The Bioscan
AN INTERNATIONAL QUARTERLY JOURNAL OF LIFE SCIENCES
20(3): 260-263, 2025 www.thebioscan.com

"Effect of Plant Spacing and Nutrient Inputs from Organic and Inorganic Sources on the Growth and Yield Attributes of Rice (Oryza sativa L.) in Eastern U.P."

***[1]Saurabh Bharti, [2]Anil Kumar Singh, [3]Vishuddha Nand, [4]Aman Bharti, [5]Rudra Pratap Singh, [6]Brijesh Kumar, [7]Balveer Gautam.**

[1,6,7] Research Scholar, [2]Professor, Department of Agronomy, A.N.D.U.A.T., Kumarganj, Ayodhya, U.P, India.

[3,] Assistant Professor, (Agronomy), Department of livestock farm complex (L.F.C.), A.N.D.U.A.T., Kumarganj, Ayodhya, U.P, India.

[4] Research Scholar, Department of Geography, D.D.U.G.U., U.P, India.

[5,] Associate Professor, Department of Entamology, A.N.D.U.A.T., Kumarganj, Ayodhya, U.P, India.

Corresponding e-mail: saurabhbharti112@gmail.com

DOI: 10.63001/tbs.2025.v20.i03.pp260-263

KEYWORDS
Leaf area index, yield attributes

Received on:

03-05-2025

Accepted on:

08-06-2025

Published on:

19-07-2025

ABSTRACT

Rice (*Oryza sativa* L.) is the most important staple food of the Indian population. The present study was conducted at Agronomy Research Farm, Acharya Narendra Deva University of Agriculture and Technology, Kumar Ganj, Ayodhya, Uttar Pradesh, on silty loam soil during 2023–24 and 2024–25 to study the productivity of rice. Two-year field experimentation was carried out under a split-plot design grown under Four planting Spacing in main plots, *viz.* 20 cm × 10cm, 15 cm × 15 cm, 20 cm × 15 cm and 30 cm × 15 cm and four nutrient management treatment combinations using 100% RDF (150:60:60), 100% RDF (150:60:60) + micronutrients mixture @ 0.5% (foliar spray at 30 DAT and 60 DAT), 100% RDF (150:60:60) + Blue green algae @ 10 kg ha^{-1}, and 100%RDF + Jeevamrut @ 10% (foliar spray at 30 DAT and 60 DAT) in subplots with three replications. on crop growth like leaf area index and Yield attributes of rice. Careful observation from the growth indices confirmed that in the main plot, 20 cm × 10 cm, and in the sub-plot, 100% RDF + 0.5% foliar spray of micronutrients recorded significantly the highest in terms of Leaf area index and yield attributes of rice respectively.

