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Effect of Different Levels of Nitrogen and Phosphorus on Yield and Nutrient Uptake of Low Glycemic Index Rice Variety RNR 15048 during Summer Season

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ABSTRACT

A low glycemic index fine rice variety RNR 15048 (Telangana Sona) suitable for both kharif and summer seasons was introduced in southern Odisha in 2019 kharif season. Its nitrogen and Phosphorus requirement was not worked out for *kharif* / *rabi* / *summer* seasons. An experiment was conducted during summer season of 2022 at M.S. Swaminathan School of agriculture (MSSSoA), Parlakhemundi, Odisha to study the effect of nitrogen and phosphorus levels on yield attributes and yield of low glycemic rice variety RNR 15048 in split plot design with four levels of nitrogen (0, 50, 100 and 150 kg/ha) in main plots and three levels of phosphorus (0, 30 and 60 kg/ha) in subplots replicated three times. The panicle number, number of spike lets per panicle, number of filled spike lets and 1000 grain weight, grain, straw and biological yield and NPK uptake in grain and straw increased significantly with increase in nitrogen levels from 0 to 50, 100 and 150 kg ha $^{-1}$ and phosphorus level from 0 to 30 and 60 kg ha^{-1}. For low glycemic index rice variety RNR 15048 during summer, application of 150 kg N and 60 kg P_2O_5 along with 50 kg K_2O ha^{-1} found to give higher yield in southern Odisha.

Key words: Nitrogen levels, Phosphorus levels, RNR 15048 rice variety.

In India, rice occupies an area of 45.07 million ha with a production of 122.27 million tons and productivity of 2713 Kg/ha (Anonymous, 2021). In Odisha, rice is cultivated in 4.03 million ha during *kharif* and *rabi* / *summer* seasons with a production of 8.73 million tons and productivity of 2173 kg ha^{-1}. Generally, coarse varieties are cultivated in Odisha. Recently fine variety RNR 15048 having low glycemic index (Padhi *et al*., 2020) was introduced in Gajapathi district during *kharif* and *rabi* / *summer* seasons.

The RNR 15048 (Telangana Sona) rice variety developed by PJTSAU, Hyderabad is a fine variety with 120-125 days duration suitable for both kharif and rabi / summer seasons. The RNR 15048 is cultivated in Gajapati district because of its advantage of low glycemic Index and high yields. During *kharif,* the RNR 15048 (Telangana Sona) variety gave higher yield at 160 kg N ha^{-1} (Nikitha *et al.,* 2018) to 180 kg N ha^{-1} (Lavanya *et al*., 2018). In on farm trials conducted in Gajapati district, the RNR 15048 variety gave more yield at higher levels of N application (Padhi *et al*., 2020).

The productivity of rice is influenced by different management factors such as variety, cultural, nutrient and water management. Among these, the nutrient management, especially nitrogen and phosphorus are the most important. The Indian soils are low in nitrogen and low to medium in soil phosphorus. Hence, it becomes essential to apply proper level of nutrients for getting higher yields.

Nitrogen is one of the essential macro nutrient required for plant growth and development. The rice crop requires large quantity of fertilizer especially nitrogen, as this nutrient is deficient in majority of the soils (Dey and Shekon, 2016 and Motsara, 2002). The application of N fertilizer has become an important and cost effective strategy to increase the crop yields.

Reports indicate that there was an increase in shoot and root dry mass with the increase in phosphorus concentration. Reduction in photosynthetic rate, stomatal conductance, transpiration rate and internal CO_2 concentration at low phosphorus concentrations were observed at both tillering and reproductive stages (Veronica *et al*., 2017). Sharma *et al.* (2010) reported with an increase in N P levels, there was significant increase in growth parameters, yield contributing characters (panicles/m^2, grains/panicle), yield (grain and straw) and nitrogen and phosphorous uptake.

The performance of RNR 15048 at different nitrogen and phosphorus levels was not worked out and tested during

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summer season in Southern Odisha. There is need to find out the right level of nitrogen and phosphorus for RNR 15048 variety during summer in South Odisha, hence, this experiment was conducted.

The field experiment was carried out during summer season of 2022 at PG Research farm, M. S. Swaminathan School of Agriculture, Gajapati district situated at south-east part of Odisha at 18°48′16″N latitude and 84°10′45″E longitude with an altitude of 64 m above the mean sea level. The weather during crop growing period was normal. The soil of the experimental site is sandy clay loam, acidic in nature having low in nitrogen, medium in phosphorus and high in potassium.

