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RESEARCH ARTICLE

EFFECT OF TOP DRESSING NITROGEN AND POTASSIUM ON YIELD AND YIELD COMPONENTS OF RICE (*Oryza sativa* L.)

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ABSTRACT

Apot experiment was conducted during kharif season in 2011 inthe Department of Agriculture Botany JantaMahavidiyalayaAjeetmal, Auraiya (U.P.)- India, to evaluate the effects of different doses (0, 23 and 46 kg N ha^{-1}) of nitrogen and potassium (0, 30 and 60 kg K_2O ha^{-1}) as a top dressing on yield, yield components of rice.Nitrogen was applied in the form of urea (46% N) and potassium in the form of potassium chloride (60% K_2O). Results indicated that plant height, panicle length, number of tiller, number of grain per panicle,hollow grain percentage, grain and biological yield were significantly affected by application of N and K. Maximum grain yield (75.50 g pot^{-1}) occurred at 23 kg N ha^{-1} and 30 kg K_2O ha^{-1}. However, lowest grain yield (58.8 g pot^{-1}) was recorded at 0 kg N ha^{-1} and 60 kg K_2O ha^{-1}.

Key Words **:** Rice, potassium, nitrogen, top-dressing and yield**.**

Increase in rice production in India during 1960s and 1970s brought about by improved germplasm was associated with increased use of fertilizers, but without a corresponding increase in the use of potassium (K) fertilizers. As a result, most irrigated rice production systems were conducted under negative K balances (Wihardjaka et al., 1999).Nitrogen is one of the most important plant nutrients and plays a vital role in plant photosynthesis and biomass production. Studies have shown that when there is a slight N deficit within plants, the demands for NO^-_3 -N, free amino acid and free amino N increase quickly, without simultaneous marked change in total nitrogen in plant (Reager et al., 2011 and Devi et al., 2012). Increasing panicle numbers in per unit area is the main factor of yield increment as a result of nitrogen application (Bindra et al., 2000Laroo and Shivay, 2011). Urea and potassium chloride application significantly increased soil N, K, magnesium (Mg), and sodium (Na) concentrations(Sulok et al., 2007and Achazai, 2012). N, K, Na and Mg uptakes in stem were significantly higher for fertilized condition than under unfertilized condition.

Potassium is the mostabundant nutrient in plants including rice plant. This isespecially true for improved cultivars that uptake Kconsiderably up to four-fold higher than native cultivars(Dobbermann et al., 1998 and Bahmanyar and Mashaee, 2010. It is also one of the mostimportant factors influencing crop metabolism, growth,development and yield. K plays a number of indispensableroles in a wide range of functions: photosynthesis,enzyme activation, protein synthesis, osmotic potentialand as a counter ion to inorganic ions and organicbiopolymers (Marschner, 1995). K deficiency results in adecrease in net photosynthetic rate and dramatic decreasein crop yield (Ding *et al.*, 2006).Datta and Gumez (1985) showed that K hasadditive influence on filled grain percentage per panicleand its deficiency cause sterility of pollen seeds at thereproductive stage and consequently results in decreased number offilled grains. Qiangsheng*et al.*, (2004) reported that Kuptake by rice is maximized in the growthseason of elongation stage to heading stage. No fertilizerand/or excessive fertilizer application enhancedplant K uptake before the elongation stage, but reducedeffective panicles. Also, with one-time application of K asbasal dressing compared to one-time application as topdressing,K application at panicle initiation causedincrease in plant K uptake and its proportion from elongationstage to heading stage as well as number of filledgrain. Combined application of K and N had a remarkable positive effect on crops, and was an importantapproach in improving K use efficiency (Li *et al.,* 2009).Kavitha*et al.,* (2008) reported that application of N and Kin four equal splits at active tillering, panicle initiation,booting and flowering recorded higher yield of 7484 kg ha^{-1}in kharif seasons for hybrid ricein India.The main objective of the present study isto consider the effects of urea and potassium chloride with different proportion in two stages as top-dressing, on yield and yield components of rice.

