Original Research Article

Response of rice varieties at varying nitrogen levels

ABSTRACT

A field investigation to ascertain the response of rice varieties at varying nitrogen levels was conducted at Crop Research Farm, Department of Agronomy, Sam Higginbottom University of Agriculture, Technology a nd Sciences, Prayagraj, U.P, during the Kharif 2022 with nine treatments replicated thrice in randomized block design, which consists ofthree rice varieties (NDR-359, SahbhagiDhan, BPT-5204) and three nitrogen levels (100, 120, 140 kg ha^{-1}).The results revealed that application of nitrogen 120 kg ha^{-1} in SahbhagiDhan recorded significantly higher plant height (146.20 cm), dry weight (103.77 g hill^{-1}), grain yield (4.27 t ha^{-1}) and straw yield (7.23 t ha^{-1}), highest gross returns (1,00,166.70 INR ha^{-1}), net returns (60,185.92 INR ha^{-1}) and benefit cost ratio (1.52). However, number of tillers hill^{-1} (30.87), number of productive tillers hill^{-1} (8.93), number of grains panicle^{-1} (115.87) and harvest index (38.71%) were recorded significantly higher in BPT-5204withnitrogen 120 kg ha^{-1}.The best application was thus found to be at the 120kg ha^{-1}nitrogen level.

Keywords: Rice varieties, Nitrogen application, Yield and economics

Introduction

"Rice is Life" for many people and "Food for Life" for more than half of the world's population. More than 90% of the world's rice is produced and consumed in Asia (Amar Singh and Bhim Singh, 2021; Debbarma et al., 2015; Ghosh et al., 2014). It is the important crop for national food security as it is the means of livelihood for numerous rural households (Reddy A Amarendar, 2018; Seema et al., 2015) and fulfill 43% calorie requirement of more than 70% of Indians. Hence, termed as "Global Grain" (Srinivas et al., 2015). Rice (*Oryzasativa* L.) is grown in 45.07 mha in India with the production level of 122.27 mt and the national average productivity is about 2,713 kg ha^{-1}. Annual production of rice in Uttar Pradesh is 15.66 mt from an area of 5.68 mha, with productivity of 2,759 kg ha^{-1} (Anonymous, 2021).

Varietal substitution for enhancing the yield per unit cultivable areawith judicious use of fertilizers especially nitrogen fertilizationis the best efficient sustainably possible way to meet the demand of food for growing population.The breeding of high yielding varieties has laid the basis for rice production in India. Numerous rice varieties were being developed for mitigating biotic stress (pest tolerance and disease resistance) and abiotic stress (floods and drought tolerance) that helps in yield augmentation.

Apart from varietal substitution, productivity and quality of rice depends upon judicious nitrogen fertilization (Sridhar et al., 2022). Nitrogen is one of the irreplaceable elements for development of various plant cellular systems (Sangwan et al., 2022) and its deficiency limits crop production (Arif et al., 2019).Nitrogen is essential in rice crop being a component in synthesis of amino acids, nucleic acids, enzymes and hormones (Panda et al., 2021). It comprises 1.5-2% of plant dry matter and on average 16% of total plant protein (Weckwerth et al., 2020).Excessive nitrogen fertilization not only increase the input cost but also encourages rapid vegetative growth which makes the plant susceptible to insect, pest and diseases (Jana, 2014; Wani et al., 2017) which increases the sensitivity of rice crop to lodging and ultimately reduces yield (Wang et al., 2022). Crop varieties can give the anticipated yield per unit area, when grown under favourable environmental conditions and nitrogen fertilization management without which they are unable to manifest their productivity and enhance income to farmer. Keeping in view the above points,the present studywas hypothesized to assess the effect of different graded nitrogen levels on growth parameters, yield attributes, yield and economy of three rice varieties.