INTRODUCTION

Rice is one of the most important cereal crops of *kharif* season. It is tolerant to a range of soils with pH from 4.5 to 8.5 and can be grown successfully on saline or sodic soils. Rice is the most important cereal food crop of the developing world and staple food for more than half of the world's population. Based on aroma, rice varieties are groups into two categories namely scented and no scented rice. Scented rice gives a distinctive aroma due to the presence of natural chemical compounds and having a unique quality feature, excellent cooking and eating quality, long slender grains with delicate curvature and remarkable linear elongation. Since, present population rate in the world is expected to increase to 8.5 billion by 2025, an increase of 2 to 3 % of rice production has to be maintained per year within limited land resources in order to maintain self-sufficiency in rice production In 2024-2025 Rice is cultivated world-wide over an area of about 167.6 million hectares and total production of rice 535.8 metric tonnes. it is the world's second most important cereal crop. In India rice is cultivated over an area of about 50.0 million hectares with an annual production of about 147.0 million tons in 2024-2025. Uttar Pradesh is an important rice growing state in the country. The area and production of rice in this state is about 6.26 million hectare and 21.74 million metric tons respectively with the productivity of 3472 kg ha^{-1} (Anonymous, 2024). Plant spacing is an important non-monetary input to maintenance of an optimum level of rice plant population in field is necessary to maximizing grain yield. Dense cultivated crops may face with competition for temperature, solar radiation, moisture and soil fertility which affects their growth, yield and grain quality performance (Bozorgi *et al*. 2011). Planting spacing in rice significantly effects on the tillers production, number of panicles, total biomass and grain yield thus, plant spacing has an important role on growth and yield of rice. Optimum plant population in a proper plant spacing is most important, it plays a major role in yield maximization of rice. The planting spacing had great influenced on tillering pattern and spikelet formation per panicles (Mahato *et al*. 2017). Close planting (15 cm × 15 cm or 44 hills (m^{-2}) may improve the grain yield of rice by 3.95% over wider spacing (20 cm × 15 cm or 33 hills (m^{-2}), (Saha *et al.* 2022). Judicious and proper use of fertilizers can markedly increase the yield and improve the quality of rice (Alam *et al.* 2009). There has been serious concern about long term adverse effect of continuous and indiscriminate use of inorganic fertilizer on soil health, biodiversity and environment. Because of continuous growing of HYV rice and injudicious fertilizer management, many soils are getting exhausted. This is resulting in problems of N, P, and K deficiency in soils (Saleque *et al.* 1998). Phosphorus is an indispensable macro nutrient necessary for key metabolic processes in plants such as cell division, energy generation, bio-synthesis of macro molecules, membrane integrity, signal transduction and photosynthesis. It also plays a vital role in respiration in plants (Khan *et al.* 2010). Zinc is involved in the synthesis of chlorophyll, enzymes, proteins and metabolic reactions (Ali *et al.* 2008). In countries where rice is a major staple food, Zn deficiency is most prevalent. About 49% zinc (Zn) reported to be deficient in Indian soils. Plants suffering from zinc deficiency produce symptoms like chlorosis, low membrane integrity and leaf size, retarded shoot growth, reduced grain yield, pollen formation, root development, water uptake and transport and increased vulnerability to heat, light and fungal infections (Kamran *et al.* 2017). Applied Zn about 96 to 99% in to soils is converted to different insoluble forms depending on soil type and physical and chemical reactions (Zhang *et al.* 2017). Jeevamrut is low-cost improvised preparation that enriches the soil with indigenous microorganism required for mineralization from native cow dung, cow urine, horse gram and jaggery. Jeevamrut, in acidic soil when applied increases pH and in alkaline soil decreases pH, thus creates favourable condition for availability of maximum nutrients to plants P^H 6.5 to 7.8. This condition increases the crop yield and cuts down an entire expense of chemical fertilizer. Cyanobacteria (Blue-Green Algae) is the one of the major components of the nitrogen fixing biomass in paddy fields. The agricultural importance of cyanobacteria in rice cultivation is directly related with their ability to fix nitrogen and other positive effects for plants and soil. After water, nitrogen is the second limiting factor for plant growth in many fields and efficiency of this element is met by fertilizer.

Materials and methods;

A field experiment was conducted during the *kharif* season of 2023 and 2024 at Agronomy Research Farm of Acharya Narendra Deva University of Agriculture and Technology, Kumar Ganj, Ayodhya, Uttar Pradesh on silty loam soil. Geographically, this experimental site falls under semi-arid, sub-tropical climate of Indo-Gangetic alluvial plains (IGP) having alluvial calcareous soil and is located at 26o 47" N latitude and 82o 12" E longitude on an elevation of about 113 meters above mean sea level. The soil of experimental site was silty loam in texture, having *p*H 7.85. Two-year field experimentation was carried out under a split-plot design grown under Four planting Spacing in main plots, *viz.* 20 cm × 10cm, 15 cm × 15 cm, 20 cm × 15 cm and 30 cm × 15 cm and four Different treatments were of the following combinations using 100% RDF (150:60:60), 100% RDF (150:60:60) + micronutrients, 100% RDF (150:60:60) + algae Blue green algae @ 10 kg ha^{-1}, and 100%RDF + Jeevamrut @ 10% (foliar spray at 30 DAT and 60 DAT) in sub-plots design with three replications. The rice variety 'Bounakalanamak' was transplanted in 19 and 23 July in both years. The half dose of N and full dose of P_2O_5 and K_2O were applied at the time of transplanting. Remaining N were applied at the time of maximum tillering stage. 0.5% foliar spray of Micronutrients mixture and 10% foliar spray of jeewamrut were applied at the time of 30 DAT and 60 DAT, and Blue green Algae powder 10 kg/ha were applied in the field 1 week after transplanting. The crop was raised with a recommended package of practices. During the crop-growing period, data with respect to different parameters of growth, and yield attributes of rice were collected. The morphological parameters such as leaf area index yield attributes were recorded at 30, 60, 90 DAT stage and five random plants were selected in each plot for plant hight and average length was recorded. During the crop-growing period, data with respect to different parameters of growth, yield attributes and yield of rice were collected. Leaf area index (LAI) was computed from the samples collected for dry matter estimation; leaves of 5 hills were plucked at tillering, panicle initiation and flowering and leaf area was measured using leaf area meter (LA-3100). The leaf area for each sample recorded was averaged to give the leaf area of plants/ hill. The following relationship was used to compute LAI (Watson, 1952) at each stage.

