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REVIEW ARTICLE **OPEN ACCESS**

Effect of Nitrogen on Performance of Boro rice: A Review

Pooja[1], Sudhanshu Verma[2]*, Khushboo Gupta[3], Abhishek Shori[4]
*Corresponding author- sudhanshubcn@gmail.com
[1,2,4]Department of Agronomy, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi
[3]Department of Plant Physiology, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi

ABSTRACT
The efficient nutrient management is essential to achieve crop yield sustainability. Based on the different references the accurate dose of N for the better performance of boro rice has been proved. This information is mostly from Indian situation (different climatic conditions and varieties) in which the experiment was conducted. However, some foreign literatures have also been cited. This study has gone through several research papers concern with nitrogen management in rice crop. In the study found that nitrogen doses vary from 60 Kg ha^{-1} to 200 Kg ha^{-1} in different experiment. In most of the experiments 120-150 Kg N ha^{-1} found best for growth, yield attributes and yield of rice, while recommended dose of P_2O_5 and K_2O was also applied as a basal dose.
Key Words: *Nitrogen, Growth, Yield attributes and Yield*

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INTRODUCTION

Nitrogen is one crucial plant nutrients required for plant growth. For maximizing yield of rice, nitrogenous fertilizer is the kingpin in rice farming. It is essential for the synthesis of protein, which is the constituent of protoplasm and chloroplasts. It is a constituent of numerous important compounds found in living cells, including amino acid, protein (enzymes), nucleic acid and chlorophyll. This element is the most essential element in determining the yield potential of intensified agriculture system. But nitrogen use efficiency is very low and the recovery of N in wetland rice seldom exceeds 40%. Many factors determine the fertilizer efficiency for rice crop during cultivation such as soil, cultivar, season, environment, planting time, water management, weed control, cropping pattern, source, form, rate, time of application and method of application. In many cases aerial spray of nutrients is preferred and gives quicker and better results than the soil application [21-23]. Recently foliar application of nutrients has become an important practice in the production of crops while application of fertilizers to the soil remains the basic method of feeding the majority of the crop plants.

EFFECT OF NITROGEN ON GROWTH

An experiment conducted with four variety and four level of nitrogen viz. control (no urea), prilled urea (50 kg N ha^{-1}), one pellet (0.9g) of urea super granules-4 hills of two adjacent rows (30 kg N ha^{-1}) was applied at 10 days after transplanting (DAT) and two pellets of USG (0.9g each) one applied at 10 DAT and the another at 45 DAT/4 hills of two adjacent rows (60 kg N ha^{-1}). Results of the experiment showed that levels of nitrogen had significant effect on plant height, number of tillers hill^{-1} and leaf area index (LAI) of HYV transplant rice [23]. Chamely *et al*. [6] conducted an experiment with comparative study of three varieties viz., BRRI dhan28, BRRI dhan29 and BRRI dhan45; and five rates of nitrogen viz., control, 50 kg, 100 kg, 150 kg and 200 kg N ha^{-1}. The growth analysis results indicate that the tallest plant (80.88 cm) and the highest number of total tillers hill^{-1} (13.80) were observed in BRRI dhan29 at 70 DATs and the highest total dry matter (66.41 g m^{-2}) was observed in BRRI dhan45. The shortest plant (78.15 cm) and the lowest number of tillers hill^{-1} (12.41) were recorded from BRRI dhan45 and the lowest dry matter (61.24 g) was observed in BRRI dhan29. The tallest plants (84.01 cm), highest number of tillers hill^{-1} (14.06) and the highest dry matter (69.58 g m^{-2}) were obtained from 200 kg N ha^{-1}. The tallest plants

