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# Response of Different Plant Spacings and Nitrogen Levels on Yield and Economics of Black Rice

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## ABSTRACT

Black rice has more amount of antioxidants than any other rice varieties. It is considered to have multiple benefits in human health due to the presence of different antioxidants in the grain. A field experiment was conducted during the rainy season of 2021 to assess the yield and economics of black rice production under different crop geometries and nitrogen levels in Bapatla. The black rice variety of BPT-2841 was evaluated under different plant spacings (10 cm x 15 cm, 15 cm x 15 cm, 20 cm x 10 cm, 20 cm x 15 cm) and the levels of nitrogen (90 kg N $ha^{-1}$, 120 kg N $ha^{-1}$, 150 kg N $ha^{-1}$) for the yield and economic returns. An increase in spacing induced vigorous plant growth as well as increased the number of yield attributing characters leads to increased economic returns. The spacing 20 cm x 15 cm proved more appropriate because it produced the better plant stand, gave more panicle density and higher grain yield results in greater net returns than other three spacings tested. The nitrogen level of 150 kg N $ha^{-1}$ produced significantly the highest yield and the economic returns as compared with all other levels of nitrogen tried.

**Keywords:** *Antioxidants, Planting density and Nitrogen levels.*

Rice is one of the most promising staple food consumed by more than half of the global population and whose demand increases with increase in human population. Black rice is one of the variant species gaining importance at present conditions due to their antioxidant activity which helps as a medium in curing wide range of health problems. Crop geometry in plant varied according to genetic characteristics of the plant (size of the plant, elasticity of the plant, foraging area or soil cover dry matter partitioning and crop and variety), time of sowing, environmental factors, and fertilizer application and the main aim is to reduce the cost of cultivation without compromising the yield in order to make this happen there is a need to evaluate the proper plant spacing for black rice. Excess use of fertilizer nutrients implies increase of cost and decrease of returns and risk of environmental pollution and are not able to harness the full yield potential of rice. On the other hand, under use of nutrients depress the scope for increasing the present level of nutrients to the economically optimum level to exploit production potential to a larger extent (Singh *et al*., 2001). Application of inadequate and unbalanced fertilization to crops not only results in low crop yields but also deteriorate the soil health (Sharma *et al*., 2003). In order to explain the ability of this black rice variety in the nitrogen consumption point of view, this research was framed with three levels of nitrogen under different plant spacings.

## MATERIAL AND METHODS

The experiment was plotted at the Agricultural College Farm, Bapatla. The soil of the experimental field was sandy clay loam in texture and slightly acidic in reaction (pH 6.57) with low organic matter content (0.45%). The total available nitrogen, available phosphorus and exchangeable potassium were 198 kg $ha^{-1}$, 36.7 kg $ha^{-1}$, 232.8 kg $ha^{-1}$ soil. The total rainfall during the crop season was 1061.7 mm. The mean maximum temperature during the experimental period ranged from 28.9$^0$C to 37.2$^0$C. The layout of the trial was split plot design having four plant spacings *i.e.,* 10 cm x 15 cm, 15 cm x 15 cm, 20 cm x 10 cm, 20 cm x 15 cm in main plots and three nitrogen levels *i.e.*, 90 kg N $ha^{-1}$, 120 kg N $ha^{-1}$, 150 kg N $ha^{-1}$ in sub plots were taken for these studies. The area of each plot was 6m x 5.1m. Twenty-five days seedlings were transplanted with an average of two seedlings $hill^{-1}$. The nitrogen was supplied in the form of urea and it was applied as per the treatments. The fertilizer in the form of single superphosphate (SOP) and murate of potash (MOP) was applied at the rate of 60 P and 40 K (kg $ha^{-1}$) and potash is applied in two split doses. The basal dose of 20 K (kg $ha^{-1}$) was applied before transplanting while the remaining quantity of 20 K (kg $ha^{-1}$) was applied as top dressing after 40 DAT. Standard cultural practices were carried out till the crop was obtaining its maturity.