Result and Discussion

Leaf Area Index

The leaf area index was influenced by different plant spacing and nutrients management through organic and inorganic sources. The leaf area index of rice was significantly affected by variations in plant spacing and nutrient management practices across both years. At 30, 60 and 90 DAT as evidenced by the data presented (Table 1). The highest leaf area index at 30DAT (1.829 and 1.908), 60 DAT (3.997 and 4.077) and 90 DAT (5.658 and 5.710) was observed under the plant spacing of 20 cm × 10 cm (S1), which was statistically comparable to the spacing of 15 × 15 cm (1.770 and 1.848), (3.811and 3.851) and (5.441 and 5.463). Conversely, the widest spacing (30 cm × 15 cm) resulted in the leaf area index (1.435 and 1.510), (3.360 and 3.467) and (0.098 and 0.101). A similar type of result was recorded by (Kumar, *et al.*, 2023) The SPAD value increases with the increased application rate of nitrogen in rice crop because nitrogen help in chlorophyll accumulation in leaves (Fang *et al.*, 2018.). in Nutrient management also played a crucial role, with the application of 100% RDF combined with a micronutrient mixture (0.5% foliar spray at 30 and 60 DAT) significantly enhancing leaf area index (1.831 and 1.902), (4.146 and 4.235) and (5.722 and 5.811). Additionally, the combined application of 100% RDF with blue-green algae (10 kg ha^{-1}), (1.699 and 1.761), (3.656 and 3.697) and (5.138 and 5.195). after that 100%RDF + Jeevamrut @10% (foliar spray at 30 DAT and 60 DAT) which was at par with (N3) (1.648 and 1.731), (3.554 and 3.605) and (5.098 and 5.135) also improved height presented in (table 1). Minimum plant hight observed in (1.546 and 1.610), (3.380 and 3.424) and (4.845 and 4.863) 100 % RDF (150:60:60 NPK kg ha^{-1}). The increase of leaf area index is due to foliar application of the micronutrients and helps in cell elongation and chlorophyll formation (Zayed *et al.*, 2011).

Table.1. "Effect of Plant Spacing and Nutrient Inputs from Organic and Inorganic Sources on the Growth of Rice (Oryza sativa L.) in Eastern U.P."

Treatments	**Leaf Area Index**					
	30 DAT		**60 DAT**		**90 DAT**	
	2023	**2024**	**2023**	**2024**	**2023**	**2024**
Plant spacing (Main Plot)						
20 cm × 10 cm	1.829	1.908	3.997	4.077	5.658	5.710
15 cm × 15 cm	1.770	1.848	3.811	3.851	5.441	5.463
20 cm × 15 cm	1.691	1.739	3.566	3.585	5.062	5.086
30 cm × 15 cm	1.435	1.510	3.360	3.467	4.723	4.742
SE(m)±	0.023	0.025	0.067	0.078	0.098	0.101
C.D. (P=0.05)	0.078	0.081	0.223	0.225	0.315	0.324
Nutrient management (Sub-Plot)						
100% RDF (150:60:60 NPK kg ha^{-1})	1.546	1.610	3.380	3.424	4.845	4.863
100% RDF + Micronutrient mixture @ 0.5% (foliar spray at 30 DAT and 60 DAT)	1.831	1.902	4.146	4.235	5.722	5.811