(86.48 cm) and maximum dry matter (72.30 g m^{-2}) were recorded from BRRI dhan28 with 200 kg N ha^{-1} and BRRI dhan45 with 200 kg N ha^{-1}, respectively. Ali *et al.* [2] conducted an experiment with four nitrogen level (0, 40, 80, 120 and 160 kg ha^{-1}) and four zinc levels (0, 8, 10, 12 and 14 kg ha^{-1}) and recorded maximum tillers, plant height and leaf area m^{-2} with 120 kg N ha^{-1}. Azarpour *et al.*[5] reported that significantly increase leaf area index (LAI), total dry weight, leaf dry weight, crop growth rate, relative growth rate, net assimilation rate, leaf area duration, leaf area ratio, leaf weight rate, specific leaf area and grain yield with 90 kg N ha^{-1} as compared to rest of the treatments. In an experiment examined the four levels of N viz. 0, 46, 60 and 75 kg ha^{-1} with four rice varieties and found that tallest plant (111.70 cm), highest number of total tillers $hill^{-1}$ (12.34) with 75 kg N ha^{-1} [16]. Puteh *et al.*[24] examined the three nitrogen doses (80, 120 and 160 kg ha^{-1}) with rice cultivars and reported tallest plant (119.5cm), highest leaf area, chlorophyll content, and number of total tillers $hill^{-1}$(15.33) with 160 kg N ha^{-1}. Thi Phong and Moe [27] conducted a pot experiment with treatments T_0 (no nitrogen application), T_1 (40:40:20), T_2 (50:50:0), T_3 (50:30:20), and T_4 (50:20:30), the ratios under parentheses indicating the percentages of total nitrogen applied at the basal, active tillering, and panicle initiation stages. They reported that highest tiller m^{-2} and panicle number were recorded with T_2 (50:50:0).
An experiment carried out with 4 nitrogen levels, (control, 75%, 100% and 125%) to DSR with half dose of nitrogen after 2 weeks and rest half of nitrogen was applied 5 weeks after sowing. The results showed that 125% of recommended dose of nitrogen produced significantly taller plant, higher leaf area, tillers and CGR as compared to all other levels of nitrogen [12]. Yoseftabar [28] investigated the effect of nitrogen and phosphorus fertilizer on growth and yield in rice. Nitrogen fertilizer @ 50, 100 and 150 kg ha^{-1} was applied in main plot and phosphorus levels 4 level 0, 30, 60 and 90 kg ha^{-1} in sub plot. Maximum tiller number was observed for 150 kg ha^{-1} nitrogen and minimum of that was obtained for 50 kg ha^{-1} nitrogen fertilizer**.** Lawal and Lawal [19] conducted experiment with four N rates (0, 40, 80 and 120 kg ha^{-1}) and two fertilizer placement methods (deep and surface placement) and reported maximum plant height and crop growth rate with 120 kg Nha^{-1}. Alagesan and Raja [3] conducted an experiment with five levels of nitrogen (40, 80, 120, 160 and 200 kg N ha^{-1}) and four equal splits *viz.* seedling, active tillering, panicle initiation and flowering. They reported that maximum tillers m^{-2} (529) found with 160 kg N ha^{-1}. Heiossny and Maftoun [14] investigated with five N levels (0, 50, 100, 200, and 400 mg N kg^{-1} soil) with four N sources [urea, sulfur-coated urea, ammonium sulfate, and ammonium chloride] and three Zn rates (0, 5 and 10 mg Zn kg^{-1} soil as zinc sulfate), results showed that the highest leaf area, plant height and top dry weight was obtained with application of N 200 mg kg^{-1}(ammonium sulfate). Singh and Tripathi [26] reported that optimum nitrogen dose of N, result showed that maximum plant height, LAI, and dry weight was obtained with 120 kg N ha^{-1}.