The experiment was conducted with low glycemic index rice variety RNR 15048 in split plot design with four levels of nitrogen (0, 50, 100 and 150 kg ha^{-1}) in main plots and three levels of phosphorus (0, 30, 60 kg ha^{-1}) in subplots replicated three times. The crop was transplanted with 30 day old seedlings on 7 February at a spacing of 15 cm × 15 cm. The nitrogen, phosphorus and potassium were supplied to the crop through urea, single super phosphate and muriate of potash. The fertilizers were applied as per treatments (Table 1). Fifty percent N and the entire level of phosphorus and potassium were applied at transplanting. Potassium at @ 50 Kg K_2O/ha was applied. The remaining 50% N was top dressed in two equal splits at 20 and 40 DAT. The observations on yield attributes ; panicle number per m^2, filled spike lets per panicle, panicle length and grain and straw yield were recorded as per standard procedure. At harvest the grain and straw samples were analyzed for N content by following the alkaline permanganate method and P and K by tri-acid digestion method. Data recorded were analyzed statistically by using analysis of variance (ANOVA) and the treatment means were compared using the critical difference (CD) at 5% level of probability (Gomez and Gomez, 1984).

Effect of nitrogen levels

Grain, straw and biological yield increased significantly with increase in nitrogen levels from 0 to 50,100 and 150 kg ha^{-1} (Table 2). The increase in grain yield was 14%, 59%, 77% respectively at 50, 100 and 150 kg ha^{-1} over 0 kg N ha^{-1}. The response to applied nitrogen was greater at 100 kg N ha^{-1} as compared to 150 kg N ha^{-1} such that with each kilogram of nitrogen added, grain yield was increased by 6.72 kg, 14.41 kg and 12.69 kg over 0 kg N/ha at 50, 100 and 150 kg/ ha, respectively. The increase in straw yield also showed a similar trend as that of grain yield.

The plant height, number of tillers, leaf area index and dry matter production were significantly higher with an increase in nitrogen levels from 0 to 50,100 and 150 kg N ha^{-1}. The increased growth at higher levels of N was due to greater availability of N to crop at vegetative stage this might have resulted in better root development and the greater N availability might have played a vital role in cell division, greater production of photosynthates and higher drymatter production.

The increased dry matter production helped in an increase in yield attributing characters; number of panicle per m^2, panicle length, filled spikelets per panicle, 100 grain weight with increased application of nitrogen (Table 1).

The nitrogen uptake at harvest by grain, straw and total dry matter was significantly increased with increase in nitrogen application from 0,50,100 and 150 kg N ha^{-1} (Table 2). Application of additional doses of fertilizers enriched the available nutrient status of plants consequently resulted in higher nutrient uptake (Rayan, 1990). The nitrogen contributes to sink size by decreasing the unfilled spikelets and increased the grain filling period (Table 2), a large amount of nitrogen is required (Mac,1997).

The effect of N on yield attributes is primarily a function of assimilate accumulation and in turn facilitating higher N assimilation with adequate supply of photosynthates to grain

Table 1: Effect of different levels of nitrogen and phosphorus on yield attributes of RNR15048 rice variety during summer season 2022.

Treatments	No of panicles/m^2	Panicle length (cm)	No of spikelets per panicle	No of filled spikelets per panicle	Percentage of filled spikelets	1000 grain weight (g)
Nitrogen levels, kg ha^{-1}						
0	169	17	147	131	90	19
50	184	20	171	156	91	19
100	204	20	197	180	91	21
150	220	21	227	205	90	23
S.Em.±	0.54	0.2	2.2	2.2	0.5	0.7
CD (5%)	1.87	0.7	7.7	7.9	NS	2.6
Phosphorus levels, kg ha^{-1}						
0	189	19	176	159	90	19
30	195	20	184	167	90	20
60	200	20	196	178	90	21
S.Em.±	0.57	0.2	1.7	1.8	0.7	0.2
CD (5%)	1.70	0.8	5.1	5.6	NS	0.8
Nitrogen × phosphorus						
S.Em.±	1.14	0.59	3.4	3.7	1.5	0.56
CD (5%)	NS	NS	NS	NS	NS	NS

Table 2: Effect of different levels of nitrogen and phosphorus on grain, straw and biological yield and harvest index of RNR15048 rice variety during summer season 2022.