## RESULTS AND DISCUSSION

Data from the table reveals that grain yield increased with increase in spacing. The maximum grain yield (4519 kg $ha^{-1}$) was recorded with planting geometry of 20 cm x 15 cm which was statistically significant with the yield of other planting geometries. The yield was minimum (3560 kg $ha^{-1}$) with planting geometry of 10 cm x 15 cm spacing. The wider spacing had linearly increasing effect on the performance of individual plants. The plants grown with wider spacing have more area of land around them to draw the nutrition and had more solar radiation to absorb for better photosynthetic process and hence performed better as individual plants reported by Baloch *et al.* (2002).The maximum grain yield (4298 kg $ha^{-1}$) was recorded with 150 kg N

**Table 1. Grain yield (kg $ha^{-1}$) of black rice as influenced by planting geometry and nitrogen levels**

| Nitrogen levels (kg $ha^{-1}$) | | | | |
|---|---|---|---|---|
| Spacings | $S_1$: 90 | $S_2$: 120 | $S_3$: 150 | Mean |
| $M_1$: 10 cm x 15 cm | 3385 | 3569 | 3727 | 3560 |
| $M_2$: 15 cm x 15 cm | 3683 | 4057 | 4400 | 4047 |
| $M_3$: 20 cm x 10 cm | 3639 | 3776 | 3800 | 3738 |
| $M_4$: 20 cm x 15 cm | 3809 | 4481 | 5266 | 4519 |
| Mean | 3629 | 3971 | 4298 | |
| | SEm± | CD | CV | |
| Main plot | 79.9 | 276 | 6 | |
| Sub plot | 76.3 | 229 | 6.7 | |
| Interaction | | | | |
| S at same level of M (S X M) | 152.6 | 458 | | |
| M at same or different level of S (M X S) | 148.0 | 464 | | |

**Table 2. Gross returns (Rs. ha$^{-1}$) of black rice as influenced by planting geometry and nitrogen levels**

| | Nitrogen levels | | | |
|---|---|---|---|---|
| Spacings | $S_1$: 90 | $S_2$: 120 | $S_3$: 150 | Mean |
| $M_1$: 10 cm x 15 cm | 173492 | 182862 | 190952 | 182435 |
| $M_2$: 15 cm x 15 cm | 188685 | 207856 | 225586 | 207375 |
| $M_3$: 20 cm x 10 cm | 186467 | 193553 | 194756 | 191592 |
| $M_4$: 20 cm x 15 cm | 195279 | 229733 | 269751 | 231588 |
| Mean | 185981 | 203501 | 220261 | |
| | SEm± | CD | CV | |
| Main plot | 4143.4 | 14339 | 6.1 | |
| Sub plot | 3921.8 | 11758 | 6.7 | |
| Interaction | | | | |
| S at same level of M (S X M) | 7843.7 | NS | | |
| M at same or different level of S (M X S) | 7627.8 | NS | | |

**Table 3. Net returns (Rs. ha$^{-1}$) of black rice as influenced by planting geometry and nitrogen levels**

| | Nitrogen levels | | | |
|---|---|---|---|---|
| Spacings | $S_1$: 90 | $S_2$: 120 | $S_3$: 150 | Mean |
| $M_1$: 10 cm x 15 cm | 97451 | 106499 | 114258 | 106069 |
| $M_2$: 15 cm x 15 cm | 113393 | 132242 | 149642 | 131759 |
| $M_3$: 20 cm x 10 cm | 111675 | 118439 | 119312 | 116475 |
| $M_4$: 20 cm x 15 cm | 121238 | 155369 | 195057 | 157221 |
| Mean | 110939 | 128137 | 144567 | |
| | SEm± | CD | CV | |
| Main plot | 4143.4 | 14339 | 9.7 | |
| Sub plot | 3921.8 | 11758 | 10.6 | |
| Interaction | | | | |
| S at same level of M (S X M) | 7843.7 | NS | | |
| M at same or different level of S (M X S) | 7627.8 | NS | | |

ha$^{-1}$ which was significantly higher than the yield at 120 and 90 kg N ha$^{-1}$*i.e.*, 3971 and 3629 kg ha$^{-1}$, respectively. The interaction effect between the plant spacings and nitrogen levels was seen to be significant. Among the different treatments the highest grain yield (5266 kg ha$^{-1}$) was observed with a combination of 20 cm x 15 cm coupled with 150 kg N ha$^{-1}$ and the minimum (3385 kg ha$^{-1}$) was seen at a treatment combination of 10 cm x 15 cm combined with 90 kg N ha$^{-1}$.

