Original Research Article

~~Effect of~~ Nitrogen levels and Planting methods on Growth and Yield of Black ~~r~~Rice (*Oryza sativa* L.~~,~~)

ABST~~R~~ACT:

The experiment was conducted during *Kharif* season 2021, at Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences (SHUATS), Prayagraj (U.P.) to find out the "Effect of nitrogen levels and planting methods on growth and yield of ~~Black~~ black r~~R~~ice (*Oryza sativa* L.)". The experimental design was ~~laid out in~~ r~~R~~andomized ~~Block~~ blocks ~~Design consisted of~~with nine t~~T~~reatment and three r~~R~~eplications comprising three levels of nitrogen and planting methods. The T_9 where the dose of~~:~~ Nitrogen was ~~at~~ 75kg~~.~~/ha^{-1} + SRI method~~)~~ developed~~found significantly~~ higher plants~~in plant height~~ (118.13 cm), number of tillers/hill (11.00), plant dry weight (31.62 g/plant), and ~~also recorded significant and~~ higher number of panicles/hill (10.83), number of grains/panicle (196.70), number of filled grains/panicle (116.33), grain yield (4.61 t/ha) and straw yield (11.38 t/ha). The T_7, where the Nitrogen dose was 55kg/ha + Direct sowing, the plants had ~~noticed~~ lowe~~s~~rt responses~~in the combination of Nitrogen at 55kg/ha + Direct sowing~~.

Key words:- Nitrogen levels, transplanting, direct sowing, SRI, Black rice.

Introduction

Rice is a genus in the ~~derived from a~~ cereal grass family Gramineae where is ~~called~~species *Oryza sativa* L.~~, a genus in the family of Gramineae~~. Rice is a ~~staple~~ staple food for many cultures and countries~~. It is the world most important food crop,~~ providing one-fifth of all calories consumed by humans~~ kind~~. The most important rice producing countries are China, India, Indonesia, Bangladesh, Vietnam, Thailand, Myanmar, Philippines, and Japan. It is grown on every continent except Antartica. Rice consumption is highest in Asia, with an average of 455 pounds ~~consumed~~ per person per year. As, it is the staple food for billions of people across Asia and other parts of the world. It accounts for more than 60% of global production and consumption, with approximately 76 millions tons produced in 2010 alone. It

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is one of the significant sources of carbohydrates and protein for 50% of the worlds population. Rice is important because it provides some of the primary nutrients needed for human health, such as protein, carbohydrates, fibre, and minerals. There are many different varieties of rice, over 40,000 types. Some of the most popular types include white, brown, red, black, and purple. Among all this varieties black rice is one kind of rice that is getting more popular recently and is consumed as functional food due to its health benefits. There are a total of more than 200 types of black rice widely grown in South, and Southeast Asian counties such a China, Sri Lanka, India, Indonesia, and Thailand (**Kong *et al.* 2008**) with China considered the highest black rice production country. Black rice contains higher levels of proteins, vitamins and minerals than common white rice. It contains the highest number of antioxidants, protein and dietary fibre than of all rice varieties. Black rice has the highest content of total anthocyanins (327.60 mg 100 g^{-1}) among all of the studied coloured grains. However, yield of black rice is low as 10% as compared to other varieties.