MATERIALS AND METHODS

A pot experiment was conducted at Deptt. of Agriculture Botany JantaMahavidiyalayaAjeetmal, Auraiya (U.P.)- India. Treatmentswere as follows;

N_0:0(control)	K_0: 0 (control)
N_1: 23 Kg N ha^{-1}	K_1:30 K_2O ha^{-1}
N_3: 46 Kg N ha^{-1}	K_2: 60 K_2O ha^{-1}

In all the treatment combinations were nine. Nitrogen supplied in the form of urea with N content of 46%and K fertilizer was potassium chloride with K_2O content of 60%.These fertilizers were applied in two splits as 50% at mid of tillering(15 days after transplanting) and 50% at panicle initiation (35 daysafter 1st application) as top-dressing per pots. Seeds of rice genotypes (KRH-2) were collected from NSC center Etawah. Earthen pots with 15litervolume were filled up to 15 kg paddy soil (0 - 30 cm Ap. horizon) andthen submerged to balance chemical reactions in the flooded soilfor two weeks. The experimental soil type was claytype paddy soilwith pH 7.2, total N of 12.7 g kg^{-1}, available K of 175 mg kg^{-1} andavailable phosphorous of 9 mg kg^{-1}. 50 kg superphosphate and 50kg urea ha^{-1} were added to pots as basal dressing, based on soiltesting results. After preparation of nursery seed sowing was done in the last week of May and transplanting was carried out in the last week of June. Spacing wasmaintained at 20 × 20 cm with four plants per pots. At maturity, straw and grain weights were measured in a 12-hillsample (three pots) dried at 75°C to constant weight. Plant height, Panicle length, number of grainsper panicle, hollow grain percentage, length of flagleaves, 1000 grain weight, tiller number and biological yield were determined. Harvest index wascalculated as the ratio of grain dry weight to the total abovegrounddry weight at maturity.The experimental design was completely randomized design (CRD)with five replications. Recorded data was analyzed statistically to detecttreatment effect according to Panse and Sukhatmeandthe critical differences were computed at 5 % level of significance for comparison.

RESULTS AND DISCUSSION

Mean squares from the analyses of variance (Table 1)showed that N treatment effects for grain yield and yieldcomponents, except for 1000 grain weight, was significant($p < 0.01$) while potassium ($p <0.01$) treatment effects weresignificant for number of grains per panicle, hollow grainpercentage, biological yield and harvest index. Interactioneffect of N and K was significant for number of grains perpanicle, hollow grain percentage, biological yield andharvest index ($p < 0.01$).Plant height was significantly influenced by nitrogen treatment (Table 1). The highest plant height (181 cm) was found in N_1K_1 which was similar to N_1K_0 (179 cm) and N_1K_2 (178 cm) treatments, while the lowest plant height (150 cm) was recorded for N_0K_0 treatment (Table 2). These results are similar to those obtained by Rahman et al. (2007) and Bahmanyar and Mashaee (2010).Panicle length was significantly influenced by nitrogen treatment (Table 1).Increasing N and K fertilizers causedan increase in panicle length from 22.1 cm in (N_0K_0) to26.8 cm in N_1K_2, but panicle length decreased with higherrates of N (N_2 treatments). This showed that stimulatingvegetative plant growth and increasing tiller numbers bynitrogen could cause a decrease of panicle length (Shenet al., (2003) and Devi et al., (2012).Length of flag leaves from 33.3 to 43.3 cm in N_2K_2 andnumber of tillers from 10.2 to 15.9 in N_2K_1 were increased.Length of flag leaves and number of tiller increased withincreasing amount of N and K which could be attributed tothe influence of N on leaf development, tiller productionand increasing leaf photosynthetic activity (Ntanson andKoutroubas, 2002). However, this necessarily did notresult in case of yield increase, because net photosynthesisof canopy, total dry matter production and grain yieldcould decrease with increase in leaf development andtiller number (Ohnishi et al., 1999).Number of grains per panicle increased with increasingN and K from 80.8 (N_0K_2) to 108.4 in N_1K_2 and hollowgrain percentage from 6.2% in N_0K_1 to 38.6% in N_2K_1.Number of grains per panicle increased with increasing Nand K rates (Table 2), and treatment combinations ofN_2K_0 and N_2K_1 (46 Kg N ha^{-1} with 0 or 30 kg K_2O ha^{-1})increased

Table 1 : Variance analysis of rice grain yield and yield components (MSS)

S.O.V.	df	Mean sum squares (MSS) Plant height (cm)	Panicle length (cm)	Length of flag leaves (cm)	Number of tiller	Number of grains per panicle	Hollow grain (%)	1000 grain weight (g)	Grain yield (g pot-1)	Biological yield per pot (g)	Harvest index per pot
Nitrogen	2	1641**	15.8**	189**	47.5**	1009**	1402**	2.7ns	421**	2247**	793**
Potassium	2	25ns	5.4ns	3.5ns	1.5	202**	15*	2.4ns	1.9	21.4*	20**
NxK	4	16ns	3.6ns	6.6ns	0.4	193**	90**	0.6ns	18.1*	16.3*	23**
Error	18	14	1.8	2.5	1.6	15	2.6	1.9	15.2	3.8	3.2
CV (%)		2.3	5.6	4.2	9.7	4.2	7.1	7.24	5.8	3.32	5.3