EFFECT OF NITROGEN ON YIELD ATTRIBUTES AND YIELD

In an experiment with three levels of nitrogen i. e. 60, 120 and 180 kg ha^{-1} combined with three Sulphur rate S 20, 40 and 60 kg ha^{-1} along with two levels of Zn 5 and 10 kg ha^{-1} and reported that maximum grain and straw yield of 61.38 and 86.58 q ha^{-1} was recorded at 180 kg N ha^{-1}[10]. Ahmad *et al* [1] conducted a field experiment with four levels of N (0, 80, 120, and 160 kg ha^{-1}) and five levels seed rates (20, 40, 60, 80, and 100 kg ha^{-1}) reported that Maximum yield was achieved at the highest N rate with a seed rate of at least 40–60 kg ha^{-1}, suggesting that DSR has a higher fertilizer N requirement than the recommended rate for PTR. Chamely *et al*. [6] conducted an experiment with comparative study of three varieties viz., BRRI dhan28, BRRI dhan29 and BRRI dhan45; and five rates of nitrogen viz., control, 50 kg, 100 kg, 150 kg and 200 kg N ha^{-1}. The yield attributes showed that the highest number of tillers $hill^{-1}$ (15.14) was obtained from BRRI dhan29 with 50 kg N ha^{-1}. The harvest data reveal that variety had significant effect on total tillers $hill^{-1}$, effective tillers $hill^{-1}$, non-effective tillers $hill^{-1}$, panicle length, grain yield, straw yield and harvest index. The highest grain yield (4.84 t ha^{-1}) was recorded from BRRI dhan29. The results of the experiment also indicate that total tillers $hill^{-1}$, effective tillers $hill^{-1}$, grains $panicle^{-1}$, sterile spikelets $panicle^{-1}$, grain yield, straw yield and harvest index were significantly affected by levels of nitrogen, while plant height, panicle length, 1000-grain weight were not significantly affected by levels of nitrogen. The highest grain yield (5.58 t ha^{-1}) was obtained from 200 kg N ha^{-1}. Interaction effect of variety × 200 kg N ha^{-1} produced the highest grain yield (5.82 t ha^{-1}). Azarpour *et al.* [5] conducted an experiment with cultivar and nitrogen levels (0, 30, 60 and 90 Kg N ha^{-1}). They reported maximum grain yield (4328 kg ha^{-1}) with 90 kg ha^{-1} nitrogen and minimum grain yield with 0 kg N ha^{-1} (2734 kg ha^{-1}). Das and Sahu [7] conducted an experiment comprised of two spacing of transplanting viz; 20 cm x 20 cm and 20 cm x 25 cm and three depths of placement of urea super granules viz; 6cm, 8cm and 10cm. The sprouted seeds of BRRI dhan29 were sown in the nursery bed on 02 December 2008. Phosphorus @ 120 kg ha^{-1} as triple super phosphate, potassium @ 60 kg ha^{-1} as muriate of potash, sulphur @ 40 kg ha^{-1} as gypsum and zinc @ 10 kg ha^{-1} as zinc sulphate were applied as a blanket dose in all the plots. A 2.7 g urea supper granule

