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Effect of Different Nitrogen and Potassium Levels on Yield and Nutrient Uptake of RNR 15048 during Summer Season in Southern Odisha

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ABSTRACT

Background: The low glycemic rice variety RNR 15048 was introduced in Southern Odisha recently but the nitrogen and potassium requirement was not worked out for *rabi*/*summer* season.

Methods: In this study, RNR 15048, a low glycemic index rice variety, was conducted in a split plot design with four main plots at 0, 50, 100 and 150 kg of nitrogen per hectare and three subplot levels at 0, 30 and 60 kg of potassium per hectare, each of which was reproduced three times.

Result: A significant increase in yield, yield components and NPK uptake was noted with increase in nitrogen levels from 0 to 50, 100 and 150 kg/ha and potassium levels from 0 to 30 and 60 kg/ha.

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

INTRODUCTION

The Indian soils are low in nitrogen, low to medium in phosphorus and medium in potassium. Among these, the nitrogen plays greater role in increasing the yield of rice followed by phosphorus and potassium. The nitrogen is the most crucial and vital nutrient for plant growth and development. The photosynthetic activity of the plant and their capacity to utilize available nutrients increases with nitrogen application. In plant tissue, the potassium is attributed to the transport of water, minerals and carbohydrates. Furthermore, it plays a role in enzyme activation, ATP production and subsequently regulating the pace of photosynthesis.

The rice crop requires large quantity of fertilizer especially nitrogen, as this nutrient is deficient in majority of the soils. It has been reported that during *kharif,* the RNR 15048 (Telangana Sona) variety gave higher yield at 160 kg N ha^{-1} (Nikitha *et al*., 2018) and up to 180 kg N ha^{-1} (Lavanya *et al*., 2018). On other hand, Padhi *et al.* (2020) in on farm trials in Gajapati district observed improved yields at higher levels on N with RNR 15048.

From different parts of India, the reports indicated that during *kharif* season an increase in nitrogen dose up to 120 kg ha^{-1} (Dar *et al*., 2000) significantly improved the grain yield and growth (Singh *et al*., 2014) over lower levels of N application. The rise in nitrogen levels from 120 to 150 and 180 kg N ha^{-1} and potassium levels from 40 to 50 kg ha^{-1} during *Rabi*, according to Murthy *et al*. (2015), increased grain production. With increased levels of application of potassium resulted in improved the growth and yield and yield components (Awan *et al*., 2015) of rice.

The fine rice variety RNR 15048 having 120-125 days duration, low glycemic index was introduced in Gajapati district during *kharif* and *rabi* seasons. The information on the nitrogen and potassium requirement for RNR 15048 a low glycine Index variety during summer season in Southern Odisha is not available. Hence, there is need to find out the right nitrogen and potassium requirement of this variety during summer in South Odisha.

In the light of above facts, an experiment on response of RNR 15048 rice variety to nitrogen and potassium levels in Southern Odisha was conducted during summer season of 2022.

MATERIALS AND METHODS

A field investigation was carried out to study the impact of nitrogen and potassium levels on RNR 15048 rice variety during rabi/summer season of 2022 at Post Graduate Research Farm, MSSSoA located at 18°48′16″N latitude and 84°10′45″E longitude with altitude of 64m above the mean sea level. The weather during the crop growing period was favorable for rice. The experimental site's soil had a sandy loam texture, a pH that was somewhat acidic and was low

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in available nitrogen (230 kg/ha) and was medium in both phosphorus (13 kg/ha) and potassium (121 kg/ha) availability.

In the present study, RNR 15048 (low glycemic index rice) was conducted in split plot design with four main plots at 0, 50, 100 and 150 kg of nitrogen per hectare and three subplot levels at 0, 30 and 60 kg of potassium per hectare, each of which was replicated three times. The crop was transplanted with 30 day old seedlings on 7 February, 2022 by adopting a square geometry of 15 cm × 15 cm. Urea, single super phosphate and muriate of potash were used to supply the crop with nitrogen, phosphorus and potassium. The fertilizers were applied by broadcasting in accordance with the treatments outlined in Table 1.

