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EFFECT OF DIFFERENT LEVELS OF K AND S ON THE YIELD OF BINA DHAN7

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ABSTRACT

A field experiment was carried out in Old Brahmaputra Floodplain (AEZ-9) soil at Soil Science Field Laboratory of Bangladesh Agricultural University, Mymensingh during aman season of 2011 to evaluate the response of BINA dhan7 to different levels of potassium and sulphur. The experiment was laid out in a randomized complete block design with three replications. There were six treatments such as T_1: Control, T_2: $NPZnK_0S_0$, T_3: Recommended Fertilizer Dose (RFD), T_4: RFD-20% KS, T_5: RFD-40% KS, T_6: RFD + 20% KS and T_7: RFD + 40% KS. Eighty kg N ha^{-1}, 15 kg P ha^{-1}, 50 kg K ha^{-1}, 12 kg S ha^{-1} and 2 kg Zn ha^{-1} were applied as Recommended Fertilizer Dose (RFD). Nitrogen, phosphorus, potassium, sulphur and zinc were supplied from urea, TSP, MoP, gypsum and zinc oxide, respectively. The full dose of TSP, MoP, gypsum and zinc oxide were applied as basal dose during final land preparation while urea was applied in three equal splits. The application of K and S had a significant influence on plant height, effective tillers $hill^{-1}$, panicle length and filled grains $panicle^{-1}$. The grain and straw yields of BINA dhan7 were significantly affected due to different treatments. The highest grain yield of 5.23 t ha^{-1} and straw yield of 7.05 t ha^{-1} were observed with the treatment T_7 (RFD + 40% KS) and statistically similar yields were recorded with the treatments T_6 (RFD + 20% KS) and T_3 (RFD). The grain yield was increased by 48.3 to 97.4% over control due to application of different levels of K and S fertilizers. Overall results indicate that there is no need to add more K and S beyond the recommended rate (50 kg K and 12 kg S ha^{-1}) for achieving the satisfactory yield of BINA dhan7 in Old Brahmaputra Floodplain Soil of BINA dhan7 at BAU farm soil, Mymensingh.

Key words: Fertilizer, BINA dhan7, potassium, sulphur

Introduction

Soil is the principal supplier of plant nutrients. Plant derives 13 essential nutrients out of 17 from the soil. But soil varies considerably in their inherent capacities to supply nutrients, which are gradually declining over time due to intensive cropping with high yielding rice varieties. Practically no soil can sustain higher crop yields for an indefinite period from its own nutrient reserves. Even the most fertile soils can do so only for certain years and at one time the yield will be declined due to deficiency of some nutrients. Nitrogen, phosphorus and potassium are the primary macronutrients and sulphur, calcium and magnesium are the secondary macronutrients and they can play key roles to increase the production of rice to a great extent. Among the plant nutrients, potassium is considered to be the third important essential plant nutrient element for crop production. It plays a major role in crop growth and development and can alleviate the sterility problem in rice. As evidenced by research findings, a large percentage of sterile or unfilled spikelets are caused by poor pollen viability and this retards carbohydrate translocation due to potassium deficiency (Dobermann and Fairhurst, 2000). Potassium helps control or reduces the severity of plant diseases and increases the plant's resistance to drought and other stresses. It performs many functions in plant, such as promoting growth and increasing yield, increasing resistance to pests, promoting root growth, regulating 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. Potassium increases strength of rice stalk, and thus prevents lodging and reduces sterility. Sulphur has been recognized as essential for plant growth and plays a unique role in plant metabolism. Before 1980's deficiency of NPK was a major problem in Bangladesh soils, and thereafter, along with NPK, deficiencies of S are frequently

reported (Islam *et al.,* 1986; Hoque and Jahiruddin, 1994). Sulphur deficiency has been recognized in many areas of Bangladesh, which roughly covers 44% of the total cropped area (Hussain, 1990). The use of almost S free fertilizers such as urea, TSP and MoP may be an important reason for widespread occurrence of S deficiency problem. Besides these, use of S free pesticides and flooding of land lead to S to be remained in reduced condition for a considerable period of time, resulting in decreased S availability in soils. Sulphur is increasingly being recognized as the 4th major nutrient after nitrogen (N), phosphorus (P) and potassium (K) (Tandon, 1995). Although, the essentiality of sulphur for plants had been recognized in 1911 (Tamhane *et al.,* 1970), its deficiency on wet land rice was first reported in 1938 in Burma (Chang, 1978). Considering the above points, the present study was, therefore, undertaken with the following objectives: i) to evaluate the effect of different levels of potassium and sulphur on the yield and yield contributing characters of BINA dhan7 and ii) to examine the effect of different levels of potassium and sulphur on nutrient uptake by BINA dhan7.

