Open Access

Journal of Environmental And Sciences

Effect of varied nitrogen levels on yield and yield qualities of several rice types under DDSR conditions in Kanchanpur, Nepal

Dipesh Giri1

***Corresponding author**

Dipesh Giri1
Agriculture and Forestry University, Parasi-33007, NEPAL.

Received Date : June 12,2022
Accepted Date : June 13,2022
Published Date : July 12,2022

Abstract

From March 2021 to July 2021, an experiment on the impact of various nitrogen levels on the production and yield characteristics of various rice cultivars was done at Kanchanpur, Nepal. Two parameters, nitrogen levels and rice varieties, each with three levels (nitrogen: 60 kg/ha, 120 kg/ha, and 180 kg/ha; rice varieties: Hardinath 1, Hardianth 3, and Chaite 5), were used in the experiment to create nine treatment combinations. On March 24, 2021, rice seeds were immediately seeded in experimental plots under dry conditions. Plants were separated by 20x20cm2. Rice growth characteristics, grain yield, and yield-attributing features were noted. The statistical findings showed substantial variations between the treatments in terms of agronomical metrics, yield attributing grain yield and character. The findings showed that the 180 kg/ha level of N treatment is associated with greater plant height (74.502 cm), tiller number (1016.667), effective tiller number (577.222), filled grain per panicle (116.490), panicle length (25.241 cm), grain yield (4.7 ton/ha), and straw yield (10.564 ton/ha). In comparison to Hardinath 1 and Chapter 5, Hardinath 3 greatly outperformed the other types in terms of plant height (79.68 cm), panicle length (25.68 cm), sterility %, and 1000 grain weight (24.60 g). However, Chaite 5 had much greater yield and yield-related traits such grain production, straw yield, efficient tillers, and full grains per panicle. Therefore, for increased productivity in Kanchanpur, Nepal, a nitrogen level of 180 kg/ha and the variety Chaite5 may be used.

Introduction

More than half of the world's population depends on rice (Oryza sativa L.), one of the most significant cereal crops, for daily subsistence (Chauhan and Johnson, 2011). A staple food for nearly two-thirds of the world's population, rice is consumed by 2500 million people, 90% of whom reside in Asia, with the remaining 10% living in America, Africa, Australia, and Europe (Dahipahle and Singh, 2018). Nepal is a mountainous nation with many different rice ecologies. Rice is raised.from the Terai to the high mountains, in all agroecological zones. There have been many landraces found that are suitable for diverse climatic situations and farmer requirements. A member of the Poaceae family, rice is an annual, self-pollinating, semi-aquatic plant. More than half of Nepalese people's total calorie requirements are met by rice, which provides 50% of all edible grain production and 20% of the nation's agricultural gross domestic product (AGDP) (Basnet, 2008). To cultivate rice, seedlings are typically put into dirt puddles. Water percolation losses are reduced. Article of Puddling is advantageous for rice because it gets rid of weeds, makes seedling establishment straightforward, and promotes anaerobic conditions that boost nutrient availability. The development of hardpans at shallow depths, persistent puddling, and the disintegration of soil aggregates, however, all have a negative impact on the physical characteristics of soil (Kumar et al., 2019). Direct-seeding (DSR) is a less expensive alternative to transplanting that involves planting rice seeds directly in the ground. Because rice may be planted directly, the need for nursery preparation, seedling, uprooting, and transferring is no longer necessary (Singh et al.,2018). Considering the date of planting Puddling is advantageous for rice because it gets rid of weeds, makes seedling establishment straightforward, and promotes anaerobic conditions that boost nutrient availability. The development of hardpans at shallow depths, persistent puddling, and the disintegration of soil aggregates, however, all have a negative impact on the physical characteristics of soil (Kumar et al., 2019). Direct-seeding (DSR) is a less expensive alternative to transplanting that involves planting rice seeds directly in the ground. Because rice may be planted directly, the need for nursery preparation, seedling, uprooting, and transferring is no longer necessary (Singh et al.,2018). Considering the date of planting transplanting, as well (Singh et al.,2018). Agronomic management in direct seeding can differ from permanent inundation in terms of planting date, water requirements during the early stages of the crop, weed management and control, and N fertiliser rates (Khan et al.,2012). Direct seeding (DS), a potential cultivation approach that produces crops with nearly comparable or slightly lower yields to traditional transplanting (TP), saves irrigation water by 12-35 percent and labour by up to 60 percent (Farooq et al.,2011; Kumar and Ladha, 2011). Since it is less expensive, uses less water, and requires less labour than traditional crop establishment techniques, direct seeded rice (DSR) is growing in popularity (Kumar et al., 2019). transplanting, as well (Singh et al.,2018). Agronomic management in direct seeding can differ from permanent inundation in terms of planting date, water requirements during the early stages of the crop, weed management and control, and N fertiliser rates (Khan et al.,2012). Direct seeding (DS), a potential cultivation approach that produces crops with nearly comparable or slightly lower yields to traditional transplanting (TP), saves irrigation water by 12-35 percent and labour by up to 60 percent (Farooq et al.,2011; Kumar and Ladha, 2011). Since it is less expensive, uses less water, and requires less labour than traditional crop establishment techniques, direct seeded rice (DSR) is growing in popularity (Kumar et al., 2019). and the atmosphere's volatilization of ammonia. Appropriate N fertiliser application also improves dry matter formation, increases pest resistance, and promotes improved nutrient uptake in rice plants. Excessive N application harms ecosystems because it enriches the soil, atmosphere, and water with reactive N from agriculture (Ju et al.,2009). Limiting grain filling rate by reducing post-anthesis assimilates translocation can reduce grain production (Zhang et al.,2009). Therefore, it is crucial to research the appropriate nitrogen and the atmosphere's volatilization of ammonia. Appropriate N fertiliser application also improves dry matter formation, increases pest resistance, and promotes improved nutrient uptake in rice plants. Excessive N application harms ecosystems because it enriches the soil, atmosphere, and water with reactive N from agriculture (Ju et al.,2009). Limiting grain filling rate by reducing post-anthesis assimilates translocation can reduce grain production (Zhang et al.,2009). Therefore, it is crucial to research the appropriate nitrogen For the Kanchanpur district's spring rice varieties to be more productive and profitable, it is necessary to understand the ideal nitrogen levels.