The observations on yield components such as panicle number per square meter, filled spike lets per panicle, panicle length (cm) and yield (grain, straw and biological yield) were recorded using a standard procedure. At harvest the grain and straw samples were analyzed for nitrogen, phosphorus and potassium content which was used to compute nitrogen, phosphorus and potassium uptake. Data recorded were analysed 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).

RESULTS AND DISCUSSION

Nitrogen

The perusal of data presented in Table 2 revealed a marked increase in grain, straw and biological yield with 150 kg N ha^{-1} as compared to 0, 50 and 100 kg N ha^{-1} such that 74%, 25% and 6% response was recorded with the application of 50 kg, 100 kg and 150 kg nitrogen per hectare, respectively over 0 kg N/ha. A similar trend was observed by straw and biological yield. The rise in rice grain production is a result of yield characteristics, which are dependent on growth of the crop.

The nitrogen was applied in three splits at transplanting, tillering and panicle initiation stage. It has been reported that the number of panicles is decided at maximum tillering, number of spikelets per panicle at panicle initiation stage and test weight at grain filling stage (De Datta, 1981). At higher levels of nitrogen application, there was greater availability of N at these stages which helped in increased growth-plant height, dry matter production, tillers there by the panicle number, filled spikelets per panicle (Table 1). The higher nitrogen content and uptake by the crop at harvest with higher nitrogen doses clearly indicates that the crop has taken more nitrogen at greater levels of nitrogen (Table 2) until the crop nutrient demand is compromised. In plants with larger N contents, protoplasm is synthesized more quickly and there is more rapid vegetative development. Increased N levels encourage better nutrient absorption, which causes leaves to develop quickly and eventually accelerate growth (Jain *et al*., 2018; Murthy *et al*., 2015). A similar effect of increased was observed in the present study. Earlier studies indicated a positive correlation of rice to increased N supply (Raju and Reddy, 1997; Blaise and Prasad 1996 and Ramulu *et al*., 2020). Nitrogen levels have an impact on yield characteristics and yield owing to increased N assimilation and a sufficient supply of photosynthates to grain (Kumar, 1986). The improved stature of growth and yield traits generating longer sink diameters together with effective transfer of photosynthates from source to sink may be the reason for the greater yield at 150 kg N ha^{-1} compared to lower levels of N. This would have led to more filled grains and increased grain yield (Nayak *et al*., 2015; Pradhan *et al*., 2014 and Uddin *et al*., 2013). The increase in yield at higher levels of N might bedue to cumulative effect of all the yield components. It has been observed that the grain yield had positive and significant co-relation with yield attributes

Table 1: Effect of different levels of nitrogen and potassium yield attributes of RNR 15048 Rice variety at various stages of crop growth during summer season 2022.

Treatments	No. of panicles/m^2	Panicle length (cm)	No. of spikelets per panicle	No. of filled spikelets per panicle	1000 seed weight (g)
Nitrogen levels, kg ha^{-1}					
0	187	17.17	173	147	18
50	224	18.50	264	234	19
100	270	20.23	334	307	20
150	321	22.31	426	402	20
S.Em.±	1.34	0.605	9.99	9.20	0.36
CD (5%)	4.65	2.09	34.56	31.82	1.25
Potassium levels, kg ha^{-1}					
0	238	18.78	282	256	19
30	249	19.17	299	272	19
60	264	20.72	317	289	20
S.Em.±	1.25	0.485	6.60	6.30	0.18
CD (5%)	3.74	1.45	19.80	18.88	0.55
S.Em.±	2.50	0.970	13.21	12.59	0.37
CD (5%)	NS	2.37	NS	NS	NS

Table 2: Effect of different levels of nitrogen and potassium on grain, straw and biological yield and harvest index of RNR 15048 Rice variety at various stages of crop growth during summer season 2022.