Materials and Methods

A field experiment was carried out at the Soil Science Field Laboratory of Bangladesh Agricultural University, Mymensingh during aman season of 2011 to evaluate the effect of different rates of K and S on the growth and yield of BINA dhan7. The soil belongs to the sonatola soil series under the AEZ of Old Brahmaputra Floodplain. Characteristically, the soil was silt loam having pH 6.24, organic matter content 3.31%, total N 0.179%, available P 12.76 ppm, exchangeable K 0.13 me/100 g soil and available S 10.47 ppm and CEC 15.10 me/100 g soil. The experiment was designed with 7 treatments and laid out in randomized complete block design. The unit plot size was 4m X 2.Sm. The treatments used in the experiment were T_1: Control, T_2: NPZnK_0S_0, T_3: Recommended Fertilizer Dose (RFD), T_4: RFD-20% KS, T_5: RFD-40% KS, T_6: RFD+20% KS and T_7: RFD+40% KS. Eighty kg N ha^{-1}, 15 kg P ha^{-1}, 50 kg K ha^{-1}, 12 kg S ha^{-1} and 2 kg Zn ha^{-1} were applied as recommended fertilizer dose (RFD). Nitrogen, phosphorus potassium, sulphur and zinc were supplied from urea, TSP, MoP, gypsum and zinc oxide, respectively. TSP, MoP, gypsum and zinc oxide were applied as basal dose during final land preparation. Urea was applied in three installments: one-third 10 days after transplanting, second installment after 30 days of transplanting and third installment after 60 days of transplanting. The seedlings of 35-day-old were transplanted in the experimental plots on 20 August 2011. Intercultural operations were done as and when necessary. The crop was harvested at full maturity on 5 December 2011. Ten hills were selected from 1 m^2 area of each plot to record the yield contributing characters like plant height, effective tillers hill^{-1}, panicle lengt6, filled grains panicle^{-1} and 1000-grain weight. Grain and straw samples were collected, dried, ground, sieved and kept for chemical analysis. The grain and straw yield was recorded plot wise and expressed on 14% moisture basis. Grain and straw samples were analyzed to determine the N, P, K and S content. The analysis of variance for crop characters as well as nutrient concentrations and nutrient uptake was done following the F-test. Mean comparison of the treatments was made by the Duncan's Multiple Range Test (Gomez and Gomez, 1984).

Results and Discussion

Yield components of BINA dhan7: The yield components include the plant height, effective tillers hill^{-1}, panicle length, filled grains panicle^{-1} and 1000-grain weight. These data are presented in Table 1.

Plant height: The plant height of BINA dhan7 was significantly affected due to application of different levels of potassium and sulphur (Table 1). The tallest plant (92.14 cm) was found in the treatment T_1 (RFD + 40% KS). The shortest plant (80.26 cm) was found in the treatment T_1 (control). It might be due to no use of fertilizers that greatly reduced plant growth and development resulting in shorter plant. These results are also in agreement with the findings of Moreno *et al.* (1985).

Effective tillers hill^{-1}: Data in Table 1 show that the effect of different levels of K and S on the number of effective tillers hill^{-1} was significant. The number of effective tillers hill^{-1} due to different treatments varied from 7.90 to 10.60. The effective tillers hill^{-1} produced by the treatment T_7 (RFD + 40% KS) was higher

but statistically similar to that in T_6 (RFD + 20% KS) treatment and simultaneously higher but statistically similar to those given by T_3 and T_4 treatments. It might be due to smaller (20%) reduction of the K and S fertilizers from the recommended doses of all other fertilizers which did not affect growth and development of plants remarkably. The minimum number of effective tillers hill^{-1} (7.90) was found in the treatment T_1 (control) which was lower than that of T_2 and T_3.