Treatments	Grain yield (kg/ha)	Straw yield (kg/ha)	Biological yield (kg/ha)	Nutrient uptake, kg ha^{-1}		
				N	P	K
Nitrogen levels, kg ha^{-1}						
0	2460	4666	7127	32.1	11.1	65.8
50	2796	5247	8043	45.7	13.7	104.5
100	3901	6586	10487	79.2	18.2	132.7
150	4364	7383	11748	101.0	21.2	148.5
S.Em.±	16.9	36.5	37.5	0.93	0.08	0.68
CD (5%)	58.6	126.4	129.8	3.23	0.28	2.34
Phosphorus levels, kg ha^{-1}						
0	3210	5787	8997	59.6	14.2	108.2
30	3380	5954	9334	64.7	16.1	112.0
60	3551	6171	9722	69.1	17.8	118.4
S.Em.±	16.9	18.7	28.4	0.44	0.05	0.35
CD (5%)	58.6	56.2	85.4	1.30	0.16	1.05
Nitrogen × phosphorus						
S.Em.±	35.5	37.5	56.9	0.87	0.10	0.70
CD (5%)	NS	NS	NS	2.34	1.12	1.07

Table 3: Correlation between grain yield vs yield attributes of RNR 15048 grown during summer at different levels of N and P_2O_5.

Grain yield, kg ha^{-1} vs	Calculated r value	Significant level
Number of panicles	0.697	*
Panicle length, cm	0.848	**
Number of spikelets per panicle	0.889	**
Number of filled spikelets per panicle	0.902	**
1000 seed weight	0.700	*
N uptake	0.874	**
P uptake	0.847	**
K uptake	0.933	**

*Significant at 5% and **significant at 1%.

(Kumar, 1986). The increase in grain yield at higher nitrogen rates might be primarily due to increase in chlorophyll concentration in leaves leading to higher photosynthetic rate (Mohinder Singh *et al*., 2017) and might be due to the cumulative effect of increased translocation of photosynthates to sink resulting in the increase in yield compared to lower levels (Rao *et al*., 2004).

It has been observed that the dry matter production, panicle number, filled spikelets have positive and significant correlation with grain yield indicating any improvement in these yield attributing characters will improve the grain yield of rice (Table 3).

The grain yield resulted with application of 100 kg N ha^{-1} was significantly higher over 50 and 0 kg N ha^{-1} nitrogen. It has been observed that increase in N application resulted in higher N, P, K uptake as compared to lower levels of N (Table 3). The greater uptake of NPK at N 100 and 50 kg N ha^{-1} helped in improved growth, yield attributes and thereby grain yield over 0 N ha^{-1} (Table 3). The results are in conformity with those reported by Padmavathi (1997) and Dwivedi *et al*. (2000).

Effect of phosphorus levels

The grain yield increased significantly with application of Phosphorus from 0 to 30 and 60 kg ha^{-1} (Table 2). The increase was 5.3% and 10.6% at 30 and 60 kg ha^{-1} over 0 kg P_2O_5 ha^{-1}. The plant height, dry matter, leaf area index and tiller number increased with application of phosphorus. The yield attributes like number of panicles per m^2, panicle length, filled spikelets per panicle and grain and straw and biological yield were increased with addition of phosphorus (Table 2). There was significant increase in phosphorus uptake with application from 0 to 30 and 60 kg P_2O_5 ha^{-1}. (Table 2). The increased growth and yield attributes at higher levels of 60 kg P_2O_5 ha^{-1} over 30 kg P_2O_5 ha^{-1} might be due to timely availability of phosphorus.

The phosphorus fertilization improves various metabolic and physiological process and adequate supply of phosphates early in life cycle of plant. There are reports that P uptake increased with progressive increase in supply of N and P_2O_5 to crops because of more availability of these nutrients and thereby higher biomass production and yield attributes. The grain yield had positive correlation between yield attributes which indicates that increase in fertilizer level, there was increase in yield attributes with application of 30 and 60 kg P_2O_5 ha^{-1} and hence improvement in grain yield. Sharma *et al*. (2009) reported that application of phosphorus fertilizers at 35.2 to 52.5 kg ha^{-1} significantly increased grain and straw yield of rice over control.

The higher yields associated at increased levels of phosphorus are due to better root growth and increased uptake of nutrients favoring better crop growth (Archana *et al*., 2017). Further P is more absorbed in first 20 days after

transplanting for better root growth and penetration. The partial productive efficiency of phosphorus for grain is higher at early growth stages than at later stages because phosphorus is needed for tillering and the total phosphorus requirement is small relative to nitrogen. Furthermore, if sufficient phosphorus is absorbed at early growth stages, it can be easily redistributed to growing organs. The need for phosphorus at early growth stages of rice advocates for basal application (Yoshida, 1981). The higher levels of phosphorus at basal has resulted in greater availability of Phosphorus at initial stages of crop growth which might have helped in better tillering which is evident from more number of panicles at higher level of phosphorus and finally grain yield.

CONCLUSION

From these results it can be concluded that in southern Odisha during summer, application of 150 kg N, 60 kg P_2O_5 along with 50 kg K_2O per ha^{-1} to low glycemic index rice variety RNR 15048 gives higher yield.