MATERIALS AND METHODS

In the spring of 2021, the experiment was carried out in the farmers' plot of the Ma-huliya hamlet (which represents Terai) at the Rice Super Zone Implementation Site of PMAMP, Kanchanpur. Three replications and nine treatments were used in the two factorial Randomized Complete Block Design (RCBD) experiment design. The main field was twice tilled and heavily ploughed. The main field measured 1.5 x 1.8 m2 and had 27 distinct plots. Three Ni-trogen levels—60 kg/ha, 120 kg/ha, and 180 kg/ha—along with three rice varieties—were used in the treatment.

In the spring of 2021, the experiment was carried out in the farmers' plot of the Ma-huliya hamlet (which represents Terai) at the Rice Super Zone Implementation Site of PMAMP, Kanchanpur. Three replications and nine treatments were used in the two factorial Randomized Complete Block Design (RCBD) experiment design. The main field was twice tilled and heavily ploughed. The main field measured 1.5 x 1.8 m2 and had 27 distinct plots. Three Ni-trogen levels—60 kg/ha, 120 kg/ha, and 180 kg/ha—along with three rice varieties—were used in the treatment.

Physical and chemical properties of the test soil To examine the initial soil physicochemical properties, soil samples were randomly taken from each of the four corners and the experimental plot in the middle, 20 cm below the surface. To determine the amount of organic matter, the sub-samples were combined, air-dried in the shade, crushed, and sieved through a 2 mm and a 0.5 mm sieve. After being collected in plastic, the samples were delivered to the Soil Testing Laboratory in Sundarpur, Kanchanpur, for analysis. The examination revealed that the research plot's soil had a loam texture. The soil's pH in nature was neutral (6.84). The soil's overall nitrogen content was moderate.

