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EFFECT OF DIFFERENT LEVELS OF POTASSIUM SUPPLIED FROM TWO DIFFERENT SOURCES ON THE GROWTH AND YIELD OF RICE (Cv. BRRI Dhan49)

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Abstract

An experiment was carried out during T. aman season of 2014 at Soil Science Field Laboratory of the Department of Soil Science, Bangladesh Agricultural University, Mymensingh to study the effect of different levels of potassium supplied from two different sources on the growth and yield of rice variety BRRI dhan49. The experiment was laid out in a randomized complete block design with three replications having 5 m × 4 m unit plot size. There were seven treatment combinations viz. Control i.e K 0 kg ha^{-1} (T_1), K 40 kg ha^{-1} as MoP (T_2), K 50 kg ha^{-1} as MoP (T_3), K 60 kg ha^{-1} as MoP (T_4), K 40 kg ha^{-1} as K_2SO_4 (T_5), K 50 kg ha^{-1} as K_2SO_4 (T_6) and K 60 kg ha^{-1} as K_2SO_4 (T_7) in the experiment. Basal dose of fertilizers @ 100 kg N, 15 kg P, 12 kg S and 2 kg Zn ha^{-1} were applied from urea, TSP, gypsum, zinc oxide, respectively for all treatments. The full doses of MoP were applied as per treatments. The results revealed that growth and yield contributing characters like plant height, number of tillers hill^{-1}, panicle length, grains panicle^{-1} and 1000-grain weight responded significantly to different levels of applied K. The grain and straw yields of BRRI dhan49 were also significantly influenced due to different treatments. The highest grain yield of 4.9 t ha^{-1} and straw yield of 5.0 t ha^{-1} were obtained in T_4 which was statistically similar to T_3. The lowest grain yield of 3.5 t ha^{-1} and straw yield of 3.9 t ha^{-1} were found in T_1. The K content and uptake by grain and straw were also higher in the treatment T_4. The potassium supplied from MoP performed better than that supplied from K_2SO_4. Hence, the application of K @ 50 kg ha^{-1} as MoP may be recommended for successful cultivation of BRRI dhan49.

Keywords: Potassium, growth, yield, BRRI dhan49.

Introduction

Bangladesh is an agro-based country and thus most of our economic activities depend on agriculture. Agriculture contributes for almost 19.95% of GDP and provides employment for 48% of the labor force (BBS, 2011). About 40% of the world's population consumes rice as major source of calorie (Banik, 1999). Almost 100% of the people of Bangladesh take rice as staple food. Among the rice growing countries, Bangladesh occupies third position in rice area and fourth position in rice production (BRRI, 2000).

Among the plant nutrients, potassium is considered to be the third important essential macro element for crop production. It plays a major role in crop growth and development. It is also necessary for basic physiological activities such as formation of sugar and its subsequent movement among different parts, the synthesis of protein, normal cell division and growth (Rao *et al.,* 1990).

Potassium increases both the yield and quality of agricultural produce and enhances the ability of plants to resist diseases, insect attacks, cold and drought stresses and other adverse conditions. It regulates the water utilization by plant, strengthening plant tissues and preventing lodging. Lodging of rice plant increases sterility during flowering, which causes the yield reduction in rice. It also helps in the development of a strong and healthy root system and increases the efficiency of the uptake and use of N and other nutrients. In addition, K has an important role in livestock nutrition. As evidenced by research findings, a large percentage of sterile or unfilled grains are caused by poor pollen viability and this retards carbohydrate translocation due to potassium deficiency (Dunn and Stevens, 2005). The problem of K deficiency as well as K mining caused by intensive cropping with high yielding varieties

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of rice and nutrient imbalance in soil can be minimized by judicial application of potassium fertilizer. Higher yield of rice with higher dose of K over the present recommended rate was reported by many workers (Mitra *et al.,* 2000; Sairam *et al.,* 2002; Singh *et al.,* 2006; Bahmaniar *et al*., 2007).