Table 1. Effect of different levels of K and S on the yield contributing characters of BINA dhan7

Treatments	Plant height (cm)	Effective tillers/ hill	Panicle length (cm)	Filled grains/ panicle	Unfilled grains/ panicle	1000 grain weight (g)
T_1: Control	80.26f	7.90f	20.50d	73.13f	17.58a	20.78c
T_2: $NPZnK_0S_0$	86.10e	8.30e	21.78c	92.13e	16.36b	22.88b
T_3: RFD	90.39c	9.75d	24.04ab	105.56b	14.59c	24.75a
T_4: RFD-20% KS	88.21d	9.55d	23.75b	102.38c	13.53d	24.50a
T_5: RFD-40% KS	86.32e	8.95e	22.43c	99.13d	12.35e	24.28a
T_6: RFD+20% KS	91.46b	10.90a	24.48ab	108.08ab	11.65f	24.86a
T_7: RFD+40% KS	92.14a	10.60a	24.94a	110.36a	11.01f	24.91a
SE (±)	0.74	0.20	0.31	2.29	0.44	0.29
$LSD_{0.05}$	0.67	0.19	0.92	1.11	0.66	0.82

The figure(s) having common letter(s) in a column do not differ significantly at 5% level of significance.
LSD = Least Significant difference; SE = Standard error of mean

Panicle length: There was a significant effect of different treatments on panicle length of BINA dhan7 (Table 1). The panicle length due to different treatments varied from 20.50 cm to 24.94 cm. The values for panicle length of all the treatments were higher than that of the treatment T_1 (control). The maximum panicle length (24.94 cm) was recorded in the treatment T_7 (RFD + 40% KS) which was statistically similar to that observed in the treatment T_6 (RFD + 20% KS) with value of 24.48 cm. The lowest panicle length (20.50 cm) was found in the treatment T_1 (control). Apostol (1989) observed that organic and inorganic fertilizers increased the panicle length of rice.

Filled grains panicle^{-1}: Results presented in Table 1 showed a significant effect of different levels of K and S supplied from respective fertilizers on the number of filled grains panicle^{-1} of BINA dhan7. The number of filled grains panicle^{-1} of different treatments ranged from 73.13 to 110.36. The highest number of filled gains panicle^{-1} (110.36) was obtained from the treatment T_7 (RFD + 40% KS) which was statistically similar to that in T_6 (RFD + 20% KS). The lowest number of filled grains panicle^{-1} (73.13) was obtained in T_1 (control) which was different from other treatments. The number of filled grains panicle' in the treatment T_2 ($NPZnK_0S_0$) was 92.13 which was lower than T_3 (RFD). This implies that these nutrients had significant role in the formation of filled grains of rice, and 20% reduced rates of K and S had important effect in the filled grain formation.

1000-grain weight: Data in Table 1 indicated that application of different fertilizer levels significantly increased the 1000-grain weight of BINA dhan7. The 1000-grain weight ranged from 20.78 g - to 24.91 g. All the treatments showed an increase in 1000-grain weight over T_1 (control) but the treatments T_4 (RFD-20% KS) and T_S (RFD-40% KS) showed a decrease in 1000-grain weight over T_3 (RFD). The highest 1000grain weight (24.91 g) was recorded from T_7 (RFD + 40% KS) treatment, while the lowest 1000-grain weight (24.28 g) was obtained in the treatment T_1 (control).

Grain yield: Grain yield of BINA dhan7 responded significantly to the different treatments (Table 2). The grain yield due to various treatments ranged from 2.65 to 5.23 t ha^{-1}. All the treatments showed higher grain yield over T_1 (control) and T_2 ($NPZnK_0S_0$). The highest grain yield (5.23 t ha^{-1}) was obtained in the treatment T_5 (RFD + 40% KS) which was statistically similar to those observed in the treatments T_6 (RFD + 20% KS) and T_3 (RFD) with values of 5.20 and 5.10 t ha^{-1}, respectively but increasing rate was lower in

the treatment T_6 (RFD + 20% KS) and T_5 (RFD + 40% KS) compared to T_3 (RFD) treatment. It is evident from the result that the treatment T_3 (RFD) assumed as normal for BINA dhan7 as the increasing level of K and S in the treatments T_6 and T_5 produced statistically similar result to T_3 treatment. The lowest grain yield (2.65 t ha^{-1}) was obtained in the treatment T_1 which was statistically different from all the treatments. This implies that these nutrients had significant role on grain yield. The highest percentage (97.35%) of increased grain yield over control was recorded in the treatment RFD + 40% KS. The lowest percentage (48.30%) of increased grain yield over control was recorded in the treatment $NPZnK_0S_0$. Similar results were also reported by Asaduzzaman *et al.* (1996).