In order to increase and optimize rice yield, different agricultural practices are applied and one of them is fertilizer application. Among the major nutrient elements, nitrogen (N) is the most limiting nutrient for rice crop growth and yield which is required in higher amounts compared to other nutrients **(Djaman *et al.* 2018)**. Nitrogen increases rice yield by playing major role in the photosynthesis, biomass accumulation, effective tillering, and spikelets formation **(Yoshida *et al.* 2006)**. Also, unsuitable method of planting not only affect the profitability due to increased cost of production, they also affect the yield and yield component of crops. Therefore, by using suitable method of planting, it is possible to increase production, productivity and profitability of rice crop **(Parameswari *et al.* 2014).** Rice crop can be cultured by three principal methods i.e., transplanting, direct sowing, and SRI methods. Transplanting is the most superior and traditional method of establishment in irrigated low land rice. **Pandey and Valesco (2005)** stated that direct seeded rice can be practiced in areas with high wages and low water availability. It reduces labour requirement, shortens the crop duration by 7-10 days and can produce as much grain yield as that of transplanted crop. In SRI, where one seedling is used to grow rice, is being evolved to increase the productivity of irrigated rice. **(Thakur *et al.* 2009)** suggested that the system of rice intensification holds a great promise in increasing the productivity. The present study was therefore, undertaken to compared and standerdize nirtrogen levels and planting methods best suited to black rice grower.

Materials and method

The experiment was conducted during *Kharif* season 2021, at the Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences (SHUATS), Prayagraj (U.P.) ~~which is located~~ at 25^{o} 39' 42" NL ~~latitude~~, 81^{o} 67' 56" EL ~~longitude~~ and altitude of 98 m ~~altitude above the mean sea level (MSL)~~. ~~Situated by the side of Rewa Road, residing on the right of Yamuna River 12 km away from city.~~ To evaluate the ~~effect~~ influence of nitrogen levels and planting methods on growth and yield of black rice. The weather conditions were m~~M~~Maxima~~um~~ and minima temperatures, rainfall, ~~minimum temperature,~~ maxima~~um~~ and minima relative humidity~~, and minimum relative humidity~~ were recorded during the rice growing periods ~~as shown in~~ (Figure. 1). Five s~~S~~oil samples from 0-30 cm depth were taken from ~~five spots of the layout of~~ the experimental field, ~~and~~ mixed ~~all the composite sample thoroughly~~ and process~~ed~~ing ~~of all soil samples~~ together. The sample had~~was~~ ~~subjected to analysis the~~ the mechanical, physical and chemical composition analyzed~~analysis~~ for~~. Available~~ sand (54.50%), silt (24.79%), clay (20.71%), Nitrogen (78.9 kg/ha), Phoshorus (32.88 kg/ha), ~~and~~ Potassium (385.10 kg/ha) ~~respectively. The~~, organic carbon (0.51%), pH 7.4 and EC (0.98 ds m^{-1}) . The~~An~~ experimental design had ~~was laid out with~~ three different levels of nitrogen fertilization~~:, viz~~ (N_1: Nitrogen at 55 kg/ha, N_2: Nitrogen at 65kg/ha, N_3: Nitrogen at 75 kg/ha) and three planting methods (P_1: Transplanting, P_2: Direct sowing, P_3: System of Rice Intensification) and their combination with possible nine treatments replicated three times~~thrice~~. b~~B~~lack rice, (Poireiton) was the ~~taken as~~ test variety in this investigation. One hundred seeds were evaluated~~tested~~ before sowing. Cold water treatment was done for germination test, seed were ~~shoaked~~soaked overnight. The overall germination percentage was 98%. The seed quantity was adjusted accordingly. The experimental field was ploughed ~~with the help of tractor drawn plough~~ followed by harrowing, and after ~~this~~ flooding and puddling operation was carried out with help of rotavator. The individual plots were limited ~~by prepared with the help of~~ rope ~~spreading~~ from end to end of the field ~~in order~~ to form a straight line and ~~by using~~ mud from the field were the~~as~~ bunds. Size of each plots were marked using pieces of wood ~~in order t~~to shape~~form~~ the~~an accurate~~ plot size. The seeds were obtained from~~by the~~ farmers of the awang sekmai koujengleima, Manipur. The recommended

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seed rate was sowedused, also calculated based on each plot requirement by maintaining proper spacing. Seedlings were uprooted from nursery bed without damaging the roots and were transplanted to the main field. In the transplanting method, 21--days--old seedlings maintaining at awere spaceding of at 20 x 15 cm withand 2-3 seedlings/hill is transplanted. In SRI 12--days--old seedling wereith a spaceding of at 25 x 25 cm withand single seedling/hill is transplanted. In direct sowing method, tThe germinated seeds wereis directly sown in line atwith a spaceing of 30 x 15 cm in Direct sowing method.