MATERIALS AND METHODS

The experiment was conducted during the *kharif* season, 2022 in Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University Agriculture, Technology and Sciences, Prayagraj located at 25°39’42’’N latitude, 81°67’56’’E longitude and 98 m altitude above the mean sea level. The soil of experimental field was sandy loam texture, with a pH of 7.3, organic carbon (1.137%), electrical conductivity (0.762 m.m cm^{-1}), nitrogen (278.48 kg ha^{-1}), phosphorus (48.1 kg ha^{-1}) and potassium (253.5 kg ha^{-1}). The experiment was laid out in randomized block design which consists nine treatments and were replicated thrice. The treatmentcombinations embodies three varieties of rice namely; NDR-359, SahbhagiDhan, BPT-5204 and three levels of nitrogen (100, 120, 140 kg ha^{-1}). Sprouted rice seeds were sown on 27^{th} June and seedlings were raised in nursery.Application of recommended dose of phosphorus 60 kg ha^{-1} through di-ammonium phosphate (DAP), potassium 40 kg ha^{-1}through murate of potash (MOP) and ¼ of the nitrogen dose were applied during main field preparation. Half(½) nitrogen dose was applied in tillering stage and remaining ¼ dosage of nitrogen was applied during panicle initiation stage through Urea. Well grown 30 days old nursery seedlings were transplanted in main field with a spacing of 30 × 10 cm on 27^{th} July. Manual weeding during initial 2 weeks after transplanting is done with proper irrigation whenever required. Observations were recorded on growth parameters (plant height, dry weight, number of tillers $hill^{-1}$), yield attributes, grain yield, straw yield and harvest index. Net returns, gross returns and benefit cost ratio were calculated for different treatments. The recorded data of various parameters was statistically analyzed following the Gomez and Gomez (1984) standard analysis of variance (ANOVA) technique.

RESULTS AND DISCUSSION

Growth attributes

Growth attributes like plant height, number of tillers $hill^{-1}$, dry weight, crop growth rate of various varieties as influenced by varying nitrogen levels were recorded and embodied in Table 1.

Significantly highest plant height (146.20 cm) was recorded with the application nitrogen 120 $kgha^{-1}$ in SahbhagiDhan variety. Significant response in plant height was recorded among varieties with different levels of nitrogen which might be due to the varietal genetic make-up and agronomic traits. The fact that due to the supply of nitrogen favours greater absorption of nutrients and better accumulation of photosynthatesresulting in increased plant height (Murthy et al.,2015).

Significantly highest number of tillershill^{-1} (30.87) were observed in BPT-5204 variety with application of 120 kg Nha^{-1}. This might be due to the differential response of tillering in the genotype could be attributed to its genetic potentiality. Tillering rate was highly influenced by many environmental factors such as nutrient availability, soil water status, competition with weeds and diseases.In fact, nitrogen encouraged the plant foliage and boosted plant growth, also responsible for branching or tillering, leaf production (Arya et al.,2019). Similar results were reported by Reddy et al. (2022).

Highest dry weight (103.77 g hill^{-1}) was recorded with the application of 120 kg Nha^{-1} in Sahbhagi Dhan variety. Increase in plant dry weight in different stages of growth of all the varieties due to the fact that adequate supply of nitrogen resulted in higher number of tillers, photosynthetic area, which leads to accumulation of dry matter. Jadon et al. (2015) reported that increased rate of nitrogen improved overall growth of the crop in term of dry matter production per plant due to impact on morphological and photosynthetic components along with accumulation of nutrients.

Significantly highest crop growth rate (64.95 g m^{2} day^{-1}) during 40-60 days after transplanting (DAT) was recorded in Sahbhagi Dhan variety with application of nitrogen 120 kg ha^{-1}. Highest relative growth rate (0.076 g g^{-1} day^{-1}) was observed during the initial growing stages of crop (20-40 DAT). Variation in crop growth rate among the treatment combinations might be due the varietal response towards the applied nitrogen levels by accumulation of photosynthates and tillering capacity.

Yield attributes and Yield

Table 2. embodies the data regarding yield attributes (number of productive tillers hill^{-1}, number of grains panicle^{-1}, test weight), grain yield, straw yield and harvest index.

Significantly highest number of productive tillers hill^{-1} (8.93), highest number of grains panicle^{-1} (115.87) were recorded with the application of 120 kg Nitrogen ha^{-1} in BPT-5204 varietywith application of 120 kg Nitrogen ha^{-1}. Significantly higher test weight was recorded in NDR-359 variety with application of 120 kg Nitrogen ha^{-1} (21.00 g). Significantly highest grain yield (4.27 t ha^{-1}), straw yield (7.23 t ha^{-1}) was recorded in Sahbhagi Dhan variety with application of nitrogen 120 kg ha^{-1} was recorded in SahbhagiDhan variety with application of nitrogen 120 kg ha^{-1}. Significantly higher harvest index (38.71%) was recorded in BPT-5204 variety with application of nitrogen 120 kg ha^{-1}.

