



The impact of nitrogen levels and varieties on growth, yield and economics of rice (*Oryza sativa* L.)

Minakshi Gupta, Sudhakar Singh, Deepak Pandey, PK Singh, SS Chanda

Department of Agronomy, Chandra Bhanu Gupta Agriculture Post Graduate College, Bakshi Ka Talab, Lucknow, Uttar Pradesh, India

Abstract

The present investigation entitled “The impact of nitrogen levels and varieties on growth, yield and economics of rice (*Oryza sativa* L.)” was conducted at Shradhay Bhagwati Singh Agriculture Research Farm, Hajipur of Chandra Bhanu Gupta Krishi Mahavidyalaya, Bakshi Ka Talab, Lucknow (U.P.) during kharif season of 2023. The experiment was laid out in factorial randomized block design with three replications keeping three varieties viz. NDR-2065, NDR-2064 and SHIUAT-1 in main plot and four nitrogen levels (0, 60, 120, 180) in sub plots. The experimental site was silty loam having medium organic Carbon (0.45%) and available nitrogen (376.0 kg ha⁻¹). Phosphorous (25.54 kg ha⁻¹) and potassium (165.84 kg ha⁻¹). Result revealed that there was significant variation among different varieties and in different nitrogen levels respect of growth. Growth parameters were higher in NDR-2065 variety as compare to rest of varieties. The yield attributes as effective tillers m⁻², panicle length (cm.), numbers of grains panicle⁻¹, grains weight panicle⁻¹ (g), panicle weight (g) and 1000 grain weight were significantly superior in NDR-2065. Variety NDR-2065 proved significantly superior in terms of grain, straw, total biological yield and harvest index when compared to rest of varieties. The N-Uptake (kg ha⁻¹) were significantly superior in NDR-2065 in grain and straw. The Protein – production (kg ha⁻¹) were significantly superior in NDR-2065 in grain and straw. Growth parameters as plant height (cm), dry matter accumulation (gm⁻²), leaf area index, yield attributes and yield of rice were higher in paddy with nitrogen level 180 kg ha⁻¹ as compared to rest of levels of nitrogen. The N-Uptake (kg ha⁻¹) and Protein yield (kg ha⁻¹) were significantly superior in paddy with nitrogen level 180 kg N ha⁻¹ in grain and straw as compared to rest of levels of nitrogen. NDR-2065 variety with 180 kg N ha⁻¹ had higher gross return, net return, and B C ratio of rice crop.

Keywords: Nitrogen, varieties, growth, yield and economics

Introduction

Rice (*Oryza sativa* L.) belongs to Poaceae (Gramineae) family with chromosome number 2n=24. It constitutes 12% water, 75 - 85% starch & only 7% protein with a full complements of amino acid with very low amount of Phosphorus, Iron & some quantity of Calcium. Rice provides 35 - 60% of the dietary calories and 50 - 80% of the energy intake of the people in developing countries. Rice involves a significant spot in Indian agriculture as it contribute 15% of yearly GDP and gives 43% calorie prerequisite to over 70% of Indians.

In World, rice is grown on 165.25 million hectares with total production 756.7 million tonnes in 2020-21. The production has increased to 30.42 q ha⁻¹ of milled rice in the last harvesting year of worldwide (Shahbandeh M, 2022). India is the world's second largest rice (*Oryza sativa* L.) producer and consumer next to China. Total area under rice in India rice is sown on 46.38 million hectares area with production of 130.29 million tonnes with average productivity of 2809 kg ha⁻¹ (Anonymous, 2022). Uttar Pradesh state contributes 9.85 million ha area under rice with an annual production of 35.50 million tonnes and productivity of 3604 kg/ha (Directorate of Economics & statistics, 2020-21) [1]. The productivity of rice in U.P. is considerable lower on compared to West Bengal (2984.0 kg/ha.), Punjab (3337 kg ha⁻¹) and Odisha (2173.00 kg ha⁻¹). Among the states, Uttar Pradesh occupied second after west Bengal where contributing 13.80% to the total rice production of the nation (Anonymous, 2021-22).

Nitrogen is normally a key factor in achieving optimum rice grain yields. It is, however, one of the most expensive inputs

and if used improperly, can pollute the ground water. Although, rice is grown in different ecosystems, 78% of the world's rice is grown under irrigated or rainfed lowland conditions (IRRI, 1997).