was applied at depths of 6 cm, 8 cm and 10 cm at the center of four hills of two adjacent rows at 10 days after transplanting (DAT). Thirty five days old seedlings were transplanted on the well puddled experimental plots. Result showed that Number of effective tillers hill^{-1}, number of grains panicle^{-1}, grain yield and straw yield of Boro rice was significantly influenced by spacing of transplanting. The higher number of effective tillers hill^{-1} (13.37) was obtained from 20 cm x 25 cm spacing than (12.87) 20 cm x 20 cm. The result revealed that 20 cm x 25 cm spacing of transplanting had the greatest opportunity to produce more number of effective tillers hill^{-1}. It might be due to the fact that wider spacing of transplanting provided enough nutrients, light and air which played vital role in producing more effective tillers hill^{-1}. Jisan *et al.* (2014) examined the four levels of N viz. 0, 46, 60 and 75 kg ha^{-1} with four rice varieties and found that grains panicle^{-1} (133.6), 1000-grain weight (24.55 g), grain yield (5.64 t ha^{-1}), straw (6.70 t ha-1) yield and harvest index (45.63 %) were obtained when N applied @ 75 kg ha^{-1} and the lowest from the 0 kg N ha^{-1}. Khatun *et al.* [17] an experiment was conducted during Boro season (November-April) to evaluate the effect of N fertilizer on seed yield and its quality. The experiment included BRRI dhan28 and BRRI dhan29 and 0, 50, 100, 150, 200 and 250 kg ha^{-1} N rates. Seed yield increased significantly in a quadratic fashion with the increase of N rate both in BRRI dhan28 and BRRI dhan29. Application of N fertilizer increased seed yield by about 3-4 t ha^{-1} compared to control. The highest yield of 5.15 and 6.34 t ha^{-1} was obtained with 150 kg N ha^{-1} in BRRI dhan28 and BRRI dhan29 respectively. However, the predicted economic optimum doses of N appeared as 156 and 158 kg ha^{-1} for BRRI dhan28 and BRRI dhan29 respectively. Nitrogen application to rice seed crop did not impair seed quality in terms of germination, viability, vigour and seed color. The seed N concentration ranged from 0.94 to 1.31% in BRRI dhan28 and 0.85 to 1.07% in BRRI dhan29 among different N rates. The seed phosphorus concentration varied from 0.30 to 0.41% in BRRI dhan28 and 0.28 to 0.36% in BRRI dhan29 among different N rates. The seed K varied from 0.23 to 0.27% and 0.20 to 0.23% in BRRI dhan28 and BRRI dhan29 respectively, among different N rates. The average seed protein of BRRI dhan28 (6.59%) was significantly higher than that of BRRI dhan29 (5.68%). Seed N and protein content slightly increased with the increase of N rate. Nitrogen application did not influence phosphorus and magnesium content in rice seed. However, seed potassium slightly decreased with the N application. Puteh *et al.*[24] examined three nitrogen doses (80, 120 and 160 kg ha^{-1}) and reported highest number of effective tillers hill^{-1}, filled grains panicle^{-1}(1147) and lowest number of unfilled grains panicle^{-1} and higher dry matter partitioning to economic yield with N_{120} and resulted the highest grain yield(6.93 t ha^{-1}) both per hill and per hectare. Hatamifar *et al.*[13] conducted an experiment with three nitrogen level (0, 60 and 90 kg ha^{-1}) and reported maximum grain yield with 90 kg N ha^{-1}. Maiti and Bhattacharya [20] an experiment was conducted with three levels of N (90,120 & 150 kg ha^{-1}) and three levels of K_2O (0, 40 & 80 kg ha^{-1}). Highest grain yield was obtained with 120 kg N ha^{-1}. Devi and Sumathi [9] reported that maximum number of effective tillers, number of filled grains per panicle, test weight, and yield was obtained with 150 kg N ha^{-1}. Kumar and Dawson [18] showed that maximum grains per panicle, grain yield, test weight and net return was obtained when 120 kgN was applied. Gill and Walia [12] experimented with four nitrogen levels, (0%, 75%, 100% and 125% of recommended dose of nitrogen). They recorded highest number of grain panicle^{-1}, test weight and spikelet with application of 125% of recommended dose of nitrogen and 88.44, 25.81 and 5.41% higher grain yield over the control, 75% of recommended dose of nitrogen and 100% of recommended dose of nitrogen, respectively. Maiti and Bhattacharya [20] conducted experiment with three nitrogen levels *i.e* 90,120 & 150 kg ha^{-1} and three levels of P_2O_5, 40, 60 & 80 kg ha^{-1}. They reported highest grain yield with 150 kg nitrogen and 60 kg P_2O_5 ha^{-1}. Youseftabar [28] studied with levels of nitrogen fertilizer at 100, 200 and 300 kg ha^{-1} in main plot with spilt application *i.e* T_1= (1/2 basal-1/2 mid tillering), T_2= (1/3 basal-1/3 mid tillaring-1/3 panicle imitation) and T_3= (1/4 basal-1/4 mid tillering-1/4 panicle initation-1/4 flowering) as sub plot. He reported highest test weight, filled grain and grain yield with 300 kg N ha^{-1} (1/4 basal-1/4 mid tillering-1/4 panicle initation-1/4 flowering). Alagesan and Raja [3] experiment was conducted with five levels of nitrogen (40, 80, 120, 160 and 200 kg N ha^{-1}) and with four split application. They reported that grain yield increase 16.9, 11.8 and 7.1 per cent with the application of 40, 80 and 120 kg N ha^{-1} over control. Application of 200 kg N ha^{-1} reduced the grain yield by 9.5 per cent over 160 kg N ha^{-1}.. Fageria *et al.* [11] conducted an experiment with N rates 0, 50, 100, 150, 300, and 400 mg N kg^{-1} of soil. Grain yield increased significantly in a quadratic fashion, when N rate was increased in the range of 0 to 400 mg kg^{-1}. Iqbal *et al.*[15] reported that panicle length, grains panicle^{-1}, grain yield increased up to 60 kg ha^{-1} and thereafter decreased. Alim *et al.* [4] conducted experiment with different sources and doses of nitrogen, and reported highest number of spikelet's panicle^{-1}, dry weight of panicle^{-1}, and individual grain weight and grain growth rate with 60 kg N ha^{-1}. Hosseiny and Maftoun [14] conducted experiment with five N levels (0, 50, 100, 200, and 400 mg N kg^{-1} soil with four N sources [urea (U), sulfur-coated urea (SCU), ammonium sulfate (AS), and ammonium chloride (AC)] and three Zn rates (0, 5, and 10 mg Zn kg^{-1} soil as

