SSARSC

Scientific Society of Advanced Research and Social Change
SSARSC International Journal of Management
Volume 3 Issue 1, January-June 2017, ISSN 2349-6975

Effect of graded levels of N, P & K on growth, yield and quality of fine rice Cultivar (*Oryza sativa* L.) under subtropical conditions.

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ABSTRACT

A field experiment was conducted in 2015 at Jammu, Chatha to study the effect of growth, yield and quality of fine rice (*Oryza sativa L.*) cultivar under sub-tropical conditions of Jammu. The experiment was laid out in split plot design with combination of three levels of P and two levels of K in main plots and four levels of N in sub plots. Experimental results revealed that among different graded levels of N, P & K application of Nitrogen at 60 kg/ha recorded significantly higher growth parameters (plant height and dry matter accumulation) as well as grain and straw yield than 30 kg and 40 kg/ha of N, but was at par with 50 kg/ha of N. Quality parameters *viz.* protein content and amylose content was significantly higher at 60 kg and 40 kg/ha of N. Uptake of nutrients was also highest with 60 kg/ha of N. Amylose content decreased with increase in N levels but increased with increase in P and K levels. Highest amylose content was recorded with $P_{35}K_{20}$ followed by $P_{35}K_{15}$. Uptake of nutrients was recorded highest at $P_{35}K_{15}$.

INTRODUCTION

Rice (*Oryza sativa L.)* is one of the most important cereal crops. In India, rice ranks first among all the crops occupying 43.95 mha area and production of 106.54 mt with an average productivity of 2424 kg/ha (Anonymous, 2015). Increasing productivity and production are essential to meet the food requirement of the burgeoning population. Fine rice occupies a pivotal position in India because of its high quality. Due to its excellent quality characters, it is also popular in the international market. India is one of the major producers and exporters of Basmati rice in the International market. The area under scented rice varieties is also increasing day by day with the opening of world market as well as domestic consumption (Singh *et al.,* 2008). Out of many aromatic rice varieties cultivated in India, traditional tall varieties of Basmati constitute a sizable proportion of export, but productivity is very low as compared to non-aromatic rice varieties (Gangaiah and Prasad 1999). Fine rice occupies a pivotal position in India because of its high quality. Due to its excellent quality characters, it is popular in the international market. India is one of the major producers and exporters of Basmati rice in the

international market. Efforts are required to increase the yield of aromatic rice for enhancing the quantum of exports to improve foreign exchange reserves. In this regard, a number of aromatic rice varieties have been developed through a systematic genetic improvement programme.

METHODOLOGY

A field experiment was conducted to study the effect of graded levels of N, P & K on growth, yield and quality of fine rice at research farm of Division of Agronomy, SKUAST-Jammu (J&K) during the *kharif*, 2015. The soil of the experimental field was sandy loam in texture, slightly alkaline in reaction, low in organic carbon, available nitrogen and medium in available phosphorous and potassium. The experiment was laid out in split plot design, replicated thrice with 24 treatments (Table 1). The source of fertilizers was urea, DAP and MOP. Full dose of phosphorus, potassium and half dose of nitrogen was applied as per treatments after puddling and remaining half dose of nitrogen was broadcasted in one split at 30 days after transplanting (DAT). The rice variety 'Pusa-1121' was used in the experiment. All recommended agronomic practices were followed throughout the crop period. The grain yield was recorded from the net plot area and expressed as t/ha. Plant samples for dry matter accumulation were taken from the second and penultimate row at different growth stages by clipping the plants close to the soil surface from each plot. They were sun dried and thereafter shifted in the oven to dry at a temperature of 65±5°C till a constant weight was achieved and dry matter accumulation was recorded which was expressed as dry weight in g/m^2. Protein content of rice grain was determined by multiplying respective nitrogen content in rice grain with a factor 6.25 (A.O.A.C, 1970). Paddy grains were cleaned, dried and dehusked for the estimation of amylose content. The iodine is absorbed within the helical coils of amylose to produce a blue coloured complex which is measured colorimetrically by spectrophotometer at 590 nm (Juliano, 1971).

RESULTS AND DISCUSSION

Table 1. Effect of N, P & K on plant height, dry matter, yield, harvest index, protein content and amyose content of Pusa-1121 rice.