Data analysis and statistical model:

The data recorded with different characteristics were subjected to statistical analysis by adopting Fishens the method of analysis of varience (ANOVA) as described by **Gomez and Gomez (1984)**. Critical difference (CD) values were calculated the 'F' test was found significantly at 5% level.

Results and discussion

Recommended dose of fertilizer was 40-40 kg P-K/ha. 10 tonnes well rotten FYM is incorporated before sowing as organic source of nitrogen. Full dose of P and K was applied during transplanting with 50% N and rest 25% N was applied at tillering stage, i.e. 30 days after transplanting and 25% N during panicle initiation stage, i.e. 45 days after transplanting. Inorganic source of nitrogen was applied through urea, DAP (Di ammonimium phosphate), and MOP (Muriate of potash). The height of plant was measured from the base up to the last node of the plant. Growth parameters was recorded at 20, 40, 60, 80 and 100 days after sowing and days after transplanting, five plants were randomly selected from each plot which was tagged for observations. The number of tillers was counted from the five tagged hills in each plot and the mean value was calculated. For determination the total dry matter per plant, three plant from each plot was uprooted at randomly from two rows. The plants were cleaned and sun dried and then kept in hot air oven at 70^{o}C till constant weight was obtained. The plants from each plot was harvested (1 m^{2}), threshed, cleaned and weighed separately. Weight of thousand seeds from five tagged plants sample was recorded for each treatment after harvest of the crop. The dried grain yield from one meter square area per plot was

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recorded and then it was converted in hectares basis t/ha. The dried straw yield from one meter square area per plot was recorded and then it was converted in hectares basis t/ha. Harvest index was obtained by dividing the economic yield (grain) by the biological yield (grain +straw). It was calculated for each of the plots and was represented in percentage.

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~~The data recorded with different characteristics were subjected to statistical analysis by adopting Fishens the method of analysis of varience (ANOVA) as described by **Gomez and Gomez (1984)**. Critical difference (CD) values were calculated the 'F' test was found significantly at 5% level.~~

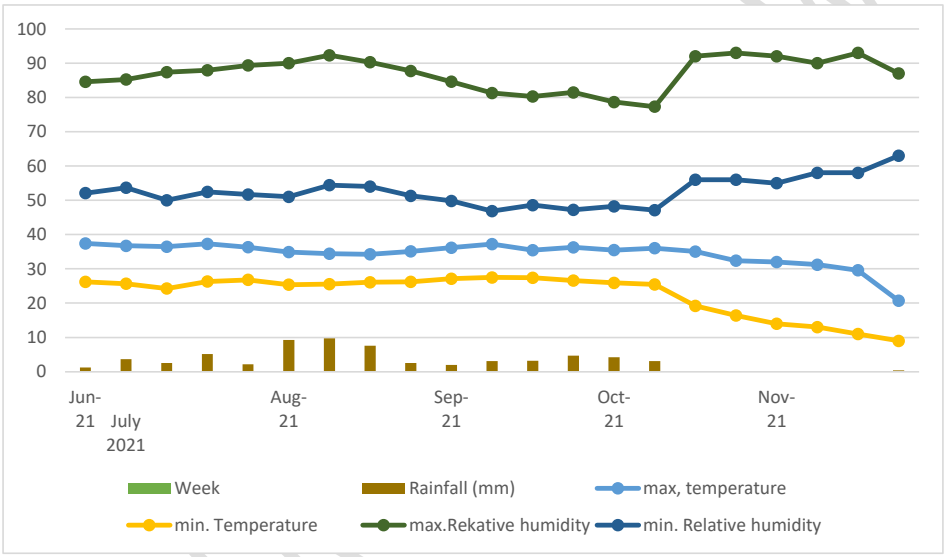

Figure.1 Mean weekly weather parameters and total rainfall during the cropping season (*Kharif* 2021)

