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EFFECT OF GRADED LEVELS OF NPK ON GROWTH, YIELD AND QUALITY OF FINE RICE (*Oryza sativa L.*) Var. PUSA BASMATI 1121

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ABSTRACT
An experiment was conducted to optimise NPK levels for higher yield and better quality of fine rice cultivar Pusa Basmati 1121. 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. The results revealed that among different graded levels of N, P and K, application of nitrogen at 60 kg/ha though at par with nitrogen @ 50 kg/ha recorded significantly higher growth parameters, yield attributes, grain and straw yield than with 30 kg and 40 kg/ha of N in comparison. Grain and straw yield also followed similar trend *i.e.* grain yield of 42.21 and 44.24 q/ha was recorded during first and second year of experimentation, respectively. Also, maximum mean net returns (Rs. 53,327.6/ha), gross returns (Rs. 77,296.2/ha), and B:C (2.22) ratio was obtained with application of N @ 60 kg/ ha. Among P and K levels, maximum mean grain, (42.93 q/ha) straw yield (57.98 q/ha) and B:C (2.18) ratio though at par with others levels of P and K in comparison was recorded with application of phosphorus @ 35 kg/ ha and Potassium @15 kg/ha in conjunction.

INTRODUCTION

Rice crop is grown on an area of 43.95 million hectares area in the country out of which basmati or fine rice is cultivated on an area of 7.76 million hectares approximately with an annual production of about 6.5 million tons. The crop is primarily exported to other countries to an extent of about 11.96 million metric tonnes annually thereby attracting more than Rs. 15,450 crore as foreign exchange contribution to the country's GDP (Anonymous, 2016). In India, rice ranks first among all the crops in term of area and production. India accounts for 22.3% of the total world's rice production. Rice is cultivated round the year in one or the other part of the country in diverse ecologies spread over 43.95 million hectares with a production of 104.8 million tonnes of rice and average productivity of 23.9 q/ha. In Jammu region, area under rice during the year 2015-16 is about 116.00 thousand ha and the production was about 328.4 thousand tonnes with an average productivity of 2.83 tonnes/ha (Anonymous 2015-16).

With the opening of world market as well as increase in domestic consumption, the area under scented rice varieties is increasing day by day (Singh *et al.*, 2008). Mostly, yields of traditional "Basmati" are lower than high yielding varieties like Pusa Basmati 1121. Also traditional basmati varieties are unable to withstand higher rates of N fertilizer as they are prone to lodging. Thus, varying NPK levels may influence the yield and quality characteristics of HYV's such as Pusa Basmati, 1121 which are primarily exported from the country. Since the fertilizer is an expensive input, determination of its economical and appropriate dose to enhance crop productivity is imperative to fetch maximum profit for the growers (Mahajan *et al.*, 2012). At present, the world is facing the shortage of major fertilizers especially nitrogenous and phosphatic fertilizers. Different varieties may have varying responses to N and P fertilizers depending on their agronomic traits. The application of nitrogen and phosphorous fertilizer either in excess or less than optimum rate affects both yield and quality to a remarkable extent (Manzoor *et al.*, 2006). Therefore, a study was planned to ascertain the optimum level of NPK for P-1121 along with proper management practice for attaining good yield levels with desired quality characteristics.