RESULTS AND DISCUSSION

Agricultural characters Plant height: 30 DAS, 45 DAS, 60 DAS, 75 DAS, and 90 DAS were used to collect data on plant height. Table 1 illustrates how rice variety and N levels affect plant height. At all growth phases, rice plants' height was considerably influenced by various nitrogen levels. The nitrogen amount of 180 kg/ha produced the tallest plants during all growth stages, followed by 120 kg/ha. The highest plant height (21.117cm) was recorded at 30 days after sowing with 180kgN/ha, which was statistically comparable to the 120kgN/ha (19.847cm). With a nitrogen level of 180 kg/ha (29.93 cm) at 45 DAS, the highest plant height (33.266 cm) was found, followed by 120 kg/ha. The tallest plant was measured at 60DAS, and its height was 44.352 cm. The nitrogen level was 120 kg/ha, which was statistically equivalent (41.793 cm, respectively). Similarly, at 75 DAS, the plant height was statistically equivalent to 120kg/ha at 180kg/ha, but it was substantially higher (56.311cm) (54.192cm). At 180kg/ha, which was statistically equivalent to 120kg/ha at 90 DAS, the plant height was substantially higher (74.502cm) (72.031cm). Nitrogen elements cause an increase in cell division, which results in an increase in height, the number of tillers, and the surface area of the leaves in the rice plant. This is because nitrogen elements stimulate the biosynthesis of cytokinin and its emission from the root to the aerial parts of the plant (Jalali-moridani and Amiri, 2014). between the nitrogen During both years of testing, the application of 150 kg N ha-1 followed the application of 180 kg N ha-1 in producing higher growth characteristics. This could be as a result of increased cell elongation and cell division in plant meristematic tissue, which are essential for growing plant height, as a result of higher nitrogen levels boosting plant height (Dahipahle and Singh, 2018). The tallest plants were recorded with the injection of 144 or 192 kg N/ha (Badawi and El-Shayb,2010). In comparison to 100 kg N/ha, 120 kg N/ha, and 140 kg N/ha, the nitrogen level of 160 N/kg produced noticeably higher plant height, dry matter accumulation/m, and total tillers/running row (Singh et al.,2018). Up to 200 kg/ha of nitrogen was added to the soil, and this significantly boosted plant height compared to previous nitrogen levels (Salahuddin et al., 2009). This result is also consistent with research by Mahato et al. (2019), who similarly found a link between an increase in plant height and a rise in nitrogen levels. The BRRI dhan58 plant's height rose dramatically as N rates were raised, with 175 kg/ha generating the greatest plant height (98.20 cm) (Jahan).et al.,2022). Plant height grew as N rates increased, and it was shown to be considerably higher at 250 kg/ha than the other levels (Khairunniza-Bejo et al., 2017). The crop's availability of nitrogen may have improved with increased nitrogen application, improving cell division, photosynthesis, metabolism, assimilation, and production, resulting in taller plants (Bhavathi et al.,2021). Except at 30 DAS, highly significant findings for rice cultivars were obtained. At 45 days after sowing, Hardinath 3 (33.264cm) and Chaite 5 had the tallest plants (31.013cm). At 60 days after seeding, Hardinath 3 (45.995 cm) and Chaite 5 had the tallest plants, respectively (40.127cm). At 75 DAS, Hardinath 3 (58.733 cm) had the greatest plant height, which was statistically comparable to Chaite 5. (55.857). In addition, Hardinath 3's plant height (79.687cm) at 90 days after seeding was greater than Chaite 5's and Hardinath 1's (71.096 cm and 64.411cm, respectively). This variance in plant height between rice types may result from varietal traits.

Effect of rice variety and nitrogen levels combined on plant height Only at 45DAS was there a significant correlation between nitrogen levels and rice variety in terms of plant height (Table 2). The treatment N3V2 (180 kg/ha & Hardinath 3) produced the highest plant height (32.52 cm), followed by the treatment N2V2 (120 kg/ha & Hardinath 3), which was statistically comparable to N3*V3 and N3V1 (32.800 and 32.690, respectively). The alternative treatment resulted in noticeably shorter plants. The data were gathered on 30 DAS, 45 DAS, 60 DAS, 75 DAS, and 90 DAS, respectively, in terms of the number of tillers per m2. At all growth stages, the N levels and rice cultivars had a considerable impact on the number of tillers (Table 3). The number of tillers per square metre was considerably influenced by nitrogen levels throughout all growth phases. The maximum number of tillers (277.778 m-2) was recorded at 180 kg/ha 30 days after planting, followed by 120 kg/ha (211.111 m-2). The largest number of tillers (967.222 m-2) were visible 45 days after sowing with a nitrogen application of 180 kg/ha, which was statistically comparable to 120 kg/ha (808.333m-2). 180 kg/ha produced the most tillers (1462.222 m-2) at 60 DAS, followed by 120 kg/ha (1268.333 m-2). The number of tillers increased. Tiller mortality caused the number of tillers per square metre to decrease after DAS. When 180 kg/ha of nitrogen was sprayed, the most tillers (1242 m-2) were recorded at 75 DAS, followed by 120 kg/ha (1086.67). The most tillers were produced at 90 days after planting with nitrogen doses of 180 kg/ha (1101.667 m-2), which were statistically comparable to nitrogen doses of 120 kg/ha, which again produced a similar number of tillers as with 60 kg/ha (928.33 m-2& 810 m-2respectively). The results showed that 180 kg/ha of nitrogen was more successful in boosting the number of tillers.