Proper fertilization especially potassium effectively improves yield of crops, reduces cost and increases farm income. On the contrary, imbalance fertilization not only reduces crop yield but also increases cost of fertilizers and labors. It can be minimized by applying potassium fertilizer at the right time of physiological needs of the crops. The present study was, therefore, undertaken to evaluate the effect of different levels and sources of potassium on the growth and yield of rice cv. BRRI dhan49.

Materials and Methods

The experiment was carried out in the Soil Science Field Laboratory of Bangladesh Agricultural University, Mymensingh during T. aman season in 2014. The study was performed to evaluate the effect of different levels of potassium supplied from two different sources on the growth and yield of rice. The soil of the experimental site belongs to the Sonatala series under the AEZ of Old Brahmaputra Floodplain. The soil was silt loam in texture having pH 6.7, organic matter 2.70%, total N 0.141%, available P 4.2 ppm, exchangeable K 0.09 meq% and available S 14.9 ppm. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications of each treatment. There were seven treatments in the experiment. Three rates of K; 40, 50 and 60 kg ha^{-1} from muriate of potash (MoP) and potassium sulphate (K_2SO_4) were used in the experiment. The treatment combinations were T_1 - Control i.e. K 0 kg ha^{-1}, T_2 - K 40 kg ha^{-1} as MoP, T_3 - K 50 kg ha^{-1} as MoP, T_4 - K 60 kg ha^{-1} as MoP, T_5 - K 40 kg ha^{-1} as K_2SO_4, T_6 - K 50 kg ha^{-1} as K_2SO_4 and T_7 - K 60 kg ha^{-1} as K_2SO_4. The variety was BRRI dhan49 which is widely grown in Bangladesh. The unit plot size was 5m x 4m. Thirty-four days old seedlings of BRRI dhan49 were transplanted in the experimental plots on 1 August 2014 maintaining spacing at 20 cm x 20 cm. Three seedlings were planted $hill^{-1}$. All the treatments received a basal dose of 100 kg N, 15 kg P, 12 kg S and 2 kg Zn ha^{-1} from urea, TSP, gypsum and zinc oxide, respectively as per soil test basis (FRG, 2012). Full amount of TSP, MoP, gypsum and zinc oxide along with K as per treatments were applied during final land preparation. Urea was applied in three equal splits. The first split was applied during final land preparation, the second split was in active tillering stage and the third one was in panicle initiation stage. Different intercultural operations such as irrigation, weeding, pest control etc. were done as and when required. The crop was harvested plot wise at full maturity and the data on plant height, panicle length, number of effective tillers $hill^{-1}$, number of filled grains $panicle^{-1}$, 1000 grain weight, grain and straw yields were recorded. Five hills from each plot were sampled randomly for agronomic data collection prior to harvest. The grain and straw samples were analyzed for K content and uptake. All the data were statistically analyzed by F-test and the mean differences were adjudged by Duncan's Multiple Range Test (DMRT) (Gomez and Gomez, 1984) at 5% level of significance using statistical package MSTAT-C.

Results and Discussion

Growth and yield contributing characters: All yield contributing characters like plant height, number of tillers $hill^{-1}$, panicle length, grains $panicle^{-1}$, 1000-grain weight, grain yield and straw yield significantly responded to different levels of applied K (Table 1). Among the treatments, the tallest plant (77.67 cm) was recorded in T_4 and the highest panicle length (23.67 cm) was observed in T_7. Bahmaniar *et al.* (2007) found that plant height increased significantly due to K application. Similar result was also found by Mukherjee and Sen (2005). The shortest plant (71.00 cm) and panicle (16.33 cm) were observed in T_1 (Control). The highest number of tillers $hill^{-1}$ (15.00) was found in T_7. Sarker *et al.* (2006) also observed that application of potassium increased the number of tillers $hill^{-1}$ of rice. The highest number of grains $panicle^{-1}$ (74.00) was recorded in T_4 which was statistically similar to those observed in T_7. The highest 1000-grain weight (23.47 g) was recorded from T_5. This result is in agreement with the findings of Bahmaniar *et al.* (2007) who observed that potassium application increased plant height, number of tiller, length of panicle, number of grains $panicle^{-1}$ and grain yield of rice.