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Growth Parameters

Plant height

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Data related to plant height influence by different planting method and nitrogen level treatment combination are presented in Table 1. The plant height was increased with advancement of growth period. The plant height of Black rice was measured and recorded at 20, 40, 60, 80 and 100 DAS/DAT (Table 1.). Plant height observed during 60, 80 and 100 DAS/DAT were significantly increased among treatments and T_9 i.e. Nitrogen at 75 kg/ha + SRI contribute maximum plant height 75.67cm, 116.97cm and 118.13 cm at 60, 80 and 100 DAS/DAT, respectively. T_4 i.e. Nitrogen at 65 kg/ha + transplanting method, T_6 i.e. Nitrogen

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at 65 kg/ha + SRI and T_7 i.e. Nitrogen at 75 kg/ha + transplanting method was followed similarly and found to be at par with T_9 i.e. Nitrogen at 75 kg/ha + SRI. Plant height significantly increased with the increase in the levels of nutrients due to supply of readily available forms and in adequate amounts of the plants. In rice cultivation, organic sources of nutrients supplemented with inorganic sources of nutrients application increases the nutrient availability at different growth stages and helped in increasing the plant height **(Rao *et al.* 2004; Malik *et al.* 2014; Dekhane *et al.* 2017)**.

Number of tillers/hill

Data pertaining to number of tillers/hill was recorded at 40, 60, 80 and 100 DAS/DAT (Table 2.). Maximum number of tillers initially at 40 DAS/DAT was observed in T_6 i.e. Nitrogen at 65 kg/ha + SRI, but at lateral stage 60 and 100 DAS/DAT maximum number of tillers/hill i.e. 14.67, 12.27 and 11.00 was observed with T_9 i.e. Nitrogen at 75 kg/ha + SRI. While T_6 i.e. Nitrogen at 65 kg/ha + SRI and T_7 i.e. Nitrogen at 75 kg/ha + transplanting method were noticed to be at par with T_9 i.e. Nitrogen at 75 kg/ha + SRI. With the combination of organic and inorganic source of nitrogen increases number of tillers/hill **(Banik and Bijbaruah, 2004; Kundu *et al.* 2016; Wang *et al.* 2017)**.

Plant dry weight (g/hill)

Plant dry weight at 20, 40, 60, 80 and 100 DAS/DAT were recorded and presented in Table 3. At 60, 80 and 100 DAS/DAT maximum plant dry weight 13.87, 25.07 and 31.62 g/hill was recorded with T_9 i.e. Nitrogen at 75 kg/ha + SRI, respectively. While T_6 i.e. Nitrogen at 65 kg/ha + SRI, T_7 i.e. Nitrogen at 75 kg/ha + transplanting method and T_8 i.e. Nitrogen at 75 kg/ha +direct sowing method were noticed to be at par with T_9 i.e. Nitrogen at 75 kg/ha + SRI. However minimum dry weight per hill was recorded with T_1 i.e. Nitrogen at 55 kg/ha + transplanting method. As the levels of nutrients supplied increased, adequate amounts and in available forms of nutrients for plants also increases which in turn gives robust growth thereby increasing the dry matter accumulation. **Meena *et al.* 2003** also reported significant improvement in dry matter accumulation of rice with increasing nutrition on account of better growth and development of the plant.