Table 2. Effect of different levels of K and S on the yield of BINA dhan7

Treatments	Grain yield (t/ha)	% increase over control	Straw yield (t/ha)	% increase over control	Biological yield (t/ha)	% increase over control
T_1: Control	2.65d	-	3.71d	-	6.36	-
T_2: $NPZnK_0S_0$	3.93c	48.30	4.85c	30.72	8.78	38.05
T_3: RFD	5.10a	92.45	6.83a	84.09	11.93	87.57
T_4: RFD-20% KS	4.91a	85.28	6.52a	75.74	11.43	79.71
T_5: RFD-40% KS	4.50b	89.81	5.62b	51.48	10.12	59.12
T_6: RFD+20% KS	5.20a	96.22	6.95a	87.33	12.15	91.03
T_7: RFD+40% KS	5.23a	97.35	7.05a	90.02	12.28	93.08
SE (±)	0.17	-	0.23	-	-	-
$LSD_{0.05}$	0.32	-	0.52	-	-	-

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LSD = Least Significant difference, SE = Standard error of mean

Straw yield: The straw yield obtained from different treatments ranged from 3.71 to 7.05 t ha^{-1}. All the treatments gave higher straw yield over T_1 (control) treatment. Again, the straw yield was always higher in all the treatments than that of grain yield. Like grain yield, the treatment T_7 (RFD + 40% KS) also produced the highest straw yield (7.05 t ha^{-1}) which was statistically identical to that observed in the treatment T_6 (RFD + 20% KS) with value of 6.95 t ha' and followed by the treatment T_3 (RFD). The lowest straw yield (3.71 t ha^{-1}) was recorded in the treatment T, (control). The straw yield due to different treatments ranked in the order of $T_7 > T_6 > T_3 > T_4 > T_5 > T_1$. The results revealed that combination of recommended rates of K and S fertilizer with a greater (40%) reduction had significant effect to reduce straw yield.

Biological yield: The biological yield obtained from different treatments ranged from 6.36 to 12.28 t ha^{-1}. The highest biological yield (12.28 t ha^{-1}) was recorded in the treatment T_7 (RFD + 40% KS) which was statistically identical with those recorded in the treatments T_6 (RFD + 20% KS) and T_3 (RFD) with values 12.15 and 11.93 t ha^{-1}, respectively. The lowest biological yield (6.36 t ha^{-1}) was noted in the treatment T_1 (control) which was statistically different from all other treatments. The highest percentage (93.08%) of increased biological yield over T_1 (control) was observed in the treatment T_6 (RFD + 40% KS). The biological yield obtained from different treatments ranked in the order of $T_7 > T_6 > T_3 > T_4 > T_5 > T_1$.

Nutrient contents in grain and straw

Potassium content: Potassium content in both grain and straw of BINA dhan7 was significantly affected by the different treatments under study (Table 3). Potassium content in grain due to different treatments ranged from 0.123 to 0.237%. The highest value of 0.237% K was found in the treatment T_7 (RFD + 40% KS) and the lowest value of 0.123% was found in the treatment T_1 (control). The value of T_3 (RFD) is greater than T_1 (control), T_2 ($NPZnK_0S_0$), T_4 (RFD-20% KS) and T_S (RFD-40% KS), respectively. In case of straw, K content ranged from 1.149 to 1.567%. The highest K content (1.567%) was found in the treatment T_7 (RFD + 50% KS). The lowest value (1.149%) was recorded in the treatment T_1 (control) which was statistically different from all other treatments. It was also observed that K content in straw was higher than that of grain in all treatments.