Variations in yield attributes might be due to the impact genetic character and adaptability to the environment and climatic conditions that determines the tillering potential of rice varieties (Rai et al., 2020). Number of panicles hill^{-1}are dependent on tillering ability of the variety based on the dosage of N fertilization (Vishnukiran et al., 2020). The productivity parameters are based on the cumulative effect of the genetic ability and production efficiency of the varieties, their fertility management and the agro-climatic conditions of growing region. Nitrogen absorbed by rice during the vegetative growth stages contributes in growth during reproduction and grain-filling through translocation. Adequate nitrogen fertilization in rice crop plays kingpin role in augmenting number of productive tillers and grains, test weight which enhances grain yield. Nitrogen prime fu nction of assimilates accumulation and in turn facilitating higher nitrogen assimilation with adequate supply of photosynthates to grain (Murthy et al., 201; Jana 2014). Nitrogen supplied in adequate amount resulted in more profuse tillering which leads to accumulation of dry matter in early stages which have enhanced straw yield. These results are in line with Dar et al. (2020). Jehangir et al. (2022) also reported that many workers found that there was a significant increase in grain, straw and biological yield of rice variety with a limited dose of nitrogen ha^{-1}.

Economics

Table 3. embodies the data regarding gross returns, net returns and benefit cost ratio. Highest gross returns (1,00,166.70 INR ha^{-1}), net returns (60,185.92 INR ha^{-1}) and benefit cost ratio (1.51) were recorded with the SahbhagiDhan variety with application of Nitrogen 120 kg ha^{-1} might be due to the market price of the for the graded level based on the quality of the seed. The application of nitrogen at required amount might have enhanced the productivity of the variety which enhanced the gross returns, net returns and benefit cost ratio.These results are in line with Rai et al., (2020) and Jehangir et al., (2022).

Based on the study it can be concluded that rice variety SahbhagiDhan with application of Nitrogen 120 kgha^{-1} is recommended under Eastern Uttar Pradesh Agro-Climatic conditions for highest yield and economic returns.The best application was thus found to be at the 120kg ha^{-1}nitrogen level.

REFERENCES

Amar Singh and Bhim Singh. 2021. Quadratic Trend Model for Forecasting of Rice in Western Uttar Pradesh. *Environ. Ecol.*, **39**(3): 584-588.

Anonymous, 2021. Directorate of Economics and Statistics. Ministry of Agriculture and Farmers Welfare Depar tment of Agriculture, Cooperation & Farmers Welfare, Government of India. Agricultural statistical at a glance data 2021.

Arif, M., Dashora, L.N., Choudhary, J., Kadam, S.S. and Moshin, M. 2019. Effect of nitrogen and zinc manage ment on, growth yield and economics of bread wheat (*Triticumaestivum*) varieties. *Indian J. Agric. Sci.*, **89**(10): 1664-8.

Arya, R.K., Tiwari, R.K., Mishra, R.M., Choudhari, M.K. and Namdeo, K.N. 2019. Performance of rice (*Oryza sativa*) varieties to applied nitrogen under irrigated condition. *Ann. PlantSoil Res.*, **21**(3): 221-225.

Dar, M.H., Waza, S.A., Shukla, S., Zaidi, N.W., Nayak, S., Hossain, M.et al. 2020. Drought tolerant rice for ensuring food security in eastern India. *Sustainability*. 12, 2214. doi:10.3390/su12062214

Debbarma, S., Senapati, B.K. and Prasad, I.2015. Assessment of genetic parameters for quantitative characters in summer rice (Oryzasativa L.). *Environ. Ecol.*,**33**(1B): 507-512.

Ghosh, M., Patra, P.K. and Bhattacharyya, C. 2014. Effect of limited irrigation on growth and yield of rice varieties in a typicHaplustalf soil of Red and Laterite zone of West Bengal. *J. Crop and Weed*, **10**(1): 42-47.

Gomez, K.A. and Gomez, A.A.1984.Statistical procedures for agricultural research, second edition,John Wiley and Sons, New York.

Jadon, K.P.S., Gupta, D., Singh, S.B., Singh, L. and Singh, P. 2015. Effect of nitrogen on growth, yield and nutrient uptake by malt barley genotypes. *Ann. PlantSoil Res.*,**17**(4): 377-380.