**Table 4. Benefit cost ratio of black rice as affected by planting geometry and levels of nitrogen**

| | Nitrogen levels | | | |
|---|---|---|---|---|
| Spacings | $S_1$: 90 | $S_2$: 120 | $S_3$: 150 | Mean |
| $M_1$: 10 cm x 15 cm | 1.3 | 1.4 | 1.5 | 1.4 |
| $M_2$: 15 cm x 15 cm | 1.5 | 1.7 | 2 | 1.7 |
| $M_3$: 20 cm x 10 cm | 1.5 | 1.6 | 1.6 | 1.6 |
| $M_4$: 20 cm x 15 cm | 1.6 | 2.1 | 2.6 | 2.1 |
| Mean | 1.5 | 1.7 | 1.9 | |
| | SEm± | CD | CV | |
| Main plot | 0.06 | 0.2 | 9.7 | |
| Sub plot | 0.05 | 0.2 | 10.6 | |
| Interaction | | | | |
| S at same level of M (S X M) | 0.1 | NS | | |
| M at same or different level of S (M X S) | 0.14 | NS | | |

Data from the table reveals that grain yield increased with increase in spacing. The maximum grain yield (4519 kg ha$^{-1}$) was recorded with planting geometry of 20 cm x 15 cm which was statistically significant with the yield of other planting geometries. The yield was minimum (3560 kg ha$^{-1}$) with planting geometry of 10 cm x 15 cm spacing. The wider spacing had linearly increasing effect on the performance of individual plants. The plants grown with wider spacing have more area of land around them to draw the nutrition and had more solar radiation to absorb for better photosynthetic process and hence performed better as individual plants reported by Baloch *et al.* (2002).The maximum grain yield (4298 kg ha$^{-1}$) was recorded with 150 kg N ha$^{-1}$ which was significantly higher than the yield at 120 and 90 kg N ha$^{-1}$ *i.e.*, 3971 and 3629 kg ha$^{-1}$, respectively. The interaction effect between the plant spacings and nitrogen levels was seen to be significant. Among the different treatments the highest grain yield (5266 kg ha$^{-1}$) was observed with a combination of 20 cm x 15 cm coupled with 150 kg N ha$^{-1}$ and the minimum (3385 kg ha$^{-1}$) was seen at a treatment combination of 10 cm x 15 cm combined with 90 kg N ha$^{-1}$.

The effect of planting geometry and nitrogen levels on gross returns was found to be significant. But the interaction between these two factors was found to be non-significant. Significantly the highest gross returns (2,31,588 Rs. ha$^{-1}$) was obtained with the spacing of 20 cm x 15 cm. The spacing 20 cm x 10 cm was found on par with 15 cm x 15 cm and the lowest gross returns (1,82,435 Rs. ha$^{-1}$) was recorded at a spacing of 10 cm x 15 cm. In case of nitrogen levels, significantly the highest gross returns (2,20,261 Rs. ha$^{-1}$) were recorded with the application of 150 kg N ha$^{-1}$ but showed significant effect with other levels of nitrogen. Results of experiments conducted by Jain and Upadhyay (2008) and Mohan and Pillai (2014) confirmed the present findings.

Data pertaining to the net returns revealed that significantly the highest net returns (1,57,221 Rs. ha$^{-1}$) were recorded with the spacing of 20 cm x 15 cm. Among the N levels tried, significantly the highest net returns (1,44,567 Rs. ha$^{-1}$) were obtained with an application of 150 kg N ha$^{-1}$.Similar finding was

reported by Philip *et al*. (2012) and Maqsood *et al*. (2013).

Significantly the highest B:C ratio (2.1) was obtained with the spacing of 20 cm x 15 cm and the lowest B:C ratio (1.4) was recorded with a spacing of 10 cm x 15 cm. With respect to nitrogen levels, significantly the highest B:C ratio (1.9) was attained with an application of 150 kg N $ha^{-1}$ which was found on par with 120 kg N $ha^{-1}$ and the lowest B:C ratio (1.5) was observed with application of 90 kg N $ha^{-1}$.

## CONCLUSION

This investigation concluded that black rice is responsive to applied nitrogen and found relatively higher yield in wider crop geometry (20 cm × 15 cm) with the application of 150 kg N $ha^{-1}$. Highest economic returns and highest B:C ratio can be obtained from highest level of nitrogen (150 kg N $ha^{-1}$) with wider spacing (20 cm × 15 cm).

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