Increased fertiliser uptake and higher nitrogen availability to crops may be the reasons for the largest number of tillers per square metre (Dahipahle et al., 2018). Ramesh et al. also observed the favourable impact of higher N treatment on tiller output (2009). When N was used, there were more tillers per square metre (Mandana et al.,2014). Nitrogen promotes vegetative growth, therefore 140 kg/ha results in more tillers per square metre (Bokado et al.,2020). Better development and early tiller initiation before the start of reproductive growth may be the cause of the increased number of effective tillers/m2 seen in 160 kg N/ha and 140 kg N/ha (Singh et al.,2018). Tiller per square metre was greatly impacted by N levels (Jahan et al.,2022). The addition of nitrogen considerably improved the varieties' tillability (Nneke, 2016). Significant changes in the number of tillers were seen according on the types. Chaite 5 and Hardinath 1 had the most tillers (262.222 m-2) at 30 days after sowing, respectively (195.566 m-2). At 45 days after sowing, Chaite 5 had the most tillers (852.777 m-2), which was statistically comparable to Hardinath 1. (846.111 m-2). Additionally, considerably more tillers were reported for Chaite 5 at 60 DAS, 75 DAS, and 90 DAS (1308.333 m-2, 1116.111 m-2, and 1007.778 m-2, respectively), which was statistically comparable with Hardinath 3. (1293.333 m-2, 1109.444 m-2, and 990.556 m-2respectively). The varietal characteristics may be to blame for the findings that were seen.314 Arch. Agric. Environ. Sci., 7(3): 310-317 Dipesh Giri et al (2022) Characteristics of rice attributed to yield Table 1 illustrates the relationship between rice variety and nitrogen levels and yield-attributing features such as panicle length, effective tiller, filled grains per panicle, thousand grain weight, and sterility percentage. Panicle length: 4. In response to nitrogen levels, the mean value of panicle length was significantly significant. 180kg/ha produced the largest panicle length (25.241cm), followed by 120kg/ha (24.370cm). Similar conclusions were reached by Singh et al. (2018) and Dahipahle et al. (2018).

When nitrogen applications were compared, 160 kg N ha-1 produced panicles that were longer and contained more grains (Kumar et al., 2019). Since 140 kg N ha-1 had the longest panicle length, it is likely that nitrogen played a part in both panicle creation and elongation. As a result, longer panicles were produced due to higher N-fertilization (Bokado et al.,2020). For panicle length, 180kg/ha was discovered to be the most efficient (Sah et al.,2019). These findings concur with those of Bhuiyan et al (2017)Panicle length rose noticeably with increasing nitrogen levels (Bhavathi et al., 2021). At the greatest nitrogen application level, the longest panicle was likewise recorded by Ghoneim et al. (2018). Varieties have a substantial impact on panicle length. Hardinath 3 had the greatest panicle length (25.688 cm), and Chaite 5 came in second (24.645cm).

Effective tillers per square metre: Due to nitrogen levels, a highly significant result was obtained. The nitrogen treatment with 180 kg/ha produced the most effective tillers (577.222 m2) and was statistically comparable to the nitrogen dose of 120 kg/ha with 511.944 m2. The maximum number of active tillers per square metre were produced at a nitrogen level of 140 kg/ha, which may be associated to enough nitrogen encouraging cellular activity during panicle formation and development, which enhanced the number of active tillers per square metre (Bokado et al.,2020). These findings are in line with those that Dahipahle et al. (2018), Singh et al. (2018), and Bhuiyan et al. (2018) have previously documented (2017). The highest number of productive tillers was seen at a nitrogen level of 240 kg/ha (Bhavathi et al.,2021). Regarding the variety, Chaite 5, which was statistically identical to Hardinath 3, obtained the largest number of effective tillers (566.944 m-2) (503.333 m-2). With Hardinath 1, the fewest number of productive tillers (454.722) was noted. that Dahipahle et al. (2018), Singh et al. (2018), and Bhuiyan et al. (2018) have previously documented (2017). The highest number of productive tillers was seen at a nitrogen level of 240 kg/ha (Bhavathi et al.,2021). Regarding the variety, Chaite 5, which was statistically identical to Hardinath 3, obtained the largest number of effective tillers (566.944 m-2) (503.333 m-2). With Hardinath 1, the fewest number of productive tillers (454.722) was noted.

