Influence of nitrogen levels and seed rates on growth and yield of puddled direct seeded rice (*Oryza sativa* L.)

Kangujam Bokado, Vikram Singh and Rowndel Khwairakpam

DOI: [https://doi.org/10.22271/chemi.2020.v8.i6ac.11068](https://doi.org/10.22271/chemi.2020.v8.i6ac.11068)

Abstract

A field experiment was conducted in Crop Research Farm, Department of Agronomy, SHIATS during kharif season, 2014 to study the “Influence of nitrogen levels and seed rates on growth and yield of puddled direct seeded rice (*Oryza sativa* L.)”. The treatments consisted of four levels of Nitrogen (80, 100, 120 and 140 kg ha\(^{-1}\)) and three seed rates (50, 60 and 70 kg ha\(^{-1}\)). The experiment consisted of 12 treatments replicated thrice in a randomized block design. Growth and yield components of rice were significantly influenced by nitrogen levels and seed rates. Number of tillers m\(^{-2}\), number of effective tillers m\(^{-2}\), panicle length (cm), number of grains panicle\(^{-1}\), test weight (g), grain yield (t ha\(^{-1}\)), straw yield (t ha\(^{-1}\)), harvest index (%) was observed to be maximum at 140 kg N + 70 kg seed ha\(^{-1}\).

Keywords: Rice, nitrogen level, seed rates, direct seeded rice

Introduction

Rice (*Oryza sativa* L.) is one of the most important food crops in India and 2\(^{nd}\) of the world. It feeds more than 50% of the world population. It is the staple food of most of the people of South East Asia. Asia accounts for about 90\% and 91\% of world’s rice area and production respectively. Among the rice growing countries, India having the largest area under rice in the world and in case of production it is next to China. However, productivity of India is much lower than that of Egypt, Japan, China, Vietnam, USA & Indonesia and also the average productivity of the world. It contributes 42\% of total food grains production and 45\% of the total cereal production in the country. Each and every part of the plant has various uses in society (Diwakar, 2009) [8]. Rice production constitutes the major economic activity and a key source of livelihood for the rural household of the India. Rice is cultivated in India in a very wide range of eco-systems from irrigated to shallow lowlands, mid-deep lowlands and deep water to uplands. Transplanting is the major method of rice cultivation in India. However, transplanting is becoming increasingly difficult due to shortage and high cost of labour, scarcity of water and reduced profit. Thus, direct-seeding is gaining popularity among farmers of India as in other Asian countries. Direct-seeding constitutes both wet and dry-seeding and it does away with the need for seedlings, nursery preparation, uprooting of seedlings and transplanting. Upland rice, which is mostly dry-seeded, is found in parts of Assam, Bihar, Chhattisgarh, Gujarat, Jharkhand, Kerala, Karnataka, Madhya Pradesh, Orissa, Uttar Pradesh and West Bengal. The upland rice area is around 5.5 million hectares which accounts for 12.33\% of the total rice area of the country. Wet-seeded rice (WSR) is increasing in area in parts of Andhra Pradesh, Punjab and Haryana (Rao, 2011) [25]. Nitrogen, the most deficient element in our soils being an integral part of structural and functional proteins, chlorophyll and nucleic acid plays a vital role in crop development (Tisdale et al., 1990) [28]. Nitrogen is one of the major nutrients, which is required in adequate amount at early stages, mid tillering and panicle initiation and at ripening stage for better grain development. Nitrogen is the element most often required for high yield of rice. Nitrogen fertilizer increases tillering and vegetative growth, increases plant height, grain and straw yield and number of heads usually are proportionally to the amount of nitrogen added (Ahmed et al., 2005) [2]. Nitrogen is the integral part of chlorophyll and enzymes essential for plant growth process.
Its deficiency or excess application may adversely influence these processes and ultimately reduce crop yield (Savant and De Data, 1982) [27]. Nitrogen absorbed by rice during the vegetative growth stages contributed in growth during reproduction and grain-filling through translocation (Bufogle et al., 1997; Norman et al., 1992) [6, 22].

Although, transplanting method of establishment is reported to be the best for higher productivity of rice, but looming water crisis, water-intensive nature of rice cultivation and escalating labour costs drive the search for alternative management methods to increase water productivity and profitability in rice cultivation. Direct seeded rice (DSR) has received much attention because of its low input demand (Ganie et al., 2013) [10].

