Original Research Article

Response of rice varieties at varying nitrogen level

ABSTRACT

A field investigation to ascertain the response of rice varieties at varying nitrogen level 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 of three rice varieties (NDR-359, Sahbhagi Dhan, BPT-5204) and three nitrogen levels (100, 120, 140 kg ha^{-1}). The results revealed that application of nitrogen 120 kg ha^{-1} in Sahbhagi Dhan 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}), maximum 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-5204 with nitrogen 120 kg ha^{-1}.

Keywords: BPT-5204, NDR-359, Nitrogen, Rice, Sahbhagi Dhan, Yield.

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 (*Oryza sativa* 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 area with judicious use of fertilizers especially nitrogen fertilization is 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 study was 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 treatments combinations embodies three varieties of rice namely; NDR-359, Sahbhagi Dhan, BPT-5204 and three levels of nitrogen (100, 120, 140 kg ha^{-1}). Sprouted rice seeds were sown on 27th 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, 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 27th 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 higher plant height (146.20 cm) was recorded with the application nitrogen 120 kg ha^{-1} in Sahbhagi Dhan 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 photosynthates resulting in increased plant height (Murthy et al., 2015).

Significantly higher number of tillers hill^{-1} (20.53) were observed in BPT-5204 variety with application of 120 kg N ha^{-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).

Maximum dry weight (103.77 g hill^{-1}) was recorded with the application of 120 kg N ha^{-1} in Sahbhagi Dhan variety. Increase in plant dry weight in different stages of growth of all the varieties due to the fact that ad equate 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 sue to impact on morphological and photosynthetic components along with accumulation of nutrients.

Significantly higher 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}. Maximum relative growth rat e (0.076 g g^{-1} day^{-1}) was observed during the initial growing stages of crop (20-40 DAT). Variation in crop gro wth rate among the treatment combinations might be due the varietal response towards the applied nitrogen lev els 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 variety with application of 120 kg Nitrogen ha^{-1}. Significantly higher test weight was recorded in NDR-359 variety with application of 12 0 kg Nitrogen ha^{-1} (21.00 g). Significantly highest grain yield (4.27 t ha^{-1}), straw yield (7.23 t ha^{-1}) was recorde d in Sahbhagi Dhan variety with application of nitrogen 120 kg ha^{-1} was recorded in Sahbhagi Dhan 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). N umber 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., 2014; 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 Sahbhagi Dhan 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 Sahbhagi Dhan with application of Nitrogen 120 kg ha^{-1} (Treatment-5) is recommended under Eastern Uttar Pradesh Agro-Climatic conditions for higher yields and economic returns.

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

S. No	Treatments	Plant Height (cm)	Number of tillers hill^{-1}	Dry weight (g hill^{-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 kg ha^{-1}	141.47	12.27	95.23	64.94	0.062
4	Sahbhagi Dhan + Nitrogen 100 kg ha^{-1}	140.00	16.93	98.87	55.11	0.056
5	Sahbhagi Dhan + Nitrogen 120 kg ha^{-1}	146.20	14.80	103.77	64.95	0.051
6	Sahbhagi Dhan + 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 tillers hill^{-1}	Number of filled grains panicle^{-1}	Test weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Harvest index (%)
1	NDR-359 + Nitrogen 100 kg ha^{-1}	7.00	98.40	20.03	3.80	6.80	35.85
2	NDR-359 + Nitrogen 120 kg ha^{-1}	7.40	100.33	21.00	4.13	7.00	37.11
3	NDR-359 + Nitrogen 140 kg ha^{-1}	7.33	99.40	20.63	3.90	7.03	35.68
4	Sahbhagi Dhan + Nitrogen 100 kg ha^{-1}	7.73	93.33	18.13	3.57	7.07	33.54
5	Sahbhagi Dhan + Nitrogen 120 kg ha^{-1}	8.47	103.33	18.07	4.27	7.23	37.08
6	Sahbhagi Dhan + Nitrogen 140 kg ha^{-1}	8.07	97.40	18.27	3.67	6.97	34.49
7	BPT-5204 + Nitrogen 100 kg ha^{-1}	7.80	111.67	14.27	3.43	5.73	37.49
8	BPT-5204 + Nitrogen 120 kg ha^{-1}	8.93	115.87	14.70	4.00	6.33	38.71
9	BPT-5204 + Nitrogen 140 kg ha^{-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 (INR ha^{-1})	Net returns (INR ha^{-1})	B:C Ratio
1	NDR-359 + Nitrogen 100 kg ha^{-1}	87,200.00	47,759.25	1.21
2	NDR-359 + Nitrogen 120 kg ha^{-1}	92,866.67	52,985.92	1.33
3	NDR-359 + Nitrogen 140 kg ha^{-1}	89,766.67	49,455.92	1.23
4	Sahbhagi Dhan + Nitrogen 100 kg ha^{-1}	88,833.33	49,292.58	1.25
5	Sahbhagi Dhan + Nitrogen 120 kg ha^{-1}	1,00,166.70	60,185.92	1.51
6	Sahbhagi Dhan + Nitrogen 140 kg ha^{-1}	89,833.33	49,422.58	1.22
7	BPT-5204 + Nitrogen 100 kg ha^{-1}	83,600.00	43,583.25	1.09
8	BPT-5204 + Nitrogen 120 kg ha^{-1}	95,666.67	55,209.92	1.36
9	BPT-5204 + Nitrogen 140 kg ha^{-1}	91,433.33	50,546.58	1.24