Filled grain per panicle: Filled grain per panicle was significantly influenced nitrogen levels. Maximum filled grain per panicle (116.490) was recorded at 180kg/ha, statistically at par with 120kg/ha (115.370). The least filled grain (94.461) was observed at a 60kg/ha nitrogen level. These results are in agreement with the findings of Bokado et al.(2020). Panicle length and grains per panicle increased noticeably with nitrogen appli-cation of 180 kg/ha (Dahipahle et al., 2018). Increases in nitro-gen rate from 0 to 220 kg N ha-1 significantly increased the number of filled grains per panicle for all rice genotypes (Ghoneim et al.,2018). At 320 kg N/ha, the number of grain panicles that were filled was significantly higher (Bhavathi et al., 2021). A significantly higher number of filled grain (136.748) per panicle was obtained with Chaite 5, which was followed by variety Hardinath 1 (101.771). A lower number of filled grain (87.801) was recorded with variety Hardinath 3 Nitrogen levels had no discernible impact on the thousand-grain weight because varietal characteristics—rather than nitrogen levels—are what determine 1000 grain weight. Similar results were seen in the experiment conducted by Kumar et al. in 2019. There was no discernible variation in the weight of 1000 grain when different N fertiliser contents were utilised (Mandana et al.,2014). Rice variety has a significant impact on thousand-grain weights. Hardinath 3 (24.600g) had the highest 1000 grain weight, followed by Hardinath 1. (22.065g). Chaite 5 has the lowest 1000 grain weight recorded (21.100g).

Nitrogen concentrations have a big impact on sterility percentage. The 60kg/ha level had the highest sterility percentage (42.544%), followed by the 120kg/ha level (38.694%). At 180 kg/ha, respectively, the lowest sterility percentage (33.860%) was discovered. The results were in line with those of Bhuiyan et al (2017). For all rice genotypes, higher nitrogen application rates led to noticeable increases in the number of unfilled grains per panicle (Ghoneim et al.,2018). Regarding variety, Hardinath 3 (47.693%) had the highest rate of sterility, which was statistically comparable to Chaite 5 (35.988%). Hardinath 1 had the lowest percentage of sterility (31.363%).

evaluation of yields Table 5 illustrates the relationship between rice variety and nitrogen levels and yield parameters (grain yield, straw yield, biological yield, and harvest index). Grain yield: Grain yield is a function of a number of yield-attributing characteristics, such as effective tiller m-2, panicle length, filled grain per panicle, thousand-grain weight, and sterility percent-age, as well as environmental conditions, input used, and their management. Because all those parameters were influenced by both the nitrogen levels and rice varietals, grain yield responded to both of these factors. Nitrogen levels had a significant impact on the grain production of rice. A greater nitrogen dose of 180 kg/ha, which was statistically equivalent to the 120 kg/ha, resulted in a significantly higher grain yield (4.732tha-1) than the lower dose (120 kg/ha).

nitrogen content (4.316tha-1). At 60kg/ha, the lowest yield (3.704 to-1) was noted.Nitrogen content had a considerable impact on production, with 300 kg/ha being the maximum yield (ZHU et al.,2017). These results concur with those made public in 2010 by Badawi and El-Shayb, 2014 by Sakarwar et al., 2018 by Singh et al., and 2009 by Mahajan et al (2012). Through enhanced rice growth rates, photosynthesis, promoting internode lengthening, activities of growth hormones like gibberellins, and other physiological processes, higher nitrogen treatments may have boosted biomass accumulation. With the application of 160 kg N ha-1 compared to 120 kg N ha-1 for nitrogen levels, higher grain and straw yields were observed (Kumar et al.,2019).