Treatment	Plant height (cm)	Dry matter (g/m^2)	Grain yield (t/ha)	Straw yield (t/ha)	Harvest index (%)	Protein content (%)	Amylose content (%)
Main plots (P_2O_5 & K_2O kg/ha)							
P_1K_1 - 25:15	102.29	652.69	3.79	5.09	42.69	5.47	19.97
P_1K_2 - 25:20	103.87	706.47	3.89	5.15	43.38	5.53	20.22
P_2K_1 - 30:15	104.07	701.89	4.02	5.27	43.25	5.42	21.75
P_2K_2 - 30:20	105.01	717.31	4.01	5.40	42.94	5.57	22.77
P_3K_1 - 35:15	106.78	724.42	4.09	5.78	41.44	5.64	23.63
P_3K_2 - 35:20	107.54	745.15	4.06	5.41	43.17	5.59	23.83
SEm±	1.60	12.88	1.07	2.93	1.41	0.12	0.42
CD (5%)	NS	NS	NS	NS	NS	NS	NS
Sub plots (N kg/ha)							
N_1 - 30	100.11	648.78	3.64	4.75	43.51	5.36	21.06
N_2 - 40	103.37	700.91	3.92	5.20	43.24	5.52	22.54
N_3 - 50	106.39	739.83	4.13	5.66	42.31	5.61	22.34
N_4 - 60	107.83	755.77	4.22	5.79	42.19	5.66	22.18
SEm±	1.20	9.45	0.88	1.53	0.65	0.07	0.39
CD (5%)	3.44	27.11	2.52	4.38	NS	0.20	1.11

All the graded levels of N, P & K treatments significantly influenced the growth parameters and yield of basmati rice. Amongst the N treatments, significantly highest plant height of 107.83 cm was recorded with application of N_4 (60 kg/ha) which was at par with N_3. Whereas, with P & K application, highest plant height of 107.54 cm was recorded with P_3K_2 (35:20 kg/ha of P_2O_5 and K_2O) which was followed by P_3K_1 (35:15 kg/ha of $P_2O_5$and K_2O), though the difference was found to be non-significant. Almost a similar trend was observed with respect to dry matter accumulation,

yield and harvest index of Pusa-1121. Highest grain and straw yield was observed to the tune of 4.22 and 5.79 t/ha with the application of 60 kg/ha of N and among the P&K application, highest grain and straw yield was observed to the tune of 4.09 and 5.78 t/ha with the application of 35:15 kg/ha of P_2O_5 & K_2O respectively, though the difference was non-significant. The values obtained for harvest index with the graded levels of NPK were statistically similar. Dry matter accumulation also increased with an increase in N, P & K application. Highest dry matter accumulation (755.77 g/m^2) was recorded with 60 kg/ha of N at harvest which was statistically at par with 50 kg/ha of N. Whereas, with P and K application, highest dry matter accumulation (745.15 g/m^2) was recorded with P_3K_2 level (35:20 kg/ha of P_2O_5 & K_2O) at harvest stage followed by P_3K_1 (35:15 kg/ha of P_2O_5 & K_2O) respectively, though the difference was non-significant. Graded levels of N, P and K had significant influence on protein content. Highest protein content was recorded with P_3K_1 (35:15 kg/ha of P_2O_5 & K_2O) which was followed by P_3K_2 (35:20 kg/ha of P_2O_5 & K_2O) but difference was found to be non-significant. Lowest protein content was recorded with P_2K_1 (30:15 kg/ha of P_2O_5 & K_2O). Whereas with N application, highest protein content was recorded with N_4 (60 kg N/ha) which remained statistically at par with N_3 (50 kg N/ha). Graded levels of N, P and K had significant influence on amylose content of rice. Amylose content in rice grain significantly increased upto 40 kg/ha of N and decreased further with increase in N levels. However, with P & K application amylose content increased with increase in P and K levels. Highest Amylose content was recorded with N_2 (40 kg/ha) and P_3K_2 (35:20 kg/ha of P_2O_5 & K_2O). The increase in yield may be due to increased NPK uptake and utilization by crop resulting in enhanced growth and yield attributes which may be due to increased photosynthetic efficiency of crop leading to greater dry matter production and translocation to sink. Positive correlation was reported among yield and nitrogen levels (Mahajan *et al.*, 2012; Gangadevi *et al.*, 2012 and Maheswari *et al.*, 2007), phosphorus levels (Yuanqiu-He *et al.*, 2007 and Sanusan *et al.*, 2009), potassium levels (Uddin *et al.*, 2013 and Arif *et al.*, 2010) and NPK levels (Choudhary and Suri, 2014). Harvest index showed non-significant difference in response to N, P & K levels. The results are in agreement with those of Choudhary and Suri (2014). Amylose content decreased with increase in N levels. Singh *et al.* (1997) and Gangadevi *et al.* (2012) concluded that protein content, kernel length, kernel breadth significantly increased with increasing level of nitrogen. Mahajan *et al.*,

2011 reported that amylose content decreased with increase in N levels. This might be due to fact that nitrogen forms principal constituent of protein and indisputably protein content would always be in direct proportion with the increased nitrogen application. Further, Ya-jie et al. (2012) reported that increased protein and amylose content may be due to increased phosphorus levels.