Table 2 : Effect of top dressing nitrogen and potassium on yield and yield components of rice

Treatments	Plant Height (cm)	Panicle length (cm)	Length of flag leaves (cm)	Number of tiller	Number of grains per panicle	Hollow grain (%)	1000 grain weight (g)	Grain yield (g pot -)	Biological yield per pot (g)	Harvest index per pot
N0K0	150	23.1	33.3	10.9	86.2	8.5	18.6	61.6	44.2	43.1
N0K0	156	22.7	33.4	10.2	89.2	6.2	18.8	59.1	41.1	45.2
N0K0	151	23.3	33.5	11.1	80.8	14.6	18.5	58.8	43.0	41.9
N1K0	179	26.0	42.1	12.8	105.0	19.0	20.8	71.6	46.6	31.5
N1K0	181	24.3	41.1	13.4	105.7	25.5	19.5	75.5	57.5	39.6
N1K0	178	26.8	41.2	13.7	108.4	27.6	19.0	73.7	63.1	23.7
N2K0	168	26.0	38.8	14.6	107.0	35.4	20.1	68.8	74.6	24.1
N2K0	165	23.5	41.9	15.9	90.0	38.6	19.0	65.2	75.3	23.1
N2K0	163	22.6	43.3	15.3	81.0	28.5	18.8	70.2	72.7	26.4

N_0: Without Nitrogen (Control) N_1: 23 kg N per hectare; N_2: 46 kg N per hectare; K_0: without potash (Control) K_1: 30 kg hectare; K_2: 60 kg K_2O per hectare.

hollow grain percentage. It seems that the cause of increase in grain number per panicle at high N level caused severe competition for carbohydrates, which resulted in increased hollow grain percentage. In lower nitrogen levels, insufficient nutrients for filling of grains led to diminished grain number per panicle. Esfehani et al., (2005) showed that potassium fertilizer has positive effect on filled grains in rice while its deficiency caused pollen sterility and decreased rice filled grains number. Weight of 1000-grains was not significantly affected by fertilizer treatments; it is a genetical character fixed by an individual variety (Wilson et al., 1996).Grain yield was significantly influenced by top dressing application of fertilizers especially of nitrogen.The highest grain yield (75.5g per pot) observed from N_1K_1 treatment, was statistically similar to N_1K_2 treatment (Table 2). The lowest grain yield recorded was with N_0 treatments. Application of 46 kg N ha-^{1} at two stages of topdressing (N_2 treatments) produced maximum straw yield; this could be a lodging agent and could eventually lead to decrease in yield. Nitrogen increased straw yield with effect on plant vegetative growth by increasing tiller number and plant height. Rahman*et al.,* (2007) and Laroo and Shivay (2011) also reported that maximum straw yield (6.98 ton ha^{-1}) was obtained with the highest dose of N level (46 Kg N ha^{-1}).With increment of nitrogen fertilizer, grain yield increased relatively, but further increase in nitrogen level produced higher straw yield that ultimately gave the lower harvest index. This result was supported by Qiangsheng*et al.,* (2004) and Achakzai (2012). Datta and Gumez (1985) showed that the effect of nitrogen on grain yield significantly affected the response in potassium presence; when nitrogen fertilizers are not utilized, rice does not react to potassium fertilizer. In this research, increasing grain yield in fertilizer treatments led to increase in straw and dry matter yield while reducing harvest index in high fertilizer levels (Table 2).

CONCLUSION

Potassium application as top-dressing together with nitrogen increased potassium content of plant, grain number in panicle and straw yield. Nitrogen concentration of upper development leaves decreased during growth stage. After first top-dressing, leaves potassium amount significantly increased and then decreased with initiation of natal stage of rice (30 days after transplanting). In flowering stage, the K concentrationwere more in stems than leaves, and N content of flag leaves (3.8% dry matter) was higher than other leaves and stems. Due to higher grain yield, decrease in the plant lodging and nutrient balance, application of 23 Kg N and 30 Kg K_2O ha^{-1} as top-dressing in mid-tillering stage (15 days after transplanting) and panicle initiation stage (35 days after 1st application) were suitable for rice, especially KRH-2 variety.

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