The highest grain production was obtained at 140 kg of nitrogen per hectare, which may have been a result of the increase in nitrogen levels, which improved features that contribute to yield such the number of grains panicles per plant and test weight (Bokado et al.,2020). The grain yield grew together with the nitrogen rate, reaching a peak of 180 kg N/ha (Sakarwar, 2014). According to the Hirzel et al. (2020) experiment, this had a considerable impact on grain yield. The considerable rise in nitrogen rates caused a significant boost in grain yield. 0 to 220 kg N ha-1, with 165 kg/ha coming in second and 220 kg N ha-1 displaying the best grain yield values (Ghoneim et al., 2018). The peak rice production was 10,981 kg/ha at 202 kg/ha as N rose (Harrell and Blanche, 2010). Additionally, rice variety has a big impact on grain productivity. Chaite 5 (4.607 tha-1) and variation Hardinath 3, which was statistically identical to variety Hardinath 1 and

produced the highest yield (5.31 tha-1) (4.017 tha-1). The fact that Chaite 5 had the most productive tillers and full panicles may have Nitrogen levels had a substantial impact on the production of rice straw. The straw yield (10.564tha-1) was found to be considerably greater at increasing nitrogen dosages, followed by the nitrogen level at 120kg/ha with 9.312tha-1. The lower nitrogen amount of 60kg/ha produced the lowest straw yield (8.260tha-1). With the balanced and ideal application of fertiliser, an increase in the plant's height, the number of green leaves per hill, and the production of dry matter are visible, which ultimately leads to a higher yield of straw. According to Singh et al. (2018) and Badawi and El-Shayb (2018), similar conclusions were reached (2010). higher indexes for tiller per square metre and leaf area During the two years of the experiment, values with higher nitrogen treatments of 180 kg/ha increased dry matter accumulation at comparable growth stages (Dahipahle et al.,2018). The maximum output of straw, 140 kg N kg/ha, may have been produced by higher nitrogen rates increasing leaf area, which in turn enhanced photo assimilates and the buildup of dry matter (Bokado et al.,2020). At 180 kg/ha, the straw yield was much higher (Thind et al., 2018). Varieties of rice had a big impact on the straw. Variety Chaite 5 produced the highest straw yield (10.033 tha-1), which was statistically comparable to Hardinath 3. (9.271 tha-1). Hardinath 1 had the lowest straw yield, according to records. Maximum straw yield can be a result of Chaite 5 having the most tillers per square metre.
Biological yield: Statistically speaking, the N levels had an impact on biological yield. The nitrogen level at 180 kg/ha (15.296 tha-1) and 120 kg/ha (13.629 tha-1) were determined to have the highest and lowest biological yields, respectively (11.965tha-1). By increasing plant height, tiller density, photosynthetic rate, and dry matter production, nitrogen application boosted biological yield. The findings of Bhuiyan et al. (2017) were comparable. Regarding rice varieties, Chaite 5 (14.641tha-1), which was statistically similar to Hardinath 3 (13.398tha-1), which was statistically similar to Hardinath 1 at the time, was found to have the highest biological yield (12.851tha-1).

Harvest index (HI): The nitrogen level had no discernible impact on HI. The harvest index was not significantly impacted by nitrogen contents (Jalali-moridani and Amiri, 2014). According to Sakarwar, similar conclusions were reached (2014). Different nitrogen levels have almost no effect on the harvest index (Kumar et al., 2019). No discernible influence was seen with regard to the rice variety either.

Conclusion

At varied nitrogen concentrations and rice types, the yield and yield-related variables, such as plant height, tiller number per square metre, effective tiller per square metre, panicle length, full grains per panicle, and yield, differed noticeably. The maximum rice yields were achieved with the cultivar Chaite 5 and a nitrogen content of 180 kg/ha, respectively. The findings indicate that a nitrogen content of 180 kg/ha is appropriate since it produces a greater yield. For the majority of the growth, variation Chaite5 performed better than Hardinath1 and Hardinath3, Based on the overall performance of the variety, yield and quality parameters

References

1. Badawi, A. T., & El-shayb, O. M. (2010). Effect of hill spacing , nitrogen levels and harvest date on rice productivity and grain quality. Crop and Environment, 1(1), 22–26.

2. Basnet, B. (2008). Envirinmental Friendly Technologies for Increasing Rice Productivity. The Journal of Agriculture and Environment, 9, 34-40.