Nitrogen (N) is a primary nutrient for all crops. The nitrogen requirement for cereal crops is higher when compared to other crops for its growth, development and grain production (Sahrawat, 2000). Providing adequate amounts of nitrogen throughout the growing period is necessary for acquiring potential yields. Nitrogen enhances the plant growth, improves grain yield and quality through increased tillering, leaf area development, grain formation, grain filling and protein synthesis. Presently 50 per cent of human population depends on nitrogen fertilizer for food production (Ladha *et al.*, 2005) [2].

There are different varieties of paddy developed recently like CO-51, SHIUAT-1, NDR-2064, NDR-2065. These newly developed varieties have their different yield potential under different nutrients management practices. These distinct strains of rice have gained popularity due to their exceptional features and ability to significantly boost yields. SHIUAT-1 is a newly released high yielding, fine grain quality and mid-early duration (maturity 128- 130 days) variety. The close discussion with farmers it was found that farmers have keen interest in adopting the improved HYVs but they not use proper agronomical practices like optimum dose of nitrogen due to lack of knowledge are also the reasons responsible for limiting the production and productivity of paddy. Keeping this in view the Directorate of Extension, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj conduct

FLDs to introduce and popularized of SHIUAT-1 variety on farmer field. NDR-2064, NDR-2065 a late duration rice variety was development at Crop Research Station, Masodha, Faizabad U.P. Another crucial features of NDR-2064 paddy varieties is their robust resistances against common rice disease and pests. Farmer find it advantageous as it positively impacts their profitability while minimizing environmental damage caused by excessive pesticide use. NDR-2064 paddy varieties exhibit a remarkable level of adaptability to diverse environmental conditions and climate changes.

Materials and method

A field experiment entitled “The impact of nitrogen levels and varieties on growth, yield and economics of rice (*Oryza sativa* L.)” was conducted at the Shradhay Bhagwati Singh Agriculture Research (Hajipur), Chandra Bhanu Gupta Krishi Snakottar Mahavidyalaya, B.K.T., Lucknow (Uttar Pradesh) during kharif season 2023. The soil of experimental field was slightly alkaline in reaction (7.8 PH), low in organic carbon (0.45%) and available nitrogen (376.0 kg ha⁻¹), medium in phosphorus (25.54 kg ha⁻¹) and potassium (165.84 kg ha⁻¹). experimental site falls under sub-tropical zone and is situated at 26.50°C North latitude, 80.52°C East longitudes with an altitude of 123 metres above mean sea level. The experimental field was properly leveled after ploughing by using leveler and plot are made according to required size (4 x 3 m²) for conducting research. Land was divided into individual experimental plot with the proper arrangement of bunds and irrigation channel as per the lay out specifications. The experiment was laid out in factorial Randomized block design keeping varieties in main plot and nitrogen levels in sub-plot. The factor of experiment include three varieties viz. NDR-2065, NDR-2064, SHIUAT-1 and four nitrogen levels viz. 0 kg ha⁻¹, 60 kg ha⁻¹, 120 kg ha⁻¹, 180 kg ha⁻¹ with three replication. The required seed was soaked in water and removed after 48 hours and tight in gunny bag till it sprouted. The sprouted seed were take in tray and sown in nursery bed. Seed was sown on 7th June 2023. 28 days old seedlings were transplanted on 02 July 2023 in well prepared puddled field. Pre emergence spray of pretilachlor @ 1.5 liter ha⁻¹ was done 2-3 days after transplanting,

followed by hand weeding at 40 DAT to control weeds. The crop was irrigated as and when required. All improved cultural practices were used to raise the crop. The data on plant height and tillers were recorded from the area already marked and tagged. From 3 plant in each plot sample for dry matter accumulation was recorded by cutting of plants 2 hill from transplanting method. The sample for dry matter accumulation were first sun dried then kept in hot hair oven 72° C 0.5° C for 48 hours till the constant weight was achieved. Yield attributes were recorded from 5 spikes selected randomly from each plot at harvest of crop. Grain and straw yield of rice was recorded at harvest, and harvest index (%) was calculated as grain yield divided by total biological yield and multiplied by hundred. The soil and plant analysis was done by using standard laboratory methods. The uptake of nutrients was calculated by multiply nutrient content (%) in grain and straw yield. Economics of different treatments was worked out on the basis of prevailing market prices.