The direct-seeded rice (DSR) offers the advantage of faster and easier planting, ensure proper plant population, reduced labour and hence less drudgery, 10-12 days earlier crop maturity, more efficient water utilization and often higher profit in areas with assured water supply (Datta, 1986) [7]. Rice is a kind of high-yield and high-efficient grain crops and seeding rate is one of the important factors which affect the yield and economic returns of rice production (Li, 2004) [18]. Optimum plant population contributes to high yield which relates directly to seeding density and not to tillering ability (Janoria, 1989) [14]. The availability and high cost of improved seeds is a major constraint for rice production by the farmers. Likewise, the wastage incurred during planting as a result of over seeding is something that needs to be curtailed in order to maximize profits and further reduce cost of rice production. More so, seeding density is believed to affect crop performance due to intense competition for the available growth factors that might be inherently limiting. Equally worrisome was the low yield that was usually recorded under farmers’ practice where plant population below the optimum lead to reduced yield (Luka et al., 2013) [19]. The optimum seed rate is another important factor that affects crop micro-environment by influencing the degree of inter- and intra-plant competition. Therefore, while fixing seed rates for direct-seeded crop, the plants should be planted neither too thick not too thin, so that the input-use efficiency may be enhanced to the maximum possible extent (Gill et al., 2006) [12]. The present study was therefore undertaken to determine the following major objectives:

1. To study the effect of different nitrogen levels on growth and yield of rice; 2. To study the effect of different seed rates on growth and yield of rice.

Materials and Methods

A field experiment was conducted in Crop Research Farm, Department of Agronomy, SHIATS (25° 24’ 42” N latitude, 81° 50’ 56” E longitude and 98 m altitude above the mean sea level) during kharif season, 2014 to study the “Influence of nitrogen levels and seed rates on growth and yield of puddled direct seeded rice (Oryza sativa L.)”. The land was medium high and the soil was sandy loam. The pH value of the soil was 7.34 and total N was 0.028%. The soil was low in organic matter content i.e. 0.36%. Available P₂O₅ and K₂O of the soil were 13.05 and 156.44 kg ha⁻¹, respectively. The treatments consisted of four levels of Nitrogen (80, 100, 120 and 140 kg ha⁻¹) and three seed rates (50, 60 and 70 kg ha⁻¹). The experiment consisted of 12 treatments replicated thrice in a randomized block design. There were 36 plots and unit plot size was 3.0 m x 3.0 m. Phosphatic and potassic fertilizer as Di-ammonium phosphate and Muriate of potash were applied as basal according to the recommended dose. Nitrogen as urea was applied as par treatments and was given in 3 split doses where the 1st dose of 50% was applied as basal while 2nd and 3rd doses of 25% each were given at 27 and 55 DAS respectively. FeSO₄ (0.5%) was sprayed at 77 DAS to take care of paleness and light colour appearance of the plant. The sprouted seeds were sown by kera method as per experimental specifications. Intercultural operations like irrigation and drainage, weed management and pest control were done whenever necessary. Maturity of the crop was determined when 78 about 90 percent of the seeds were turned into golden color. Plants of 1m² were selected randomly from each unit plot excluding border rows for collecting data on plant characters of rice. The harvested crop of each plot was separately bundled, properly tagged and then brought to the threshing floor. The grains were then threshed, cleaned, sun dried and weighed to record the grain yield. The grain yield was adjusted to 14 percent moisture content. Straw were similarly sun dried and weighed to record the straw yield. Grain and straw yields were finally expressed as t ha⁻¹. The collected data were analysed statistically as per Gomez and Gomez, 1976 [13]. The analysis of data was done following MSTAT programme by computer.

Result and Discussion

Plant height (cm)

A perusal of the table clearly shows that the highest plant height of 64.61 cm was recorded in treatment T₁₀ (100 kg N + 70 kg seed ha⁻¹) and the lowest plant height of 54.85 cm was observed in treatment T₅ (80 kg N + 70 kg seed ha⁻¹). The effect of nitrogen levels and seed rates on plant height was found to be non-significant.