MATERIALS AND METHODS

A field experiment was conducted for two years at the Research Farm, Chatha of Sher-e-Kashmir University of Agricultural Sciences Technology of Jammu, Chatha during the kharif of 2015 to 2016. The soil of the experimental field was sandy clay loam in texture and having 248 kg ha^{-1} of available N (Subbiah and Asija 1956), 13.26 kg ha^{-1} available P (Olsen *et al.*, 1954), 145.10 kg ha^{-1} 1 N ammonium acetate exchangeable K (Stanford and English 1949) and 0.45 % organic carbon (Jackson 1973). The pH of the soil was 8.03 (1:2.5 soil and water ratio).The experiment comprised of combination of three levels of P (25, 30 and 35 kg/ha) denoted as P1, P2, P3 and two levels of K (15 and 20 kg/ha) denoted as K1 and K2 in main plots and four levels of N (30, 40, 50 and 60 kg/ha) denoted as N1, N2, N3 and N4 in sub plots and was laid out in split plot design with three replications. The fine rice cultivar Pusa Basmati 1121 was used in the study and twenty five days old seedlings were transplanted into the main field at the rate of two seedlings per hill at the spacing of 20.0 x 15.0 cm. Field was puddled twice by running cultivator in the standing water (75 mm) followed by planking. Fertilizer application in the field was done as per treatments using urea, diammonium phosphate and muriate of potash as source of nutrients. Full dose of P2O5 and K2O along with half of N were applied as basal and remaining N was applied in two splits at 25 and 50 days after transplanting (DAT). Butachlor @ 1.5 kg/ha was applied two days after transplanting to control weed incidence. Intercultural operations and plant protection measures were adopted as per the recommended package of practices whenever needed right from nursery sowing up to the harvest of the crop. The crop was irrigated as and when necessary to keep a water level of about 3-5 cm from transplanting to 50 DAT and thereafter, frequent irrigation was given to keep the field wet. The crop was harvested and threshed manually in each plot and observations were recorded from individual plots. Data on growth, yield attributes, grain and straw yield of rice was calculated as per the standard procedures.

Aroma was tested by smelling decorticated rice grains, following Organoliptic test. The cooked rice was smelled by a random panel: strongly scented (SS); mild scented (MS); non scented (NS) (Anonymous, 2004). The data on kernel length and breadth was recorded as per Sharma *et al*., 2012 and Singh *et al*., 1997. The statistical analysis was done using standard statistical methods as given by Cochran and Cox (1957).

RESULTS AND DISCUSSION

Growth Parameters

Plant growth exhibited by parameters like plant height, dry matter accumulation leaf area index (LAI) and number of tillers per meter square showed significant variation due to nitrogen treatments, but remained unaffected by phosphorus and potassium levels during both the years (Table 1). These growth parameters increased at decreasing rate with subsequent increase in graded levels of nitrogen (N), phosphorus (P2O5) and potassium (K2O). Increasing nitrogen levels from 30 to 60 kg/ha increased plant height, dry matter accumulation and leaf area index. Significantly maximum plant height, dry matter accumulation and Leaf Area Index were recorded with application of 60 kg/ha of nitrogen during both the years which however remained statistically at par with 50 kg/ha of N. Similar findings on enhanced crop growth characteristics *viz*. plant height, dry matter accumulation and number of tillers *etc*.

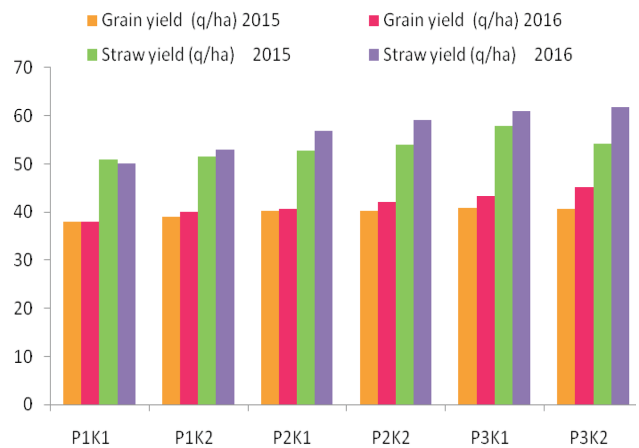

Figure 1: Effect of varying levels of phosphorus and potassium on grain and straw yield of fine rice var. Pusa Basmati 1121