Treatments	Grain yield (kg/ha)	Straw yield (kg/ha)	Biological yield (kg/ha)	Nutrient uptake at harvest, kg ha^{-1}		
				N	P	K
Nitrogen levels, kg ha^{-1}						
0	2498	4392	6891	30.01	10.49	68.02
50	3463	5708	9172	50.44	15.21	110.15
100	4104	6192	10296	83.30	18.47	127.25
150	4341	6645	10986	96.16	21.04	134.14
S.Em.±	54.61	17.80	46.05	0.493	0.079	0.229
CD (5%)	188.97	61.61	159.34	1.70	0.27	0.79
Potassium levels, kg ha^{-1}						
0	3460	5625	9.85	61.40	15.53	105.94
30	3602	5755	9358	65.16	16.29	111.48
60	3743	5822	9565	68.38	17.08	116.01
S.Em.±	39.94	13.66	47.23	0.589	0.089	0.348
CD (5%)	119.75	40.96	141.60	1.77	0.27	1.04
Interaction of nitrogen × potassium levels						
S.Em.±	79.89	27.33	94.46	1.178	0.177	0.696
CD (5%)	NS	NS	NS	2.88	0.43	1.70

Table 3: Correlation between grain yield vs yield attributes of low glycemic index rice RNR15048 grown during summer at different levels of N and K_2O.

Grain yield, kg/ha VS	Calculated r value	Significant level
Panicle length, cm	0.847	**
No. of panicles	0.944	**
No. of spikelets per panicle	0.818	**
No. of filled spikelets per panicle	0.840	**
1000 seed weight	0.834	**
Percentage of filled spike lets	0.897	**
Grain yield, kg/ha VS		
N uptake	0.970	**
P uptake	0.990	**
K uptake	0.994	**

Table r value at 10 df at 5% 0.576 and 1% 0.708.

indicating any increase in yield attributes to rise in grain yield (Table 3).

The grain yield observed with 50 and 100 kg was significantly superior over 0 kg N ha^{-1}. The N applied at 50 and 100 kg N ha^{-1} improved the growth and yield attributes (Table 1). These parameters had positive co-relation with grain yield (Table 3). The increase in dry matter, yield attributes like panicle length, filled spikelets per panicle, NPK uptake has helped in increasing the grain yield at 100 and 50 kg N ha^{-1} over no nitrogen application.

Potassium

Application of potassium at 60 kg ha^{-1} significantly increased grain output over 0 and 30 kg K_2O ha^{-1} (Table 2). The increase was 8% and 4% at 30 and 60 kg K_2O ha^{-1} over 0 kg ha^{-1}. The incremental increase from 0 to 30 and 30 to 60 kg K_2O ha^{-1} was 4.0% and 3.9% respectively. The growth-plant height, dry matter, tillers and leaf area were higher with application of 30 and 60 K_2O ha^{-1}. The potassium application helps in greater translocation of nutrients N and P which enhances the leaf area (Devi and Luikham, 2018; Murthy *et al*., 2015). Additionally, the K improves the use efficiency of both nitrogen and phosphorus (Birla, 2022). Continuous K application to the crop during the time of crop growth was more advantageous, which is reported to increase the number of tillers, dry matter, effective tillers, weight of filled grains and yield (Pandey *et al*., 1993; Meena *et al*., 2002). Due to greater availability, NPK uptake increased with higher application of K_2O ha^{-1} (Table 2) (Duraiswamy *et al*., 2011) resulting in improved sink capacity (Islam *et al*., 2015). The increase in yield attributes has resulted in higher yield at 60 kg K_2O ha^{-1} over 30 kg ha^{-1} and 0 kg K_2O ha^{-1}. This can be seen from the positive co-relation between yield and yield attributes (Table 3).

CONCLUSION

As a result of the current study, application of 150 kg N, 60 kg P_2O_5 along with 60 kg K_2O per ha^{-1} during summer season could be an ideal nutrient management strategy to achieve higher yields in low glycemic index (RNR 15048) at southern Odisha.

Conflict of interest

All authors declare that they have no conflict of interest.

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