Grain yield: Grain yield of BRRI dhan49 responded significantly due to application of K fertilizers (Table 2). The grain yield varied from 3544 to 4924 kg ha^{-1} across the treatments. All the treatments showed higher grain yield over control. The treatment T_4 produced the highest grain yield of 4924 kg ha^{-1} which was 38.94 % higher over control. The grain yield obtained in T_4 was statistically similar to T_3. The lowest grain yield (3544 kg ha^{-1}) was obtained in T_1 (Control). The percent increase in grain yield over control ranged from 26.44 % to 38.94 %. The highest percentage (38.94 %) of grain yield increase over control was recorded in T_4 and the lowest percentage (26.44 %) of increased grain yield over control was recorded in T_5. In producing grain yield, the treatments may be ranked in order of $T_4 > T_3 > T_7 > T_2 > T_6 > T_5 > T_1$. Regarding the sources of potassium, MoP performed better than K_2SO_4 in producing grain yield of BRRI dhan49. These results are well corroborated with Singh *et al.* (2006) and Bahmaniar *et al.* (2007) who reported that application of potassium increased the grain and straw yield of rice.

Table 1. Effect of different levels of K application on the growth and yield contributing characters of BRRI dhan49.

Treatment	Plant height (cm)	Effective tillers $hill^{-1}$ (no)	Panicle length (cm)	Grains $panicle^{-1}$ (no)	1000-grain weight (g)
T_1	71.00d	12.33e	16.33e	60.00d	20.43c
T_2	75.67b	12.67de	19.33d	67.00c	22.73ab
T_3	77.33a	13.67bcd	21.33c	71.00b	22.07abc
T_4	77.67a	14.67ab	23.00ab	74.00a	23.40a
T_5	74.00c	13.00cde	20.00d	67.33c	23.47a
T_6	76.00b	14.00abc	22.33b	68.67bc	22.70ab
T_7	77.33a	15.00a	23.67a	71.00b	21.40bc
SE(±)	0.381	0.333	0.317	0.962	0.569
CV%	4.87	4.24	2.63	2.44	4.41
Sig. level	***	***	***	***	*

*In a column, figure(s) followed by the same letter(s) do not differ significantly at 5% level of significance. SE (±) = Standard error; CV = Coefficient of variation; * = $p \leq 0.05$; *** = $p \leq 0.001$; T_1: Control; T_2: K 40 kg ha^{-1} as MoP; T_3: K 50 kg ha^{-1} as MoP; T_4: K 60 kg ha^{-1} as MoP; T_5: K 50 kg ha^{-1} as K_2SO_4; T_6: K 50 kg ha^{-1} as K_2SO_4; T_7: K 50 kg ha^{-1} as K_2SO_4*

Straw yield: Results in the Table 2 showed that straw yield of BRRI dhan49 was significantly influenced due to application of K fertilizers. The straw yield obtained from different treatments ranged between 3.9 t to 5.0 t ha^{-1}. All the treatments gave higher straw yield over control. It was observed that the treatment T_4 gave the highest straw yield of 5042 kg ha^{-1} which was statistically similar with T_2, T_3 and T_7 with values of 4.8, 5.0 and 4.9 t ha^{-1}, respectively. The lowest straw yield of 3.9 t ha^{-1} was recorded in T_1 (Control). In producing straw yield, the treatments may be ranked in order of $T_4 > T_3 > T_7 > T_2 > T_6 > T_5 > T_1$. The increase in straw yield over control followed same trend as observed in case of grain yield. The increase in straw yield over control ranged from 10.50 % to 27.29 %. The highest increase in straw yield (27.29 %) over control was recorded in T_4 and the lowest one (17.92 %) was found in T_6.

Table 2. Effect of different levels of K application on the grain and straw yields of BRRI dhan49.