Uptake studies

The perusal of data regarding nitrogen content of grain and straw (Table 2) showed that increasing levels of N, P and K significantly improve N uptake by crop. Highest uptake of total nitrogen including N uptake by grains and straw was recorded with application of 60 kg/ha of N which was at par with 50 kg/ha of N. Whereas, highest uptake of total nitrogen was recorded with application of P_3K_1 (35:15 kg/ha of P_2O_5 & K_2O) followed by P_3K_2 (35:20 kg/ha of P_2O_5 & K_2O) with non- significant difference. Total phosphorus uptake by grain and straw was influenced by increasing levels of NPK. Highest P uptake by grain and straw was recorded with P_3K_1 (35:15 kg/ha of P_2O_5 & K_2O) which was followed by P_3K_2 (35:20 kg/ha of P_2O_5 & K_2O), but the difference was found to be non-significant. However, among N levels highest P uptake by grain and straw was recorded with (N_4) 60 kg/ha which was at par with (N_3) 50 kg/ha. Increasing application NPK levels significantly increase potassium uptake by crop. Application of P_3K_1 (35:15 kg/ha of P_2O_5 &K_2O) recorded highest uptake of potassium by grain, straw and both by grain + straw. Potassium uptake increased significantly with the application of 60 kg/ha of N which was statistically at par with 50 kg/ha of N. Applications of fertilizers at optimum rate are responsible for greater root development followed by higher nutrient uptake and leaf area development that cause a significant improvement in yield. Further, this might be due to increased CO_2 assimilation resulting from increased nutrient uptake as reported in different studies (Mahajan *et al.,* 2012 and Uddin *et al.,* 2013). It may be due to the higher concentration of N, P and K in both grain & straw and dry matter accumulation that led to higher N, P and K uptake at higher level of fertilizers application. Improvement in N, P and K uptake by crop was reported with increased N levels (Sandhu and Mahal, 2014 and Gangadevi *et al.,* 2012), P levels (Sanusan *et al.,* 2009 and Yuanqiu *et al.,* 2007), K levels (Arif *et al.,* 2010) and NPK levels (Sandhyakanthi *et al.,* 2014).

Table 2. Effect of N, P & K on N, P and K uptake of Pusa-1121 rice.

Treatments	Nutrient Uptake (kg/ha)								
	Nitrogen			Phosphorus			Potassium		
	Grain	Straw	Total	Grain	Straw	Total	Grain	Straw	Total
Main plots (P_2O_5 & K_2O kg/ha)									
P_1K_1 - 25:15	33.34	25.12	58.46	6.52	7.30	13.82	16.80	41.18	57.98
P_1K_2 - 25:20	34.56	25.66	60.22	7.71	6.83	14.54	17.15	43.41	60.56
P_2K_1 - 30:15	34.85	26.93	61.77	8.38	7.10	15.48	17.89	44.58	62.48
P_2K_2 - 30:20	35.86	27.62	63.48	8.15	8.39	16.54	18.05	47.34	65.39
P_3K_1 - 35:15	36.95	31.12	68.07	8.90	9.30	18.21	19.69	50.93	70.61
P_3K_2 - 35:20	36.44	28.29	64.73	7.78	7.58	15.36	19.30	47.14	66.44
SEm±	0.87	1.59	1.97	0.51	0.60	0.88	0.67	3.13	3.37
CD (5%)	NS	NS	NS	NS	NS	NS	NS	NS	NS
Sub plots (N kg/ha)									
N_1 - 30	31.27	22.81	54.08	6.49	6.25	12.74	15.53	39.03	54.56
N_2 - 40	34.73	26.11	60.84	7.65	7.15	14.80	17.50	44.21	61.71
N_3 - 50	37.11	29.83	66.93	8.46	8.53	16.99	19.23	48.98	68.21
N_4 - 60	38.22	31.08	69.30	9.03	9.07	18.11	20.33	50.84	71.17
SEm±	0.92	1.10	1.73	0.34	0.43	0.58	0.72	1.50	1.81
CD (5%)	2.64	3.16	4.97	0.96	1.23	1.68	2.06	4.31	5.18

CONCLUSION

It was concluded that among the different graded levels N_4 (60 kg/ha) and P_3K_1 (35:15 kg/ha of P_2O_5 & K_2O) was the most suitable dose of fertilizer for achieving economic yield advantage as compared to other fertility levels as it improved growth and yield of Pusa-1121 variety of fine rice.

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