3. Bhavathi, B. P. T., Mrudhula, K. A., Suneetha, Y., & Veni, B. K. (2021). Effect of nitrogen levels on growth , yield , nitrogen uptake and economics of Effect of nitrogen levels on growth , yield , nitrogen uptake and economics of rice variety BPT 2782 -Bhavathi. March. https://doi.org/10.22271/chemi.2021.v9.i1ai.11603

4. Bhuiyan, M. K. A., Bhuiya, S. U., Saleque, M. A., & Khatun, A. (2017). Nitrogen application in direct wet-seeded rice under alternate wetting and drying irrigation condition: Effects on grain yield, dry matter production, nitrogen uptake and nitrogen use efficiencies. Journal of Plant Nutrition, 40(17), 2477–2493, https://doi.org/10.1080/01904167.2017.1380826

5. Bokado, K., Singh, V., & Khwairakpam, R. (2020). Influence of nitrogen levels and seed rates on growth and yield of puddled direct seeded rice (Oryza sativa L.). 8(6), 2035–2039.

6. Chaturvedi, I. (2006). Effect of Nitrogen Fertilizers on Growth, Yield and Quality of Hybrid Rice (Oryza Sativa). Journal of Central European Agriculture, 6(4), 611–618, https://doi.org/10.5513/jcea.v6i4.343

7. Chauhan, B. S., Johnson, D. E., Chauhan, B. S., & Johnson, D. E. (2011). Growth Response of Direct-Seeded Rice to Oxadiazon and Bispyribac-Sodium in Aerobic and Saturated Soils Growth Response of Direct-Seeded Rice to Oxadiazon and Bispyribac-Sodium in Aerobic and Saturated Soils. 59(1), 119–122, https://doi.org/10.1614/WS-D-10-00075.1

8. Dahipahle, A. V., & Singh, U. P. (2018). Effect of crop establishment, nitrogen levels and time of nitrogen application on growth and yield attributing parameters of direct seeded rice (Oryza sativa L.). IJCS, 2889–2893.

9. Farooq, M., Siddique, K. H. M., Rehman, H., Aziz, T., Lee, D., & Wahid, A. (2011). Soil & Tillage Research Rice direct seeding : Experiences , challenges and opportunities. Soil & Tillage Research, 111(2), 87–98, https://doi.org/10.1016/j.still.2010.10.008

10. Ghoneim, A. M., Gewaily E. E., & Osman, M. M. A. (2018). Effects of nitrogen levels on growth , yield and nitrogen use efficiency of some newly released Egyptian rice genotypes. 310–318.

11. Harrell, D. L., & Blanche, S. B. (2010). Tillage, seeding, and nitrogen rate effects on rice density, yield, and yield components of two rice cultivars. Agronomy Journal, 102(2), 592–597, https://doi.org/10.2134/agronj2009.0390

12. Hirzel, J., Paredes, M., Becerra, V., & Donoso, G. (2020). Response of direct seed-ed rice to increasing rates of nitrogen, phosphorus, and potassium in two paddy rice soils. Chilean Journal of Agricultural Research, 80(2), 263–273, https://doi.org/10.4067/S0718-58392020000200263

13. Jahan, A., Islam, A., Sarkar, M. I. U., Iqbal, M., Ahmed, M. N., & Islam, M. R. (2022). Nitrogen response of two high yielding rice varieties as influenced by nitro-gen levels and growing seasons. Geology, Ecology, and Landscapes, 6(1), 24–31, https://doi.org/10.1080/24749508.2020.1742509

14. alali-moridani, M., & Amiri, E. (2014). Effect of Nitrogen and Potassium on Yield and Yield Components of Rice Cultivar " Hashemi ". 4(4), 417–424.

15. Ju, T., Xing, G., Chen, X., & Zhang, S. (2009). Proc Natl Acad Sci USA (106: 3041–3046;106(19), https://doi.org/10.1073/pnas.0902655106

16. Karim, M., Kashem, M. A., Huda, A., Aziz, M. A., & Goswami, B. K. (2019). Effect of Different Doses of Urea on the Yield of Boro Rice Varieties in Haor Areas of Bangladesh. Asian Plant Research Journal, November, 1–9,https://doi.org/10.9734/aprj/2019/v3i230061

17. Khairunniza-Bejo, S., Zulkifli, Z., & Muharam, F. M. (2017). Effect of nitrogen fertilizer to growth, biomass and grain yield of paddy. Acta Horticulturae, 1152, 159–164, https://doi.org/10.17660/ActaHortic.2017.1152.22

18. Khan, A. W., Mann, R. A., Saleem, M., & Majeed, A. (2012). Comparative rice yield and economic advantage of foliar kno 3 over soil applied K2SO4. 49(4), 481–484.