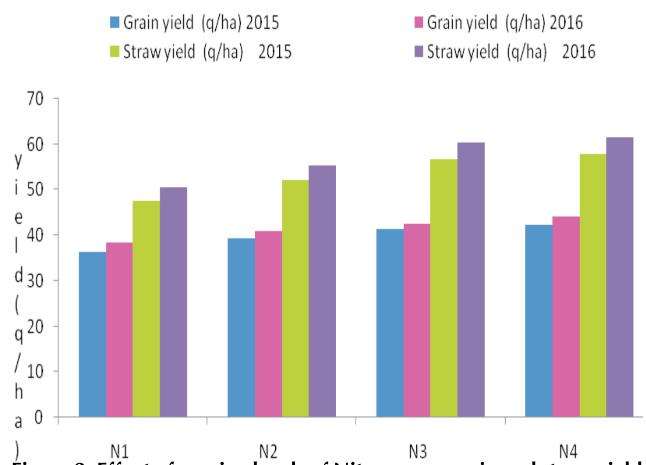

Figure 2: Effect of varying levels of Nitrogen on grain and straw yield of fine rice var. Pusa Basmati 1121

Table 1: Growth parameters as influenced by different fertilizer levels of fine rice var. Pusa-1121

Treatments	Plant height (cm)		No. of tillers/m2		DMA (g/m2)		Leaf Area Index	
	2015	2016	2015	2016	2015	2016	2015	2016
Main plots								
P1K1 - 25:15	102.29	110.98	266.51	295.98	672.69	747.69	2.8	2.82
P1K2 - 25:20	103.87	112.52	269.03	297.52	706.47	781.47	2.95	2.95
P2K1 - 30:15	104.07	113.46	271.07	298.46	701.89	776.89	2.98	2.9
P2K2 - 30:20	105.01	114.09	273.3	299.09	717.31	792.31	3.22	3.32
P3K1 - 35:15	106.78	115.16	283.5	300.16	724.42	799.42	3.26	3.36
P3K2 - 35:20	107.54	115.93	285.17	300.93	745.15	820.15	3.3	3.3
SEm ±	1.6	1.07	7.67	1.07	12.88	13.5	0.18	0.18
LSD (p=0.05)	NS	NS	NS	NS	40.58	NS	NS	NS
Sub plots								
N1 - 30	100.11	110.43	258.38	295.43	648.78	723.78	2.85	2.75
N2 - 40	103.37	113.11	272.33	298.11	700.91	775.91	3.04	3.14
N3 - 50	106.39	115	280.6	300	739.83	814.83	3.21	3.25
N4 - 60	107.83	116.23	287.74	301.23	755.77	830.77	3.25	3.27
SEm ±	1.2	0.84	3.31	0.84	9.45	9.45	0.09	0.09
LSD (p=0.05)	3.44	2.42	9.49	2.42	27.11	27.12	0.27	0.27
Interaction	NS	NS	NS	NS	NS	NS	NS	NS

Table 2: Effect of different fertilizer levels of N, P and K on yield attributes and yield of fine rice var. Pusa Basmati-1121