100% RDF + Blue green algae @ 10 kg ha^{-1}	1.699	1.761	3.656	3.697	5.138	5.195
100%RDF + Jeevamrut @ 10% (foliar spray at 30 DAT and 60 DAT)	1.648	1.731	3.554	3.605	5.098	5.135
SE(m)±	0.018	0.019	0.057	0.060	0.084	0.085
C.D. (P=0.05)	0.061	0.065	0.172	0.174	0.249	0.253

Yield Attributes

In plant spacing highest no. of effective tillers was found in spacing S1(20cm × 10cm) in both year value (333.32 and 343.50). fallowed by spacing S2 (20cm × 15cm) which was at par with S1spacing (319.84 and 325.29). Mahato *et al.* (2017) also reported similar type of variation where closer spacing gave the highest number of panicles/m2. Minimum no. of effective tillers was found in wider spacing (30cm × 15cm) (273.42 and 276.82) show in (table 2). In nutrients management practices highest no. of effective tillers was reported in (332.88 and 340.14) treatment no. N2 (100% RDF + 0.5 % micronutrients spray). Which was followed by (307.86 and 314.89) N3 (100%RDF + Algae). And after that N4 (100% RDF + jeewamrut) which are at par (295.14 and 302.36) with N3. Minimum no. of effective tillers (277.05 and 283.31) along with treatment N1(100% RDF). The data pertaining to number of productive tillers/m^{-2} had been tabulated in Table 2. The tiller number/ m^{-2} was statistically significantly influenced by levels of NPK method and doses of micronutrient (Korla Aditya Chowdary and Bikas Chandra Patra).

Table.2. "Effect of Plant Spacing and Nutrient Inputs from Organic and Inorganic Sources on the Yield Attributes of Rice (Oryza sativa L.) in Eastern U.P."

Treatments	**Yield attributes**							
	Effective tillers (m^{-2})		**Panicle length (cm)**		**No. of grain per panicle**		**1000 grain weight (g)**	
Plant spacing (Main Plot)								
20 cm × 10 cm	333.32	343.50	28.59	28.91	107.95	115.68	15.16	15.45
15 cm × 15 cm	319.84	325.29	28.19	28.31	126.51	129.12	15.98	16.42
20 cm × 15 cm	294.56	301.17	26.90	27.11	132.77	135.03	16.38	16.77
30 cm × 15 cm	273.42	276.82	25.81	26.72	118.03	127.52	15.57	16.21
SE(m)±	4.64	4.85	0.58	0.58	1.97	1.99	0.33	0.34
C.D. (P=0.05)	18.42	19.37	NS	NS	6.71	6.93	NS	NS
Nutrient management (Sub-Plot)								
100% RDF (150:60:60 NPK kg ha^{-1})	277.05	283.31	26.52	26.88	103.38	109.10	15.05	15.13
100% RDF + Micronutrient mixture @ 0.5% (foliar spray at 30 DAT and 60 DAT)	332.88	340.14	28.12	28.89	130.47	137.44	16.62	16.78
100% RDF + Blue green algae @ 10 kg ha^{-1}	307.86	314.89	27.62	27.79	122.90	129.75	15.83	15.90
100%RDF + Jeevamrut @ 10% (foliar spray at 30 DAT and 60 DAT)	295.14	302.36	27.22	27.49	118.51	124.07	15.75	15.83
SE(m)±	4.26	4.34	0.46	0.46	*1.85*	*1.87*	0.26	0.27
C.D. (P=0.05)	15.17	16.56	NS	NS	6.49	6.77	0.68	0.67

Panicle length.