Number of tillers m⁻²

A critical review of the table clearly shows that the highest number of tillers m⁻² of 394.67 was recorded in treatment T₁₂ (140 kg N + 70 kg seed ha⁻¹) and the lowest number of tillers m⁻² of 284.00 was observed in treatment T₁ (80 kg N + 50 kg seed ha⁻¹). 140 kg N ha⁻¹ results more number of tillers m⁻² as nitrogen is an element which enhances vegetative growth of plants. Therefore, with the positive physiological effects the number of tillers increased with the increased in nitrogen dose. In addition, enhanced tillering by increased nitrogen application might be attributed to more nitrogen supply to plant at active tillering stage.
The increased in number of fertile tillers with increased in nitrogen levels can be attributed to the reduction in mortality of tillers and enabling the production of more tillers from the main stem. The results are in conformity with the findings of Anisuzzaman et al.; 2010, Awan et al., 2011; Pramanik and Bera, 2013; Martin et al., 1992; Ersin et al., 2006. More number of tillers m\(^{-2}\) was observed in 70 kg seed ha\(^{-1}\) might be due to more plant establishment with more number of seed which led to increase in number of tillers m\(^{-2}\). The results are in conformity with the findings of Garba et al., 2013. 

**Number of effective tillers m\(^{-2}\)**

A critical review of the table clearly shows that the significantly higher number of effective tillers m\(^{-2}\) of 239.55 was recorded under treatment T12 (140 kg N + 70 kg seed ha\(^{-1}\)) which were statistically at par to the treatments T11, T10, T8 and T6. However, the lowest number of effective tillers m\(^{-2}\) of 172.89 was recorded in treatment T1 (80 kg N + 50 kg seed ha\(^{-1}\)).

Maximum number of effective tiller m\(^{-2}\) was obtained from 140 kg N ha\(^{-1}\) might be due to adequacy of N probably favored the cellular activity during panicle formation and development that led to increase the number of effective tillers m\(^{-2}\). The results are in conformity with the findings of Anisuzzaman et al., 2010; Yosef, 2012. Maximum number of effective tiller m\(^{-2}\) was found in 70 kg seed ha\(^{-1}\) might be due to increase in number of tillers m\(^{-2}\) with the increase in seed rate. Similar results have been also recorded by Gill et al., 2006; Walia et al., 2009; Game et al., 2013.

**Panicle Length (cm)**

A perusal of the table clearly shows that the significantly higher panicle length of 27.14 cm was recorded under treatment T12 (140 kg N + 70 kg seed ha\(^{-1}\)) which were statistically at par to the treatments T11, T10 and T8. However, the shortest panicle length of 23.12 cm was recorded in treatment T1 (80 kg N + 50 kg seed ha\(^{-1}\)).

Longest panicle length was obtained from 140 kg N ha\(^{-1}\) might be due to nitrogen because nitrogen takes part in panicle formation as well as panicle elongation and for this reason, panicle length increased with the increased of N-fertilization. The results are in conformity with the findings of Abou-Khalifa, 2012; Pramanik and Bera, 2013; Uddin et al., 2013.
and better kernel development. Similar results have been also recorded by Garba et al., 2013 [11].

**Grain yield (t ha⁻¹)**

A critical review of the table clearly shows that the significantly higher grain yield of 6.88 t ha⁻¹ was recorded under treatment T12 (140 kg N ha⁻¹ + 70 kg seed ha⁻¹) which were statistically at par to the treatment T11, T10, T8 and T6. However, the lowest grain yield of 3.21 t ha⁻¹ was recorded in treatment T1 (80 kg N ha⁻¹ + 50 kg seed ha⁻¹).

Highest grain yield was obtained from 140 kg N ha⁻¹ might be due to increase in nitrogen level which led to the improvement of yield contributing characters like number of effective tillers m⁻², number of grains panicle⁻¹ and test weight. The results are in conformity with the findings of Anisuzzaman et al., 2010; Uddin et al., 2013 [3, 29].

Highest grain yield was found in 70 kg seed ha⁻¹ might be due to increase in number of effective tillers m⁻² with the increased in seed rate. Similar results have been also recorded by Gill et al., 2006; Walia et al., 2009 [12, 30].

**Straw yield (q/ha.)**

A perusal of the table clearly shows that the significantly higher straw yield of 7.63 t ha⁻¹ was recorded under treatment T12 (140 kg N + 70 kg seed ha⁻¹) which were statistically at par to the treatment T11, T10, T8 and T6. However, the lowest straw yield of 4.84 t ha⁻¹ was recorded in treatment T1 (80 kg N + 50 kg seed ha⁻¹).