Treatments	Panicles/m2		Grains/panicle		1000 grain weight (g)		Grain yield (q/ha)		Straw yield (q/ha)		Harvest Index	
	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016
Main plots												
P1K1 - 25:15	257.46	259.5	69.63	59	22.33	22.33	37.96	38.01	50.98	50.15	42.69	19.69
P1K2 - 25:20	259.19	283.88	69.44	71.71	23.33	23.33	38.97	40.08	51.54	53.01	43.38	21.82
P2K1 - 30:15	263.12	266.5	71.84	64.34	25.91	25.91	40.2	40.72	52.78	56.84	43.25	23.38
P2K2 - 30:20	257.13	278.8	66.77	81.79	26.87	26.87	40.14	42.04	54.06	59.14	42.94	25.2
P3K1 - 35:15	267.75	287.42	75.06	70.91	27.59	27.59	40.91	43.41	57.81	60.98	41.44	26.59
P3K2 - 35:20	265.64	291.46	67.2	87.62	27.09	27.09	40.67	45.19	54.14	61.83	43.17	28.03
SEm±	4.4	11.47	3.3	7.79	1.54	1.54	1.07	1.6	2.93	2.53	1.41	2.9
LSD (p=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Sub plots												
N1 - 30	252.86	259.9	67.89	68.83	24.24	24.24	36.42	38.44	47.56	50.51	43.51	19.72
N2 - 40	262.86	266.79	68.63	70.18	24.84	24.84	39.25	40.98	52.06	55.46	43.24	23.19
N3 - 50	264.6	289.25	71.56	72.91	26.03	26.03	41.35	42.64	56.65	60.48	42.31	26
N4 - 60	266.54	295.77	71.89	78.32	26.98	26.98	42.21	44.24	57.94	61.53	42.19	27.56
SEm±	2.13	6.98	1.07	5.45	0.7	0.7	0.88	1.05	1.53	1.74	0.65	2.1
LSD (p=0.05)	6.1	20.02	3.06	NS	2	2	2.52	3.01	4.38	4.99	NS	NS
Interaction	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table 3: Effect of fertilizer schedules of N, P and K on quality parameters of fine rice var. Pusa Basmati-1121

Treatments	Before cooking			After cooking				Before cooking			After cooking			
	Kernel length (mm) 2015	Kernel breadth (mm) 2016	L:B ratio	Kernel length (mm)	Kernel breadth (mm)	L:B ratio	Aroma	Kernel length (mm)	Kernel breadth (mm)	L:B ratio	Kernel length (mm)	Kernel breadth (mm)	L:B ratio	Aroma
Main plots														
P1K1 - 25:15	9.01	2.01	4.52	15.05	3.08	4.98	Mild	9.04	2	4.54	15.07	3.09	4.88	Mild
P1K2 - 25:20	8.94	1.92	4.69	14.78	3.02	4.89	Mild	8.92	1.9	4.73	14.8	3.01	5.03	Mild
P2K1 - 30:15	9.04	2	4.54	15.19	3.11	4.98	Mild	9.03	2.04	4.46	15.17	3.15	4.83	Mild
P2K2 - 30:20	9.05	1.93	4.72	16.1	3.36	4.82	Mild	9.06	1.93	4.72	16.06	3.36	4.81	Mild
P3K1 - 35:15	9.06	2.04	4.49	15.36	2.85	5.52	Mild	9.06	2.07	4.47	15.32	2.9	5.39	Mild
P3K2 - 35:20	9.21	2.11	4.38	16.71	3.07	5.46	Mild	9.2	2.1	4.42	16.41	3.07	5.45	Mild
SEm±	0.08	0.05	0.12	0.44	0.13	0.18		0.1	0.05	0.14	0.37	0.1	0.19	
LSD (p=0.05)	NS	NS	NS	NS	NS	NS		NS	NS	NS	NS	NS	NS	
Sub plots														
N1 - 30	9.06	2	4.57	15.23	2.92	5.33	Mild	9.05	2	4.56	15.24	2.93	5.39	Mild
N2 - 40	8.96	1.99	4.52	15.43	3.2	4.84	Mild	8.95	2	4.53	15.42	3.2	4.84	Mild
N3 - 50	9	1.99	4.55	15.85	3.07	5.26	Mild	9.03	1.99	4.58	15.61	3.1	5.06	Mild
N4 - 60	9.18	2.01	4.59	15.61	3.14	5.01	Mild	9.18	2.02	4.56	15.62	3.16	4.97	Mild
SEm±	0.07	0.04	0.1	0.21	0.09	0.18		0.1	0.04	0.11	0.21	0.08	0.16	
LSD (p=0.05)	NS	NS	NS	NS	NS	NS		NS	NS	NS	NS	NS	NS	
Interaction	NS	NS	NS	NS	NS	NS		NS	NS	NS	NS	NS	NS	

Table 4: Effect of different fertilizer schedules of N, P and K on relative economics of fine rice var. Pusa Basmati 1121

