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

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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 (25^0 24' 42" N latitude, 81^0 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 P_2O_5 and K_2O 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. $FeSO_4$ (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 1m^2 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 T_{10} (100 kg N + 70 kg seed ha^{-1}) and the lowest plant height of 54.85 cm was observed in treatment T_9 (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 T_{12} (140 kg N + 70 kg seed ha^{-1}) and the lowest number of tillers m^{-2} of 284.00 was observed in treatment T_1 (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.

Table 1: Influence of nitrogen levels and seed rates on growth and yield of puddled direct seeded rice (*Oryza sativa* L.).

Treatment	Plant height (cm)	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 (%)
T_1(N1S1)	57.37	284.00	172.89	23.12	109.13	19.15	3.21	4.84	39.91
T_2 (N2S1)	56.76	312.89	205.33	24.80	113.93	19.43	3.66	5.25	41.09
T_3 (N3S1)	62.19	353.78	221.78	24.84	127.20	19.98	4.41	5.70	43.47
T_4 (N4S1)	62.24	347.44	202.22	25.20	134.53	21.75	5.24	6.20	45.66
T_5 (N1S2)	58.21	314.22	198.22	24.31	128.33	19.70	4.10	5.17	44.26
T_6 (N2S2)	58.47	305.78	208.45	24.61	128.53	19.99	4.74	5.92	44.68
T_7 (N3S2)	58.82	329.33	210.22	24.71	135.37	20.17	5.48	6.50	45.83
T_8 (N4S2)	63.42	334.22	219.56	25.61	141.67	21.83	5.99	6.92	46.26
T_9 (N1S3)	54.85	323.55	208.00	24.56	132.20	20.35	4.37	5.42	44.47
T_{10} (N2S3)	64.61	352.00	222.67	25.45	141.80	20.80	5.23	6.17	45.96
T_{11} (N3S3)	62.24	373.78	230.22	26.17	148.27	21.34	5.92	6.75	46.72
T_{12} (N4S3)	58.26	394.67	239.55	27.14	157.67	22.59	6.88	7.63	47.45
S. Ed. (±)	3.86	23.95	11.86	0.82	5.37	0.77	0.64	0.71	1.07
CD (P= 0.05)	NS	49.68	24.60	1.69	11.13	1.59	1.33	1.48	2.23
CV (%)	7.83	8.75	6.87	4.00	4.93	4.56	15.92	14.44	2.95

N_1 = 80 kg ha^{-1}, N_2 = 100 kg ha^{-1}, N_3 = 120 kg ha^{-1} and N_4 = 140 kg ha^{-1}; S_1 = 50 kg ha^{-1}, S_2 = 60 kg ha^{-1}and S_3 = 70 kg ha^{-1}.

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 Anisuzzman *et al*.; 2010, Awan *et al*., 2011; Pramanik and Bera, 2013; Martin *et al*., 1992; Ersin *et al*., 2006 [3, 4, 23, 21, 9].

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 [11].

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 T_{12} (140 kg N + 70 kg seed ha^{-1}) which were statistically at par to the treatments $T_{11,}$ $T_{10,}$ T_8 and T_3. However, the lowest number of effective tillers m^{-2} of 172.89 was recorded in treatment T_1 (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 Anisuzzman *et al*., 2010; Yosef, 2012 [3, 31].

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; Ganie *et al*., 2013 [12, 30, 10].

Panicle Length (cm)

A perusal of the table clearly shows that the significantly longer panicle length of 27.14 cm was recorded under treatment T_{12} (140 kg N + 70 kg seed ha^{-1}) which were statistically at par to the treatments $T_{11,}$ T_{10} and T_8. However, the shortest panicle length of 23.12 cm was recorded in treatment T_1 (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 [1, 23, 29].

Longest panicle length was found in 70 kg seed ha^{-1} might be due to more plant density with the increased in seed rate that result in greater interception of light and accumulate more photosynthates which ultimately increased the panicle length. Similar results have been also recorded by Khalifa *et al*., 2014 [15].

Number of grains panicle^{-1}

A perusal of the table clearly shows that the significantly higher number of grains panicle-1 of 157.67 was recorded under treatment T12 (140 kg N + 70 kg seed ha-1) which were statistically at par to the treatment T11 (120 kg N + 70 kg seed ha-1). However, the lowest number of grains panicle-1 of 109.13 was recorded in treatment T1 (80 kg N + 50 kg seed ha-1).

Maximum number of grains panicle-1 was obtained from 140 kg N ha-1 might be due to greater assimilation of photosynthates with the increase in nitrogen level resulting in higher number of filled grains. The results are in conformity with the findings of Uddin *et al*., 2013 [29]**.** The greater number of grains per panicle obtained in treatments receiving higher nitrogen rates were probably due to better nitrogen status of plant during panicle growth period (Awan *et al*., 2011) [4].

Maximum number of grains panicle-1 was obtained from 70 kg seed ha-1 might be due to optimum number of panicles bearing tillers as a result of which development of panicle was improved causing more appropriation between the panicles and the greater number of grains. Similar results have been also recorded by Khalifa *et al*., 2014 [15].

Test weight (g)

A critical review of the table clearly shows that the significantly higher test weight of 22.59 g was recorded under treatment T_{12} (140 kg N + 70 kg seed ha^{-1}) which were statistically at par to the treatment $T_{11,}$ T_8 and T_4. However, the lowest test weight of 19.15 g was recorded in treatment T_1 (80 kg N + 50 kg seed ha^{-1}).

Highest test weight was found in 140 kg N ha^{-1} might be due to the increase in nitrogen application that increased protein percentage which in turn increased the grain weight. The results are in conformity with the findings of Kausar *et al*., 1993; Begum *et al*., 2009 [17, 5].

Highest test weight was obtained from 70 kg seed ha^{-1} might be probably due to optimum number of tillers m^{-2} which provide a better environment for greater filling up of starch 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 T_{12} (140 kg N ha^{-1} + 70 kg seed ha^{-1}) which were statistically at par to the treatment T_{11} and T_8. However, the lowest grain yield of 3.21 t ha^{-1} was recorded in treatment T_1 (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 Anisuzzman *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 T_{12} (140 kg N + 70 kg seed ha^{-1}) which were statistically at par to the treatment $T_{11,}$ $T_{10,}$ T_8 and T_4. However, the lowest straw yield of 4.84 t ha^{-1} was recorded in treatment T_1 (80 kg N + 50 kg seed ha^{-1}).

Highest straw yield was obtained from 140 kg N ha^{-1} might be probably 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; Anisuzzman *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 T_{12} (140 kg N + 70 kg seed ha^{-1}) which were statistically at par to the treatment $T_{11,}$ $T_{10,}$ T_7 and T_4. However, the lowest harvest index of 39.91% was recorded in treatment T_1 (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 Anisuzzman *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.

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