Jana, K., 2014. Nitrogen response of promising rice entries under rainfed shallow lowland of red and laterite zone of West Bengal, India. *J. Crop and Weed*,**10**(2): 497-499.

Jehangir, I.A., Hussain, A., Wani, S.H., Mahdi, S.S., Bhat, M.A., Ganai, M.A. et al. 2022. Response of Rice (Oryza sativa L.) Cultivars to Variable Rate of Nitrogen under Wet Direct Seeding in Temperate Ecology. *Sustainability*, 14, 638. https://doi.org/10.3390/su14020638

Murthy, D.K.M., Rao, A.U., Vijay, D. and Sridhar, T.V. 2015. Effect of levels of nitrogen, phosphorus and potassium on performance of rice. *Indian J. Agric. Res.*,**49**(1): 83-87.

Rai, A.K., Dash, S.R., Behera, N., Behera, T.K. and Das, H. 2020. Performance of drought tolerant rice varieties in Malkangiri district of south eastern ghat zone of Odisha.*Curr. Agri. Res.*, **8**(2): 157-162.

Reddy A Amarender, 2018. Report on Socio-Economic Impact Assessment of Improved Samba Mahsuri (ISM), National Institute of Agricultural Extension Management (MANAGE), Rajendranagar, Hyderabad – 500030, Telangana State, India. 68 pp.

Reddy, P.D., Pal, A. and Reddy, M.D. 2022. Effect of nitrogen levels on yield of rice varieties during kharif in south Odisha. *Crop Res.*,**57**(3): 108-112.

Sangwan, M., Hooda, V.S. and Singh, J. 2022. Effect of nitrogen fertilization on agro-physiological and quality parameters of dual-purpose wheat (*Triticumaestivum*). *Indian J. Agron.*,**67**(3): 252-256.

Seema., Pandey, P.C., Singh, D.K. and Thoithoi, M. 2014. Effect of weed management practices along with boron manuring on yield of aerobic rice and weed control efficiency at different nitrogen levels. *Environ. Ecol.*,**33**(2A): 819-822.

Sridhar, K., Srinivas, A., Kumar, K.A., Prakash, T.R. and Rao, P.R., 2022. Productivity, nutrient uptake and productivity of winter season rice (Oryza sativa) varieties as influenced by alternate wetting drying irrigation and nitrogen management. *Indian J. Agron.*,**67**(2): 113-122.

Srinivas, T., Sameera, S., Bharathi, D. and Chamundeswari, N., 2015. Assessment of genetic diversity for grain yield and quality traits in released rice varieties of Andhra Pradesh. *Environ. Ecol.*, **33**(4A), 1791-1794.

Panda, N. and Dash, A.K., 2021. Nitrogen management can boost rice (Oryza sativa L.) production near aluminium smelter: A field study. *Oryza*,**58**(4): 217-524.

Vishnukiran, T., Neeraja, C.N., Jaldhani, V., Vijayalakshmi, P., Rao, P.R., Subramanyam, D. et al. 2020. A major pleiotropic QTL identified for yield components and nitrogen content in rice (Oryz a sativa) under differential nitrogen field conditions. *PLoS One*, 15(10), e0240854. https://doi.org/10.1371/journal.pone.0240854

Wang, W., Shen, C., Xu, Q., Zafar, S., Du, B. and Xing, D. 2022. Grain Yield, Nitrogen Use Efficiency and Ant ioxidant Enzymes of Rice under Different Fertilizer N Inputs and Planting Density. *Agronomy (Basel, Swtz.)*,**12**(2): 430. https://doi.org/10.3390/agronomy12020430

Wani, S.A., Qayoom, S., Bhat, M.A., Sheikh, A.A., Bhat, T.A. and Hussain, S. 2017. Effect of varying sowing d ates and nitrogen levels on growth and physiology of scented rice. *Oryza*,**54**(1): 97-106.

Weckwerth, W., Ghatak, A., Bellaire, A., Chaturvedi, P. and Varshney, R.K. 2020. Review PANOMICS meets germplasm. *Plant Biotechnol J*, 18, 1507-1525. doi: 10.1111/pbi.13372

Table 1: Response of rice varieties to different nitrogen levels on growth attributes.