Yield attributes and Yield

Data related to yield attributes and yield were taken at harvest and tabulated in Table 4. Maximum number of panicles/hill, number of grains/ panicle and number of filled grains/ panicle (10.83, 196.70 and 116.33) was recorded with T_9 i.e. Nitrogen at 75 kg/ha + SRI which significantly superior among all treatment except T_7 i.e. Nitrogen at 75 kg/ha + transplanting method noticed to be at par with T_9 i.e. Nitrogen at 75 kg/ha + SRI. However in case of yield parameter maximum grain yield (4.61 t/ha) and straw yield (11.38 t/ha) were recorded with T9 i.e. Nitrogen at 75 kg/ha + SRI which was significantly superior among all treatment except in straw yield T_6 i.e. Nitrogen at 65 kg/ha + SRI and T_7 i.e. Nitrogen at 75 kg/ha + transplanting method was found to be at par with the maximum one. The increased plant spacing with SRI considerably resulted in advantage of space, light and circulatory air which might resulted in increased nutrient uptake and better dry matter assimilation leading to a consequent increase in a greater number of grains/panicle by **Saju *et al*. (2019); Baloch *et al*. (2002)**. Nitrogen promotes rapid growth and increased number of grains/panicle, the percentage of filled grains/panicle **(Fallah, 2012)**. The highest yield under SRI was due to adequate supply of nutrients which might contribute towards higher dry matter accumulation and better partitioning of photosynthate resulting in higher yield traits and ultimately the straw yield **(Singh *et al*. 2015)**.

Conclusion

Black rice was planted under nitrogen levels and planting methods during *Kharif* season, proved to be economically profitable to the farmers, along with better yield and quality. Plants under T_9 (Nitrogen at 75 kg/ha + SRI method) were compared to be better over other. The treatment with Nitrogen at 75 kg/ha + SRI method was found significantly higher in plant height (126.38 cm), number of tillers/hill (12.27), dry weight (31.62 g/hill), which ultimately increases the number of panicle/hills (14.33), number of grains/panicle (164.20), number of filled grains/panicle (147.69), test weight (26.67 g), grain yield (4.61 t/ha), straw yield (11.38 t/ha) and harvest index (29.49) as compared to other treatments.

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Table 1 Effect of nitrogen levels and planting methods on plant height at different interval

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		Plant height (cm)				
	Treatments	20 DAS/DAT	40 DAT/DAT	60DAS/DAT	80 DAS/DAT	100 DAS/DAT
T_1	Nitrogen at 55 kg/ha + transplanting method	19.25	30.03	63.65	114.67	114.67
T_2	Nitrogen at 55 kg/ha +direct sowing method	13.67	20.48	51.02	112.67	112.67
T_3	Nitrogen at 55 kg/ha + SRI	19.18	30.74	63.95	115.25	115.25
T_4	Nitrogen at 65 kg/ha + transplanting method	19.67	31.29	73.54	116.63	116.63
T_5	Nitrogen at 65 kg/ha +direct sowing method	13.93	23.35	71.68	114.62	114.62
T_6	Nitrogen at 65 kg/ha + SRI	20.26	31.49	74.07	116.73	116.73
T_7	Nitrogen at 75 kg/ha + transplanting method	21.03	29.95	74.12	116.60	116.60
T_8	Nitrogen at 75 kg/ha +direct sowing method	12.54	25.25	71.71	113.43	113.43
T_9	Nitrogen at 75 kg/ha + SRI	19.47	31.00	75.67	118.13	118.13
SEm (±)		2.70	3.40	1.03	1.47	0.57
CD (5 %)		NS	NS	3.09	4.41	1.72

Table 2 Effect of nitrogen levels and planting methods on number of tillers/hill at different intervals