Result and discussion

Growth characters

The data presented in Table No.1 revealed that plant height (cm), number of tillers (m²), leaf area index and dry matter accumulation (g/m²) of rice were affected significantly due to the different varieties. Variety NDR-2065 recorded significantly tallest plant (128.88 cm), higher number of tillers (324.41 m²), highest dry matter accumulation (595.10 g/m²), and leaf area index (4.73) over NDR-2064.

Nitrogen levels significantly influenced the plant height, number of tillers, leaf area index and dry matter accumulation of rice. Nitrogen level 180 kg/ha recorded maximum plant height (130.31 cm), maximum number of tillers (360.66 m²), leaf area index (5.10) and dry matter accumulation (610.90 g/m²). The increase in plant height with increase in nitrogen levels might be due to increase in availability of nitrogen which enhance the metabolic activities which in with improve the cell division and cell elongation of the plant. Thus, more height was recorded. These results are also in agreement with Halder *et al.* (2008) and Uddin *et al.* (2013) [7].

Table 1: Growth attributes of wheat as affected by methods of sowing and levels of nitrogen management (at harvest stage)

Treatment	Plant height (cm) at harvest	Number of tillers m ⁻² at harvest	Dry matter accumulation (g/m ²) at harvest	Leaf area index at 90 DAT
Varieties				
NDR-2065	123.81	321.25	595.10	4.73
NDR-2064	121.65	319.41	510.28	4.65
SHIUAT-1	120.47	314.25	499.50	4.39
SE(m) ±	0.09	0.47	4.98	0.07
C.D (P=0.05)	0.26	1.41	14.70	0.22
Nitrogen levels (kg ha ⁻¹)				
N ₀ -0	102.50	221.25	338.10	2.99
N ₁ -60	121.13	319.00	498.50	4.46
N ₂ -120	123.65	349.11	585.10	4.91
N ₃ -180	126.93	356.00	610.90	5.10
SE(m) ±	0.10	0.55	5.75	0.07
C.D (P=0.05)	0.30	1.62	16.98	0.22

Development studies

The maximum days taken to 50% flowering (73.26) and maturity (115.84) was taken under NDR-2065 which was followed by NDR-2064. Different varieties marked variation on days to 50% flowering and physiological maturity. NDR-2065 delayed to 50% flowering and physiological maturity as compared to NDR-2064. Similar trends of variation in respect of days to 50% flowering and

maturity in rice has also been reported by Shekhar *et al.* (2009).

The maximum days taken to 50% flowering (73.27) and maturity (115.96) was recorded under 180 kg N ha⁻¹. Days to 50% flowering and physiological maturity influenced significantly due to levels of nitrogen. 180 kg N/ha delayed to 50% flowering and physiological maturity as compared to 120 kg N/ha. Similar trend was also reported by Singh *et al.* (2012) [6].

Table 2: Days taken to 50% flowering and Days taken to maturity of rice as affected by different varieties and nitrogen levels

Treatment	Days taken to 50% flowering	Days taken to maturity
Varieties		
NDR-2065	73.26	115.84
NDR-2064	71.20	113.19
SHIUAT-1	68.38	111.15
SE(m) ±	0.12	0.08
C.D (P = 0.05)	0.35	0.24
Nitrogen levels (kg ha ⁻¹)		
N ₀ - 0	68.63	110.68
N ₁ - 60	70.32	112.62
N ₂ - 120	71.57	114.32
N ₃ - 180	73.27	115.96
SE (m)	0.13	0.09
C.D (P = 0.05)	0.40	0.28

Yield attributes

Among the variety NDR-2065 recorded the maximum value of effective panicle(m²), panicle length, no. of grain panicle⁻¹, weight of grain/panicle (g) and test weight i.e. 325.41, 23.18 204.08, 3.44 and 21.75 which was followed by NDR-2064 variety. The better growth parameter of NDR-2065 owing to higher photosynthetic efficiency and synthesis of photosynthetic and its translocation to sink might have improved the value of all yield attributes as compared to poor growth parameter owing to poor photosynthetic efficiency and its slow translocation to sink caused lower value of all yield attributes with rest two varieties of rice.