Treatments	Cost of cultivation (Rs/ha)		Gross returns (Rs/ha)		Net returns (Rs/ha)		B:C ratio	
	2015	2016	2015	2016	2015	2016	2015	2016
Main Plot								
P1K1 - 25:15	23472.1	23330.18	67735.9	67729.82	44263.8	44399.64	1.89	1.9
P1K2 - 25:20	23613.7	23471.79	69457.51	71425.8	45843.75	47954.01	1.94	2.04
P2K1 - 30:15	23732.9	23591.06	71608.12	72872.49	47875.15	49281.44	2.02	2.09
P2K2 - 30:20	23874.5	23732.67	71636.88	75285.66	47762.3	51553	2	2.17
P3K1 - 35:15	23993.84	23851.94	73277.38	77717.34	49283.54	53865.4	2.05	2.26
P3K2 - 35:20	24135.45	23993.55	72515.36	80748.33	48379.91	56754.79	2	2.36
N1 - 30	23597.53	23462.87	64847.37	68483.84	41249.84	45020.97	1.75	1.92
N2 - 40	23735.03	23573.53	69973.93	73154.49	46238.9	49580.96	1.95	2.1
N3 - 50	23872.53	23683.7	73889.96	76398.2	50017.43	52714.51	2.1	2.22
N4 - 60	24010.03	23927.35	75442.84	79149.77	51432.81	55222.42	2.14	2.31

have been reported by various researchers with increase in nitrogen levels (Mahajan *et al.*, 20[illegible]1; Reddy *et al.*, 2012; Maheshwari *et al.*, 2007 and Anil *et al.*, 2014).The increase in plant height in response to increased N application may be due to enhanced vegetative growth resulting from increase in cell size and meristematic activity. These results are supported by the findings of Malav *et al.*, 2016.

Increase in plant height, dry matter production and leaf area index was also observed with application of Phosphorus @ 35 kg/ha and Potassium @ 20 kg/ha (P3K2) in conjunction which was followed by conjoint use of Phosphorus @ 35 kg/ ha and Potassium @ 15 kg/ha (P3K1), but the difference was non-significant. Similarly, highest number of tillers/m2 was recorded with 60 kg/ha of N. Among P and K treatments maximum tillers were observed with combination of Phosphorus @ 35 kg/ha and Potassium @ 20 kg/ha (P3K2) as given in Table1. The interaction effect of graded levels was found non-significant. However, minimum plant height was observed with 30 kg N/ha during both the years. These findings on enhanced crop growth characteristics *viz*. plant height, dry matter accumulation and number of tillers *etc*. are similar to those reported by various researchers with increase in phosphorus levels (Sanusan *et al*., 2009 and Yoseftabar, 2012), potassium levels (Uddin *et al*., 2013).

Yield and Yield Attributes

Yield attributes (panicles/m2 and grains/panicle) increased significantly up to application of nitrogen @ 60 kg /ha which was statistically at par with application of nitrogen @ 50 kg N/ ha (Table 2). This may be due to the reason that nitrogen application might have enhanced the photosynthetic activity and accumulation of carbohydrates, which in turn was translocated in large amount to sink site. The crop fertilized with 60 kg N/ha recorded 5.6 and 13.8 % more panicles/m2 and 5.9 and 13.7 more grains/panicle respectively during first and second year as compared to crop fertilized with 30 kg N/ ha (Fig. 1 and 2). Highest 1000-grain weight was recorded with 60 kg/ha of nitrogen. Lowest 1000-grain weight was recorded with 30 kg nitrogen/ha in both years. Meshram et al. (2015) also observed increasing grain mass with increasing levels of fertilization. Improvement in panicles/m2 and grains/ panicle are important aspects to achieve more grains per unit land area. The increase in grain yield due to increase in supply of N was associated with more number of panicles/m2, grains/ panicle and 1,000 grain weight. Increased N application ensured better availability of N to plants at active tillering and panicle growth stage that may have resulted in more productive tillers and grains. Mahajan *et al*., 2011 also reported similar results due to increase in Nitrogen levels.