zinc sulfate). They reported highest grain yield with SCU which was followed by AS, AC and U. The apparent N recovery (ANR) increased with increasing N up to 200 mg kg-^{1} as U, AS, and AC and declined thereafter. Mannan *et al.* [22] experimented with different level of nitrogen 0, 25, 50, 75 and 100 kg N ha-^{1}and concluded that maximum number of panicles, panicle length, percentage of fertile spikelet and straw yield increased with the increase of nitrogen levels but the highest grain yield was obtained at 50-75 kg N ha^{-1}. Das *et al.* [7] experimented with four levels of nitrogen (0, 60, 120 and 180 kg ha^{-1}) and three levels of potassium (0, 40 and 80 kg ha^{-1}) and reported maximum grain and straw yield with 80 kg N ha^{-1}. Singh and Tripathi [26] reported that maximum panicles length m^{-1} and weight of panicle, grains panicle^{-1}, test weight as well as highest grain yield of 58.57 q ha^{-1} was obtained with 160 kg N ha^{-1}. Rahman *et al*. [25] experiment was conducted with four nitrogen level 0, 60, 80 and 100 kg N ha^{-1}. The highest number of effective tillers hill^{-1} (9.20), maximum grains panicle^{-1} (100.80), highest grain yield (5.34 t ha^{-1}) and harvest index (44.50%) were obtained with 80 kg N ha^{-1}. The highest straw yield (6.98 t ha^{-1}) was obtained at the highest nitrogen level (100 kg N ha^{-1}). Singh and Tripathi [26] reported that the increase N uptake and protein content with increase nitrogen dose up to 120 kg N ha^{-1}. Manivannan *et al.*[21] carried out an experiment with two rice hybrids, KRH 2 and DRRH 1 and three levels of nitrogen (90, 120 and 150 kg ha^{-1}). Result showed that maximum grain yield of 4.97 t ha^{-1} was found with 90 kg N ha^{-1}.

CONCLUSION

After studied all the reviews related to N scheduling and doses it can be concluded that nitrogen doses 120-150 Kg N ha^{-1} found best for growth, yield attributes and yield of rice.

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