par. The interaction effect recorded V_1 and N_4 is the superior in case of root volume (table 6). The relative growth rate and crop growth rate recorded also same trends (Table: 7. and 8.)

Conclusion

In the case of varieties of rice HUR-2-1 recorded the highest vegetative growth parameter such as plant height, number of tillers, number of leaves, leaf area index, root volume and root length and in the case of nitrogen N_4On the basis of above findings the performance of rice variety and doses of nitrogen and there interaction given the significant effect.

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