Nitrogen levels 180 kg N ha⁻¹ produced maximum effective panicle m² (354.33), panicle length (23.78), no. of grain panicle⁻¹(196.44), weight of grain/panicle (3.42g) and test weight (21.33 g). The higher availability of nutrients with increasing levels of nitrogen resulted in higher growth due to increasing metabolic activities, and formation of higher amount of photosynthetic and its translocation to sink thus improved all yield attributes of crop. Adequacy of nitrogen probably favoured the proper cellular activities during panicle formation and development, which led to increased effective panicle m². These findings are in close conformity with those of Pandey *et al.* (2001) [3].

Table 3: Yield attributes of rice as affected by different varieties and levels of nitrogen

Treatment	Effective panicle (m ²)	Panicle length (cm)	No. of grains panicle ⁻¹	Weight of grain/panicle (g)	Test wt. (g)	Grain Yield (q ha ⁻¹)	Straw Yield (q ha ⁻¹)
Varieties							
NDR-2065	325.41	23.18	204.08	3.44	21.75	55.96	74.95
NDR-2064	316.16	22.15	171.58	2.88	19.78	48.55	65.18
SHIUAT-1	312.91	21.70	168.75	2.80	19.71	42.76	64.50
SE(m) ±	0.39	0.03	2.88	0.04	0.21	0.05	0.10
C.D (P=0.05)	1.15	0.10	8.51	0.14	0.63	0.14	0.30
Nitrogen levels (kg ha ⁻¹)							
N ₀ -0	257.33	18.32	130.10	1.31	18.58	28.55	44.70
N ₁ -60	316.33	21.82	178.77	2.93	20.10	40.30	60.72
N ₂ -120	344.66	22.68	189.97	3.32	20.98	49.71	69.45
N ₃ -180	346.10	22.78	196.44	3.42	21.33	52.60	70.98
SE(m) ±	0.55	0.03	3.32	0.05	0.14	1.12	0.47
C.D (P=0.05)	1.79	0.11	9.82	0.16	0.44	3.37	1.58

Yield studie

Among N levels, crop fertilized with 180 kg N ha⁻¹ which was non-significantly higher than 120 kg N ha⁻¹ but produced significantly maximum grain yield (52.60 q ha⁻¹), straw yield (70.98 q ha⁻¹), biological yield (123.64 q ha⁻¹) and harvest index (42.55 %) over rest levels of nitrogen. The lowest values of all yield was recorded significantly with crop without nitrogen treatments.

The higher yield was observed with application of nitrogen at 180 kg ha⁻¹ which might be due to higher growth and yield attributes which was due to efficient translocation of photosynthates from source to sink. This was in accordance with the findings of Uddin *et al.* (2013) [7] and Pradhan *et al.* (2014) [4].

Economics

The maximum net return (101463.08 Rs.), and B C ratio (2.02) was recorded with treatment combination V₁N₃ (NDR-2065 + 180 kg N ha⁻¹). Different variety maximum net return and benefit: cost ratio which might be due to the higher yield of grain and straw. Similar findings were

reported by Kumar *et al.* (2013). However, nitrogen fertilization applications of both 120 and 180 kg ha⁻¹ were at par in realizing the maximum net return and benefit: cost ratio under study. Singh and Srivastava (2001) reported the similar findings.

Table 4: Effect of varieties and nitrogen levels on economics of each treatment combinations

Treatment combination	Net return (Rs. ha ⁻¹)	B C ratio
V ₁ N ₀	91580.8	1.95
V ₁ N ₁	93908.65	1.96
V ₁ N ₂	97848.38	1.99
V ₁ N ₃	101463.08	2.02
V ₂ N ₀	72483.79	1.55
V ₂ N ₁	76674.44	1.59
V ₂ N ₂	77694.12	1.58
V ₂ N ₃	80990.08	1.61
V ₃ N ₀	55835.8	1.19
V ₃ N ₁	60461.16	1.25
V ₃ N ₂	64980.5	1.32
V ₃ N ₃	75992.68	1.51

Conclusion

It can be concluded from above result that Rice variety NDR-2065 sown with 180 kg ha⁻¹ N level obtain maximum yield and maximum B C ratio.

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