Highest straw yield was obtained from 140 kg N ha⁻¹ might be due to increase in nitrogen rates enhanced more leaf area resulting in higher photo assimilates and thereby resulted in more dry matter accumulation (Mandal et al., 1991) [20]. The results are in conformity with the findings of Begum et al., 2009; Anisuzzaman et al., 2010; Rao et al., 2013 [3, 26].

Nitrogen influence vegetative growth in terms of number of tillers per m⁻² which result in increased straw yield (Rahaman et al., 2007) [24].

Highest straw yield was found in 70 kg seed ha⁻¹ might be due to increase in number of tillers m⁻² with the increased in seed rate. Similar results have been also recorded by Ganie et al., 2013; Khalifa et al., 2014 [10, 15].

**Harvest index (%)**

A perusal of the table clearly shows that the significantly higher harvest index of 47.45% was recorded under treatment T12 (140 kg N + 70 kg seed ha⁻¹) which were statistically at par to the treatment T11, T10, T7 and T6. However, the lowest harvest index of 39.91% was recorded in treatment T1 (80 kg N + 50 kg seed ha⁻¹).

Highest harvest index was obtained from 140 kg N ha⁻¹ might be probably due to increase in nitrogen rates enhanced more grain yield and straw yield in the optimum proportion. The results are in conformity with the findings of Anisuzzaman et al., 2010; Kumar et al., 2013 [3, 16]. Highest harvest index was observed in 70 kg seed ha⁻¹ might be due favourable condition provided by the increased in seed rate which led to produce grain yield and straw yield in optimal proportion. Similar results have been also recorded by Khalifa et al., 2014 [15].

**Conclusion**

On the basis of the experiment finding, it may be concluded that the effect of nitrogen levels and seed rates are significant. 140 kg N + 70 kg seed ha⁻¹ should be use in case of puddled direct seeded rice (Oryza sativa L.). As the result is based on one season data, it needs further research for confirmation.

**References**

1. Abou-Khalifa Ali Abdalla Basyouni. Evaluation of some rice varieties under different nitrogen levels. Advances in Applied Science Research 2012;3(2):1144-1149.

2. Ahmed Mahtalat, Islam Md. Monirul, Paul Shovon Kumar. Effect of Nitrogen on Yield and Other Plant Characters of Local T. Aman Rice, Var. Jatai. Research Journal of Agriculture and biological science 2005;1(2):158-161.

3. Anisuzzaman M, Salim M, Khan MAH. Effect of seed rate and nitrogen level on the yield of direct seeded hybrid boro rice. J. Agrofor. Environ 2010;4(1):77-80.

4. Awan TH, Ali RI, Manzoor Z, Ahmad M, Akhtar M. Effect of different nitrogen levels and row spacing on the performance of newly evolved medium grain rice variety, KSK-133. The Journal of Animal & Plant Sciences 2011;21(2):231-234.

5. Begum Muhfuza, Juraimi Abdul Shukor, Amartalingu Ratan, Omar Syed, Rastan Syed, Man Azmi Bin, et al. Effect of Fimbriystilis milicia competition with MR220 rice in relation to different nitrogen levels and weed density. International Journal of Agriculture & Biology 2009;11(2):183-187.

6. Bufogle A, Bollick PK, Norman RJ, Kovar JL, Lindau CW, Macchiavelli RE, et al. Rice plant growth-and nitrogen accumulation in drill-seeded and water-seeded culture. Soil Sci. Soc. Am. J 1997;61:832-839.

7. Datta De. Technology development and the spread of direct seeded flooded rice in South-East Asia. Exptl Agric 1986;22:417-16.

8. Diwakar MC. Rice in India during tenth plan. Directorate of Rice Development, Patna RE.

9. Ersin C, Nafiz C, Rutsu H, Suban Y, Suleyman A. The effects of nitrogen and phosphorus fertilization on the plant characteristics of Turkish yellow bluestem (Bothriochloa ischaemum L.). Int. J Agic. Biol 2006-2009:8:154-156.

10. Ganie Zahoor Ahmad, Singh Samar, Singh Samunder. Effect of seed rate and weed control methods on yield of direct seeded rice (Oryza sativa). Indian Journal of Agronomy 2013;58(1):125-126.