However, among different phosphorus and potassium levels, highest value of these yield attributes were recorded with application of combination of Phosphorus @ 35 kg/ha and Potassium @ 20 kg/ha (P3K2) which was followed by application of Phosphorus @ 35 kg/ha and Potassium @ 15 kg/ha (P3K1) in conjunction. The data with respect to phosphorus and potassium application showed that there was non-significant difference in 1000-seed weight with increasing levels of phosphorus and potassium. This response of increased levels of P and K may be due to the fact that phosphorus play a key role in energy transfer reactions in the crop whereas potassium enhance the crop yield through disease resistance, enhanced water use efficiency as well as metabolic activation of enzymes which may have contributed significantly in terms of increased growth and yield attributing characters thereby resulting in increased grain and straw yield of the rice crop.

Graded levels of nitrogen, phosphorus and potassium showed significant influence on grain and straw yield of rice. Data indicated that among P and K treatment combinations, highest grain yield was recorded with application of phosphorus @ 35 kg/ha and potassium @ 15 kg/ha (P3K1) followed by application of phosphorus @ 35 kg/ha and potassium @ 20 kg/ha (P3K2) though the difference was non-significant. The results are similar to those reported by Sanusan *et al*., 2009 for phosphorus levels, Uddin *et al*., 2013 for potassium levels.

Whereas, in case of Nitrogen, highest grain yield (Table 2) was recorded with 60 kg/ha of N which was statistically at par with 50 kg/ha of N but superior to 40 and 30 kg/ha of N application. Similar trend was observed for straw yield, graded levels of N had significant influence but among P and K treatment combination though the results were non-significant, but, highest straw yield was recorded with P3K1 (35:15 kg/ha of P2O5 and K2O). The increase in yield may be due to increased nutrient 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 also reported among yield and nitrogen levels by Mahajan *et al*., 2012.

QUALITY PARAMETERS

In case of quality parameters, NPK had non-significant effect on length breadth ratio with increases in N, P and K levels (Table 3). Highest Length: Breadth ratio of before and after cooking was recorded with application of phosphorus @ 30 kg/ha and potassium @ 20 kg/ha (P2K2) followed by application of phosphorus @ 35 kg/ha and potassium @ 20 kg/ha (P3K2). Whereas, among N levels, highest L:B ratio was recorded with N2 and N1. However, lowest length and breadth ratio before cooking was recorded with application of and after cooking was recorded with application of phosphorus @ 35 kg/ha and potassium @ 20 kg/ha (P3K2) and of phosphorus @ 30 kg/ha and potassium @ 20 kg/ha (P3K2). Whereas, lowest ratio was recorded with application of nitrogen @ 60 kg/ha and 20 kg/ha respectively. Devi *et al*., (2012) concluded that kernel length and kernel breadth significantly increased with increasing level of nitrogen. Aroma of Pusa-1121 remained mild with all the graded levels of NPK. Mahajan *et al*. (2012) and Ya-jie *et al*. (2012) also reported similar results on grain quality.

Relative Economics

Variation in gross returns and net returns has been found by application of graded levels of NPK 9Table 4). Application of phosphorus @ 35 kg/ha and potassium @ 15 kg/ha (P2K2) followed by (P3K1) fetched more gross returns, net returns and benefit cost ratio followed by application of phosphorus @ 35 kg/ha and potassium @ 20 kg/ha (P3K2) though the difference was non-significant. Among Nitrogen levels, highest gross returns, net returns and benefit cost ratio were fetched with application of nitrogen @ 60 kg/ha followed by application of nitrogen @ 50 kg/ha.. However, application of nitrogen @ 60 kg /ha recorded highest B:C ratio with value of 2.14) and 2.31 during first and second years of experimentation. This was followed by application of nitrogen @ 50 kg /ha.

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