Treatment	Grain yield (t ha^{-1})	Yield increase over control (%)	Straw yield (t ha^{-1})	Yield increase over control (%)
T_1	3.54f	-	3.96d	-
T_2	4.6cd	30.98	4.86ab	22.90
T_3	4.86ab	37.39	5.01ab	26.61
T_4	4.92a	38.94	5.04a	27.29
T_5	4.48e	26.44	4.37c	10.50
T_6	4.67d	30.28	4.67bc	17.92
T_7	4.75bc	34.26	4.91ab	24.19
SE(±)	42.30	-	109.60	-
CV%	4.61	-	4.04	-
Sig. level	***	-	***	-

*In a column, figure(s) followed by the same letter(s) do not differ significantly at 5% level of significance. SE (±) = Standard error; CV = Coefficient of variation; * = $p \leq 0.05$; *** = $p \leq 0.001$; T_1: Control; T_2: K 40 kg ha^{-1} as MoP; T_3: K 50 kg ha^{-1} as MoP; T_4: K 60 kg ha^{-1} as MoP; T_5: K 50 kg ha^{-1} as K_2SO_4; T_6: K 50 kg ha^{-1} as K_2SO_4; T_7: K 50 kg ha^{-1} as K_2SO_4*

Potassium uptake: The results indicated that the K uptake by grain and straw of BRRI dhan49 was also significantly influenced by the different treatments (Table 3). The K uptake by rice grain varied from 10.99 kg to

17.40 kg ha^{-1}. The highest K uptake (17.40 kg ha^{-1}) by grain was recorded in T_4. The lowest K uptake (10.99 kg ha^{-1}) by grain was observed in T_1 (Control).

Potassium uptake by straw ranged from 83.31 kg to 116.98 kg ha^{-1}. The highest K uptake (116.98 kg ha^{-1}) by straw was observed in T_4. On the other hand, the lowest K uptake (83.31 kg ha^{-1}) by straw was obtained in T_1. The results revealed that K uptake by straw was much higher than that by grain.

Total K uptake by grain plus straw varied from 94.29 kg to 134.38 kg ha^{-1}. The highest total K uptake of 134.38 kg ha^{-1} was found in T_4 and the lowest total K uptake of 94.29 kg ha^{-1} was observed in T_1. The total K uptake due to different treatments can be ranked in the order of $T_4 > T_3 > T_7 > T_6 > T_2 > T_5 > T_1$. Yadav *et al.* (2006) reported that K application increased K content and uptake by rice. Similar result was also reported by Kanti *et al.* (2000) and Nakashgir *et al.* (2000).

Table 3. Effect of different levels of K application on K content and uptake by grain and straw of BRRI dhan49.

Treatment	K content (%)		K uptake (kg ha^{-1})		Total K uptake (kg ha^{-1})
	Grain	Straw	Grain	Straw	
T_1	0.310f	2.103d	10.99e	83.31e	94.29d
T_2	0.317e	2.180cd	14.70cd	106.13bc	120.83b
T_3	0.337b	2.263abc	16.40b	113.52ab	129.92a
T_4	0.353a	2.320a	17.40a	116.98a	134.38a
T_5	0.323d	2.187bcd	14.49d	95.74d	110.23c
T_6	0.330c	2.263abc	15.24c	105.64c	120.89b
T_7	0.340b	2.290ab	16.18b	12.52abc	128.69a
SE(±)	0.0042	0.033	0.222	2.296	2.360
CV%	2.21	2.56	2.55	3.79	3.41
Sig. level	***	***	***	***	***

*In a column, figure(s) followed by the same letter(s) do not differ significantly at 5% level of significance. SE (±) = Standard error; CV = Coefficient of variation; * = $p \le 0.05$; *** = $p \le 0.001$; T_1: Control; T_2: K 40 kg ha^{-1} as MoP; T_3: K 50 kg ha^{-1} as MoP; T_4: K 60 kg ha^{-1} as MoP; T_5: K 50 kg ha^{-1} as K_2SO_4; T_6: K 50 kg ha^{-1} as K_2SO_4; T_7: K 50 kg ha^{-1} as K_2SO_4*

From the observation, it is distinct that yield obtained from K 50 kg ha^{-1} as MoP (T_3) and K 60 kg ha^{-1} as MoP (T_4) was statistically similar. The present study suggests that application of K @ 60 kg ha^{-1} as MoP is luxurious for maximized grain yield of BRRI dhan49. Hence, among the potassium fertilizer treatments, the T_3 i.e. K 50 kg ha^{-1} as MoP may be recommended for optimum grain yield of BRRI dhan49 in the Old Brahmaputra Floodplain.

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