Plant spacing had no significant effect on panicle length. Longest panicle length (28.59 and 28.91) was observed with 20 cm × 10 cm spacing (S1) in both of the year, as compared to rest of the treatments. Shortest panicle length (25.81 and 26.72), were found in wider spacing (30 cm x 15 cm) similar results were found in Rajput *et al* (2020) show in (table 2). In nutrient management longest panicle (28.12 and 28.89) was found in treatment no. N2 (100% RDF + 0.5 % micronutrients spray) in both year of pooled value. Which was followed by (27.62 and 27.79) N3 (100%RDF + Algae). After that treatment no. N4 (100% RDF + jeewamrut) which are at par (27.22 and 27.49) with N3 treatment. shortest panicle length (26.52 and 26.88) was found in treatment no. N1 (100% RDF). in both year of experiment. In nutrient management practices the higher values of yield attributing characters might be due to combination of micronutrients along with NPK which might have activated the availability of more plant nutrients and also helped in releasing unavailable nutrients into available form to the crop plants effectively as described by Sridhara *et al*.

No. of grains / panicle. Highest no. of grains/panicle (132.77 and 135.03) was found in spacing S3 (20 cm ×15 cm) in both year of experiment and minimum no. of grains /panicle (107.95 and 115.68) was found in closer spacing S1 (20cm × 10cm). The improvement in grains/panicles was might be owing to the fact that supply of more food materials, moisture and light for the plant under optimum/wider spacing which ultimately resulted in better environment for growth and development of the crop (Uddin *et al.*, 2011). In nutrients management practices highest no. of grains/panicle (130.47 and 137.44) was found in treatment no. N2 (100% RDF + 0.5 % micronutrients spray) during both year of experiment. Which was followed by (122.90 and 129.75) N3 (100%RDF+Algae) and after that treatment N4 (100% RDF + jeewamrut) which was at par (118.51 and 124.07) with N3. minimum no. of grains /panicle (103.38 and 109.10) was found in treatment N1(100% RDF) show in (table 2). micronutrient is responsible for the translocation of food materials in plants therefore it played vital role in grain setting as well as higher number of grains in rice. Present results are in line with Increase in growth attributes was mainly due to Zn and Fe application which are involved in the synthesis of growth promoting hormones and the reproduction process of many plants which are vital for grain formation (Ramana *et al.*, 2006).

Test weight

The test weight was not influenced significantly either by the spacing Wider spacing showed higher test weight (16.38 and 16.77) than closer spacing, S1 (15.16 and 15.45). (Yadav, 2007). Adoption of wider spacing for rice transplanting may have resulted in higher grain weight than at closer spacing (Gautam et al., 2008). In Nutrients management treatment N2 found the higher test weight (16.62 and 16.78) in both year of value. Which was followed by (15.83 and 15.90) N3 and after that N4 are at par (15.75 and 15.83) with N3. Lowest test weight was found (15.05 and 15.13) in treatment no. N1.in both year of value show in (table 2). The comparative foliar application of the three macronutrients in combination proved its superiority and it gave the highest values of panicle weight and 1000-grain weight. (*B.A. Zayed, 2011*). The data revealed that micronutrients application and spacing had significant effect on the grain weight. (Md. Dhin Islam 2018).

CONCLUSION

Based on the experimental results obtained from two years of study, evaluated and the discussion given above, it can be concluded that for realizing better leaf area index and higher yield attributes of the rice has to be transplanted at a spacing of 20 cm × 10 cm with supplied application of 100% RDF +

micronutrient mixture @ 0.5% (foliar spray at 30 DAT and 60 DAT). It was found to have significantly outperformed other treatments under study in terms of the plant nutrient status.