11. Garba AA, Mahmoud BA, Adamu Y, Ibrahim U. Effect of variety, seed rate and row spacing on the growth and yield of rice in Bauchi, Nigeria. African Journal of Food, Agriculture, Nutrition and Development 2013;13(4):8155-8166.

12. Gill MS, Kumar Pardeep, Kumar Ashwani. Growth and yield of direct-seeded rice (Oryza sativa) as influenced by seeding technique and seed rate under irrigated conditions. Indian Journal of Agronomy 2006;51(4):283-287.

13. Gomez KA, Gomez AA. Three or more factor experiment. (In:) Statistical Procedure for Agricultural Research 2nd ed 1976, pp.139-141.

14. Janoria MP, A. basic plant ideotype for rice. Int. Rice Res. News 1989;14(3):12-13.

15. Khalifa Ali A, Abou ELkhoby W, Okasha EM. Effect of sowing dates and seed rates on some rice cultivars. African Journal of Agricultural Research 2014;9(2):196-201.

16. Kumar Santosh G, Raju M Srinivasa, Kumar Mahendra R. Production potentials of rice genotypes as influenced by nitrogen levels. Indian J Agric. Res 2013;47(2):169-172.
17. Kusar K, Akbar M, Rasul E, Ahmad AN. Physiological responses of nitrogen, phosphorus and potassium on growth and yield of wheat. Pakistan J Agric. Res 1993;14:2-3.
18. Li ZJ. The influence of seeding rate on the growth and accumulation of dry matter of rice. Cultivation Rice 2004;1:18.
19. Luka GL, Yahaya RA, Mahmud M, Babaji M, Arunah UL, Hinjari AD et al. Growth response of upland rice (oryza sativa L.) varieties to nitrogen and seed rates in the northern Guinea Savahah. Journal of Biology, Agriculture and Healthcare 2013;3(20):12-14.
20. Mandal MN, Puste AM, Chaudhary PP. Effect of water regimes, levels and methods of nitrogen application on growth and yield of rice. Indian Agric 1991;33:33-38.
21. Martin RJ, Sutton HK, Muyle TN, Gillespie RN. Effect of nitrogen fertilizer on the yield and quality of six cultivars of autumn sown wheat. New Zealand J Crop Hort. Sci 1992;20:273-282.
22. Norman RJ, Guindo D, Wells BR, Wilson CE. Seasonal accumulation and partitioning of nitrogen in rice. Soil Sci. Soc. Am. J 1992;56:1521-1527.
23. Pramanik K, Bera AK. Effect of Seedling Age and Nitrogen Fertilizer on Growth, Chlorophyll Content, Yield and Economics of Hybrid Rice (Oryza sativa L.). International Journal of Agronomy and Plant Production 2013;4(5):3489-3499.
24. Rahman MH, Ali MH, Ali MM, Khatun MM. Effect of Different Level of Nitrogen on Growth and Yield of Transplant Aman Rice cv brri dhan32. Int. J Sustain. Crop Prod 2007;2(1):28-34.
25. Rao Adusumilli N. Integrated Weed Management in Rice in India. Directorate of Rice Research, Rajendranagar, Hyderabad 2011
26. Rao V Prasada, Subbaiah G, Sekhar K Chandra. Response of rice varieties to high level nitrogen on drymatter production, yield and nitrogen uptake of rice. International Journal of Applied Biology and Pharmaceutical Technology 2013;4(4):216-218.
27. Savant NK, De Datta SK. Nitrogen transformation in wetland rice soils. Adv. Agron 1982;35:241-294.
28. Tisdale SL, Nelson WL, Beaton JD. Soil Fertility and Fertilizers. Macmillan Pub. Co., New York 1990, 60-62.
29. Uddin S, Sarkar MAR, Rahman MM. Effect of nitrogen and potassium on yield of dry direct seeded rice cv. NERICA 1 in aus season. International journal of Agronomy and Plant Production 2013;4(1):69-75.
30. Walia US, Bhullar MS, Nayyar Shelly, Sidhu Amandeep Singh. Role of Seed Rate and Herbicides on the Growth and Development of Direct Dry-seeded Rice. Indian J Weed Sci 2009;41(1-2):33-36.
31. Yosef Tabar S. Effect of nitrogen and phosphorus fertilizer on growth and yield rice (Oryza sativa L.). International journal of Agronomy and Plant Production 2012;3(12):579-583