S.No	Treatments	Plant Height (cm)	Number of tillershill^{-1}	Dryweight (ghill^{-1})	Crop growth rate (g m^{2} day^{-1})	Relative growth rate (g g^{-1} day^{-1})
1	NDR-359 + Nitrogen 100 kg ha^{-1}	137.93	13.40	91.03	56.17	0.046
2	NDR-359 + Nitrogen 120 kg ha^{-1}	143.67	12.53	95.87	56.61	0.057
3	NDR-359 +Nitrogen 140 kgha^{-1}	141.47	12.27	95.23	64.94	0.062
4	SahbhagiDhan + Nitrogen 100 kg ha^{-1}	140.00	16.93	98.87	55.11	0.056
5	SahbhagiDhan+ Nitrogen 120 kg ha^{-1}	146.20	14.80	103.77	64.95	0.051
6	SahbhagiDhan+ Nitrogen 140 kg ha^{-1}	143.73	10.67	101.23	60.83	0.076
7	BPT-5204 + Nitrogen 100 kg ha^{-1}	117.73	26.13	82.73	45.68	0.041
8	BPT-5204 + Nitrogen 120 kg ha^{-1}	119.60	30.87	86.97	54.06	0.047
9	BPT-5204 +Nitrogen 140 kg ha^{-1}	116.53	27.87	85.10	26.53	0.054
	SEm(±)	6.13	1.26	2.39	6.51	0.0024
	CD(5%)	18.38	3.79	7.17	19.54	----

Table 2:Response of rice varieties to different nitrogen levels on yield attributes and yield.

S.No	Treatments	Number of productive tillershill^{-1}	Number of filled grainspanicle^{-1}	Test weight (g)	Grain yield(tha^{-1})	Straw yield (tha^{-1})	Harvest index (%)
1	NDR-359 + Nitrogen 100 kgha^{-1}	7.00	98.40	20.03	3.80	6.80	35.85
2	NDR-359 + Nitrogen 120 kgha^{-1}	7.40	100.33	21.00	4.13	7.00	37.11
3	NDR-359 + Nitrogen 140 kgha^{-1}	7.33	99.40	20.63	3.90	7.03	35.68
4	SahbhagiDhan + Nitrogen 100 kgha^{-1}	7.73	93.33	18.13	3.57	7.07	33.54
5	SahbhagiDhan + Nitrogen 120 kgha^{-1}	8.47	103.33	18.07	4.27	7.23	37.08
6	SahbhagiDhan + Nitrogen 140 kgha^{-1}	8.07	97.40	18.27	3.67	6.97	34.49
7	BPT-5204 + Nitrogen 100 kgha^{-1}	7.80	111.67	14.27	3.43	5.73	37.49
8	BPT-5204 + Nitrogen 120 kgha^{-1}	8.93	115.87	14.70	4.00	6.33	38.71
9	BPT-5204 + Nitrogen 140 kgha^{-1}	8.47	114.53	14.43	3.77	6.23	37.66
	SEm(±)	0.19	0.58	0.27	0.10	0.15	0.88
	CD(5%)	0.58	1.74	0.82	0.32	0.45	2.66

Table 3:Response of rice varieties to different nitrogen levels on economics.

S.no	Treatments	Gross returns(INRha^{-1})	Net returns (INRha^{-1})	B:CRatio
1	NDR-359 + Nitrogen 100 kgha^{-1}	87,200.00	47,759.25	1.21
2	NDR-359 + Nitrogen 120 kgha^{-1}	92,866.67	52,985.92	1.33
3	NDR-359 + Nitrogen 140 kgha^{-1}	89,766.67	49,455.92	1.23
4	SahbhagiDhan + Nitrogen 100 kgha^{-1}	88,833.33	49,292.58	1.25
5	SahbhagiDhan + Nitrogen 120 kgha^{-1}	1,00,166.70	60,185.92	1.51
6	SahbhagiDhan + Nitrogen 140 kgha^{-1}	89,833.33	49,422.58	1.22
7	BPT-5204 + Nitrogen 100 kgha^{-1}	83,600.00	43,583.25	1.09
8	BPT-5204 + Nitrogen 120 kgha^{-1}	95,666.67	55,209.92	1.36
9	BPT-5204 + Nitrogen 140 kgha^{-1}	91,433.33	50,546.58	1.24