REFERENCES

- Bozorgi, H. R., Faraji, A., Danesh, R. K., Keshavarz, A., Azarpour, E., & Tarighi, F. (2011). Effect of plant density on yield and yield components of rice. *World Applied Sciences Journal*, *12*(11), 2053-2057.
- Mahato, M., & Adhikari, B. B. (2017). Effect of planting geometry on growth of rice varieties. *International Journal of Applied Sciences and Biotechnology*, *5*(4), 423-429.
- Saha, B., Ghosh, M., & Patra, B. C. (2022). Standardization of planting time, spacing and nutrient management for traditional red-husked scented rice (Oryza sativa) in West Bengal. *Indian Journal of Agronomy*, *67*(1), 6-11.
- Alam, M. M., Ali, M. H., Amin, A. K. M. R., & Hasanuzzaman, M. (2009). Yield attributes, yield and harvest index of three irrigated rice varieties under different levels of phosphorus. *Advances in biological research*, *3*(3-4), 132-139.
- Saleque, M. A., Saha, P. K., Panaullah, G. M., & Bhuiyan, N. I. (1998). Response of wetland rice to potassium in farmers' fields of the Barind tract of Bangladesh. *Journal of plant nutrition*, *21*(1), 39-47.
- Kamran, S., Shahid, I., Baig, D. N., Rizwan, M., Malik, K. A., & Mehnaz, S. (2017). Contribution of zinc solubilizing bacteria in growth promotion and zinc content of wheat. *Frontiers in microbiology*, *8*, 2593.
- Khan, M. A., Stroud, J. L., Zhu, Y. G., McGrath, S. P., & Zhao, F. J. (2010). Arsenic bioavailability to rice is elevated in Bangladeshi paddy soils. *Environmental Science & Technology*, *44*(22), 8515-8521.
- Ali, M. A., Lee, C. H., & Kim, P. J. (2008). Effect of silicate fertilizer on reducing methane emission during rice cultivation. *Biology and Fertility of Soils*, *44*, 597-604.
- Zhang, H., Liu, X. L., Zhang, R. X., Yuan, H. Y., Wang, M. M., Yang, H. Y., ... & Liang, Z. W. (2017). Root damage under alkaline stress is associated with reactive oxygen species accumulation in rice (Oryza sativa L.). *Frontiers in plant science*, *8*, 1580.
- Rajput, P., Singh, A. K., Rajput, R. K., & Singh, A. (2020). Effect of nitrogen levels on yield and yield attributes of rice (Oryza sativa) grown under different planting geometry. *Indian Journal of Agronomy*, *65*(2), 235-241.
- Uddin, M. J., Ahmed, S., Harun-or-Rashid, M., Hasan, M. M., & Asaduzzaman, M. (2011). Effect of spacings on the yield and yield attributes of transplanted aman rice cultivars in medium lowland ecosystem of Bangladesh. *Journal of Agricultural Research (JAR)*., *49*(4), 465-476.
- Sridhara, C. J. (2007). *Effect of Genotypes, Planting Geometry, Methods of Establishment and Micronutrient Application on Growth and Yield of Aerobic Rice (Oryza Sativa L.)* (Doctoral dissertation, UNIVERSITY OF AGRICULTURAL SCIENCES GKVK, BENGALURU).
- Zayed, B. A., Salem, A. K. M., & El Sharkawy, H. M. (2011). Effect of different micronutrient treatments on rice (Oriza sativa L.) growth and yield under saline soil conditions. *World Journal of Agricultural Sciences*, *7*(2), 179-184.
- Ramana, A. V., Naidu, G. J., & Murthy, K. V. (2007). Integrated weed management in rainfed upland rice (Oryza sativa). *Indian Journal of Agronomy*, *52*(4), 311-314.
- Kumar, S., Kumar, R., Mishra, J. S., Dwivedi, S. K., Prakash, V., Bhakta, N., ... & Yadav, A. (2017). Evaluation of rice (Oryza sativa) cultivars under different crop establishment methods to enhance productivity, profitability and energetics of rice in middle Indo-Gangetic Plains of India. *Indian Journal of Agronomy*, *62*(3), 307-314.
- Ramana, A. V., Naidu, G. J., & Murthy, K. V. (2007). Integrated weed management in rainfed upland rice (Oryza sativa). *Indian Journal of Agronomy*, *52*(4), 311-314.
- Yadav, R. B., Khatkar, B. S., & Yadav, B. S. (2007). Morphological, physicochemical and cooking properties of some Indian rice (Oryza sativa L.) cultivars. *Journal of Agricultural Technology*, *3*(2), 203-210.
- Islam, M. D., Miah, M. Y., Kamal, M. Z. U., & Farhana, N. (2018). Effects of micronutrient and spacing on growth and chlorophyll content of rice. *International Journal of Environment, Agriculture and Biotechnology*, *3*(5), 265263.