		Number of tillers/hill			
	Treatments	40 DAT/DAT	60DAS/DAT	80 DAS/DAT	100 DAS/DAT
T_1	Nitrogen at 55 kg/ha + transplanting method	8.73	13.73	10.73	9.33
T_2	Nitrogen at 55 kg/ha +direct sowing method	5.53	11.13	9.47	8.13
T_3	Nitrogen at 55 kg/ha + SRI	8.87	14.00	10.57	9.20
T_4	Nitrogen at 65 kg/ha + transplanting method	8.53	13.07	11.13	9.60
T_5	Nitrogen at 65 kg/ha +direct sowing method	5.93	12.00	10.07	8.73
T_6	Nitrogen at 65 kg/ha + SRI	9.13	13.73	12.07	10.73
T_7	Nitrogen at 75 kg/ha + transplanting method	8.87	13.87	11.60	10.13
T_8	Nitrogen at 75 kg/ha +direct sowing method	5.93	11.13	9.73	8.40
T_9	Nitrogen at 75 kg/ha + SRI	9.00	14.67	12.27	11.00
SEm (±)		0.38	0.61	0.43	0.41
CD (5 %)		1.13	1.30	1.29	1.23

Table 3 Effect of nirtogen levels and planting methods on plant dry weigth at different intervals

		Plant dry weight (g/plants)				
	Treatments	20 DAS/DAT	40 DAT/DAT	60DAS/DAT	80 DAS/DAT	100 DAS/DAT
T_1	Nitrogen at 55 kg/ha + transplanting method	0.33	3.21	13.10	23.12	28.37
T_2	Nitrogen at 55 kg/ha +direct sowing method	0.18	2.1	11.35	21.67	27.32
T_3	Nitrogen at 55 kg/ha + SRI	0.24	3.29	13.55	24.28	29.48
T_4	Nitrogen at 65 kg/ha + transplanting method	0.34	3.09	13.35	24.67	30.65
T_5	Nitrogen at 65 kg/ha +direct sowing method	0.22	2.42	11.47	21.83	29.60
T_6	Nitrogen at 65 kg/ha + SRI	0.25	3.52	13.50	24.73	29.08
T_7	Nitrogen at 75 kg/ha + transplanting method	0.33	3.54	13.20	24.33	29.82
T_8	Nitrogen at 75 kg/ha +direct sowing method	0.19	2.64	11.85	22.71	29.95
T_9	Nitrogen at 75 kg/ha + SRI	0.26	3.28	13.87	25.07	31.62
SEm (±)		0.01	0.18	0.29	0.51	0.74
CD (5 %)		0.05	0.54	0.88	1.52	2.22

Table 4 Yield and yield attributes of black rice

		Yield Parameter						
	Treatments	Number of panicles/hill	Number grains/panicle	Number of filled grains/panicle	Test weight (g)	Grain yield (t/ha)	Straw yield (t/ha)	Harvest Index (%)
T_1	Nitrogen at 55 kg/ha + transplanting method	8.80	168.80	94.33	21.73	2.91	9.27	24.64
T_2	Nitrogen at 55 kg/ha +direct sowing method	8.70	163.78	89.33	20.33	2.48	6.92	26.39
T_3	Nitrogen at 55 kg/ha + SRI	9.13	171.73	96.67	22.33	2.60	6.94	27.15
T_4	Nitrogen at 65 kg/ha + transplanting method	9.03	184.37	105.67	22.37	3.22	9.76	25.14
T_5	Nitrogen at 65 kg/ha +direct sowing method	8.93	179.39	99.66	21.67	3.36	8.26	28.80
T_6	Nitrogen at 65 kg/ha + SRI	9.63	186.17	105.88	22.90	4.00	11.13	26.88
T_7	Nitrogen at 75 kg/ha + transplanting method	10.27	195.81	114.67	23.11	4.25	11.14	29.14
T_8	Nitrogen at 75 kg/ha +direct sowing method	9.37	189.17	106.33	22.67	3.79	10.33	24.60
T_9	Nitrogen at 75 kg/ha + SRI	10.83	196.70	116.33	23.37	4.61	11.38	29.49
SEm (±)		0.42	1.11	1.91	0.77	0.04	0.11	2.53
CD (5 %)		1.27	3.33	5.75	NS	0.13	0.32	NS