Conflict of interest: None.

REFERENCES

Anonymous, (2021). Agricultural Statistic at a Glance (2021). Government of India, Ministry of Agriculture and Farmers Welfare Department of Agriculture, Cooperation and Farmers Welfare Directorate of Economics and Statistics. (New Delhi).

Archana, K., Reddy, T.P., Anjaiah, T., Padmaja, B. (2017). Effect of dose and time of application of phosphorus on changes in phosphorus uptake pattern and yield of rice grown on P accumulated soil. Article chronicle: Agriculture update A U background and objectives. Journal of Natural Fibers. 12(4): 960-965.

Dey, P. and Sekhon, B.S. (2016). Nitrogen fertility status of the Indian soils vis-a-vis the world soils. Indian Journal of Fertilizers. 12(4): 36-43.

Dwivedi, A.P., Dixit, R.S., Sing, S.P., Kumar, I.I. (2000). Response of hybrid rice to N. In P and K levels, (in) Extended Summaries of National Symposium on Agronomy: Challenges and Strategies for the New Millenium, Held During. (pp. 15-18).

Gomez, K.A. and Gomez, A.A. (1984). Statistical Procedures for Agricultural Research (2nd Edn.). John Wiley and Sons, New York. pp. 680.

Lavanya, N., Reddy, M. M., Revathi, P. Padmaja, G. (2018). Partial factor productivity of nitrogen, nitrogen uptake and soil health as influenced by different establishment methods, varieties and nitrogen levels in rice under late sown conditions in Telangana state. International Journal of Chemical Studies. 6: 1122-1127.

Mae, T. (1997). Physiological nitrogen efficiency in rice: Nitrogen utilization, photosynthesis and yield potential. Plant and Soil. 196201-210.

Nikitha, K., Sreenivas, G., Rani, P.L., Madhavi, A. (2018). Performance of photo sensitive rice cv. RNR 15048 (Telangana Sona) under varied nitrogen levels and environmental conditions. International Journal of Current Microbiology and Applied Sciences. 7: 3602-3605.

Motsara, M.R. (2002). Available nitrogen, phosphorus and potassium status of Indian soils as depicted by soil fertility maps. Fertiliser News. 47(8): 15-21.

Padhi, D.P., Manikanta, N., Rahul Adhikari, Nanda, S.P., Devender Reddy, M. and Rao. D.N. (2020). On Farm Trials of Low GI Rice Variety RNR 15048 in Gajapati District of South Odisha. Bioscience Biotechnology Research Communications. 13(12): 115-119.

Padmavathi, P. (1997). Studies on relative performance of conventional and hybrid rice varieties under various levels of nitrogen, plant population and planting patterns (Doctoral dissertation, IARI. Division of Agronomy: New Delhi).

Rao, K.V., Surekha, K., Kundu, D.K., Prasad, A.S.R. (2004). Nutrient management to sustain productivity targets of irrigated rice. In International Symposium on Rice: From Green Revolution to Gene Revolution (pp. 4-6).

Rayar, A.J. (1990). Effect of neem seed crush blended urea on dry matter yield and N use efficiency in rice (*Oryza sativa* L.). Madras Agricultural Journal. 77: 44-47.

Sharma, S.N., Prasad, R., Shivay, Y.S., Dwivedi, M.K., Kumar, S., Kumar, D. (2009). Effect of rates and sources of phosphorus on productivity and economics of rice (*Oryza sativa*) as influenced by crop-residue incorporation. Indian Journal of Agronomy. 54: 42-46.

Sharma, S.N., Prasad, R., Shivay, Y.S., Dwivedi, M.K., Kumar, S., Davari, M.R., Kumar, D. (2010). Relative efficiency of diammonium phosphate and mussoorie rock phosphate on productivity and phosphorus balance in a rice-rapeseed-mungbean cropping system. Nutrient Cycling in Agroecosystems. 86: 199-209.

Singh, M., Yadav, D.B., Kumar, N., Kakraliya, S.K., Khedwal, R.S. (2017). Performance of different basmati rice on phenology, growth and quality under different nitrogen scheduling as dry DSR sown condition in IGP. International Journal of Current Microbiology and Applied Sciences. 6: 73-80.

Veronica, N., Subrahmanyam, D., Kiran, TV., Yugandhar, P., Bhadana, V.P., Padma, V. Voleti, S.R. (2017). Influence of low phosphorus concentration on leaf photosynthetic characteristics and antioxidant response of rice genotypes. Photosynthetica. 55: 285-293.

Yoshida, S. (1981). Fundamentals of rice crop science. International Rice Research Institute Los Banos, Laguna, Philippines. pp .269.