19. Kumar, P., Singh, P. D., Singh, T., & Singh, A. (2019). Yield , nutrient uptake , quality and economics of rice (Oryza sativa L .) as affected by various crop establish-ment methods and nitrogen levels. 8(5), 2009–2012.

20. Kumar, V., & Ladha, J. K. (2011). Direct Seeding of Rice : Recent Developments and Future Research Needs. In Advances in Agronomy(1st ed., Vol. 111). Elsevier Inc. https://doi.org/10.1016/B978-0-12-387689-8.00001-1

21. Mahajan, G., Chauhan, B. S., Timsina, J., Singh, P. P., & Singh, K. (2012). Crop per-formance and water- and nitrogen-use efficiencies in dry-seeded rice in response to irrigation and fertilizer amounts in northwest India. Field Crops Research, 134, 59–70, https://doi.org/10.1016/j.fcr.2012.04.011

22. Mahato, M., Gautam, B., Kunwar, R., & Joshi, D. (2019). Effect of Different Date of Sowing and Nitrogen Level on Production of Direct Seeded Rice. 6(1), 1–5

23. Mandana, T., Akif, G., Ebrahim, Amiri, & Azin, N. Z. (2014). Effect of nitrogen on rice yield, yield components and quality parameters. African Journal of Biotechnology, 13(1), 91–105, https://doi.org/10.5897/ajb11.2298

24. Nneke, N. E. (2016). Response to different rates of nitrogen by five varieties of swamp rice (Orza sativa linn) under the tropical wetland conditions of Ini, Akwa Ibom state, Nigeria. Global Journal of Agricultural Sciences, 15(1), 21. https://doi.org/10.4314/gjass.v15i1.4

25. Ramesh, T., Sathiya, K., Padmanaban, P. K., & Martin, G. J. (2009). Optimization of Nitrogen and Suitable

Weed Management Practice for Aerobic Rice. 96(December), 344–348.Sah, M. K., Shah, P., Yadav, R., Sah, J. N., & Ranjan, R. (2019). Interaction of nitro gen doses and establishment methods in lowland rice at Parwanipur, Bara, Nepal. Archives of Agriculture and Environmental Science, 4(1), 113–118, https://doi.org/10.26832/24566632.2019.0401018

26. Sakarwar, P. (2014). Sequential Herbicide Application and Nitrogen Rates Effects on Weeds in Direct Seeded Rice (Oryza sativa L.). 8, 249–252.

27. Salahuddin, K. M., Chowdhury, S. H., Munira, S., Islam, M. M., & Parvin, S. (2009). Response of nitrogen and plant spacing of transplanted Amanrice. Bangladesh Journal of Agricultural Research, 34(2), 279-285.

28. Singh, A. K., Singh, M. K., & Kumari, S. (2018). Effects of nitrogen levels and weed management in direct-seeded rice. Indian Journal of Weed Science, 50(3), 290, https://doi.org/10.5958/0974-8164.2018.00062.x

29. hind, H. S., Singh, Y., Sharma, S., Goyal, D., Singh, V., & Singh, B. (2018). Optimal rate and schedule of nitrogen fertilizer application for enhanced yield and nitrogen use efficiency in dry-seeded rice in north-western India. Archives of Agronomy and Soil Science, 64(2), 196–207, https://doi.org/10.1080/03650340.2017.1340642

30. Zhang, H., Xue, Y., Wang, Z., Yang, J., & Zhang, J. (2009). Field Crops Research Morphological and physiological traits of roots and their relationships with shoot growth in "' super "' rice. 113, 31–40, https://doi.org/10.1016/j.fcr.2009.04.004

31. hang, J., Tong, T., Potcho, P. M., Huang, S., Ma, L., & Tang, X. (2020). Nitrogen Effects on Yield, Quality and Physiological Characteristics of Giant Rice. Agronomy, 10(11), 1816. https://doi.org/10.3390/agronomy10111816

32. Zhu, D. wei, Zhang, H. Cheng, Guo, B. Wei, Xu, K., Dai, Q. gen, Wei, H. yan, Gao, H., Hu, Y. jie, Cui, P. Yuan, & Huo, Z. Yang. (2017). Effects of nitrogen level on yield and quality of japonica soft super rice. Journal of Integrative Agricul-ture, 16(5), 1018–1027, https://doi.org/10.1016/S2095-3119(16)61577-0