Table 3. Potassium and sulphur contents in grain and straw of BINA dhan7 as influenced by different rates of K and S

Treatments	%K		%S	
	Grain	Straw	Grain	Straw
T_1: Control	0.123f	1.149f	0.110d	0.098c
T_2: $NPZnK_0S_0$	0.182e	1.357e	0.136bc	0.102bc
T_3: RFD	0.192de	1.452d	0.128c	0.131 a
T_4: RFD-20% KS	0.206cd	1.470c	0.150b	0.122a
T_5: RFD-40% KS	0.215bc	1.483c	0.143bc	0.115ab
T_6: RFD+20% KS	0.229ab	1.542b	0.185a	0.127a
T_7: RFD+40% KS	0.237a	1.567a	0.188a	0.130a
SE (±)	0.007	0.026	0.006	0.003
$LSD_{0.05}$	0.015	0.014	0.015	0.015

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LSD = Least Significant difference, SE = Standard error of mean

Sulphur content: Sulphur content in grain and straw was significantly affected due to application of different levels of potassium and sulphur (Table 3). Sulphur content in grain varied from 0.110% in T_1 (control) to 0.188% in T_7 (RFD + 40% KS) treatment. In case of straw, sulphur content due to different treatments varied from 0.098 to 0.130%. The highest value (0.130%) was recorded in the treatment T_5 (RFD + 40% KS) which was statistically similar to T_6 (RFD + 20% KS). The lowest value (0.098%) was observed in the treatment T_1 (control) with S content 0.098%. This implies that greater (40%) reduction of S fertilizer reduce the S content of straw.

Nutrient uptake by grain and straw

Potassium uptake: The K uptake by grain varied from 3.2 to 12.40 kg ha^{-1}. The highest (12.40 kg ha^{-1}) K uptake by grain was recorded in the treatment T_7 (RFD + 40% KS) which was statistically similar to that recorded in the treatment T_6 (RFD + 20% KS) with K uptake 11.89 kg ha^{-1}. The lowest (3.26 kg ha^{-1}) K uptake by grain was obtained in the treatment T_1 (control) which was statistically different from all other treatments. The K uptake by straw ranged from 42.61 to 110.47 kg ha^{-1}. It was noted that K uptake by straw was higher than that of grain in all treatments. The total K uptake by BINA dhan7 was also influenced significantly due to different treatments and the total K uptake ranged from 45.87 to 122.87 kg ha^{-1}. The treatment T_7 (RFD + 40% KS) showed the highest total K uptake (112.87 kg ha^{-1}). The lowest K uptake (45.87 kg ha^{-1}) was observed in the treatment T_1 (control) which was statistically dissimilar to all other treatments. The total K uptake in T_3 (RFD) is greater than T_2 ($NPZnK_0S_0$), T_4 (RFD - 20% KS) and T_5 (RFD - 40% KS) treatments due to the lower dose of K than that of T_3 (RFD). Roy and Kumar (1995) found a significant increase in K uptake with rate of K application.

Table 4. Potassium and sulphur uptake by grain and straw of BINA dhan7 as influenced by different rates of K and S

Treatments	K uptake (kg ha^{-1})			S uptake (kg ha^{-1})		
	Grain	Straw	Total	Grain	Straw	Total
T_1: Control	3.26d	42.61f	45.87e	2.91d	3.64c	6.54e
T_2: $NPZnK_0S_0$	7.15c	65.81 e	72.96d	5.34c	4.95c	10.29d
T_3: RFD	9.80b	99.26bc	109.07b	6.53bc	9.00a	15.53b
T_4: RFD-20% KS	10.11b	95.83c	105.94b	7.38b	7.95a	15.33b
T_5: RFD-40% KS	9.65b	83.36d	93.02c	6.44bc	6.46b	12.91c
T_6: RFD+20% KS	11.89a	107.17ab	119.06a	9.63a	8.83a	18.46a
T_7: RFD+40% KS	12.40a	110.47a	122.87a	9.80a	9.16a	18.96a
SE (±)	0.627	4.47	5.01	0.45	0.42	0.83
$LSD_{0.05}$	1.768	8.285	8.359	1.325	1.398	2.076

The figure(s) having common letter(s) in a column do not differ significantly at 5% level of significance.
LSD = Least Significant difference, SE = Standard error of mean

Sulphur uptake: Sulphur uptake by BINA dhan7 in both grain and straw was significantly influenced by different treatments under study (Table 4). The S uptake in grain was varied from 2.91 to 9.80 kg ha^{-1}. The higher S uptake in grain (9.80 kg ha^{-1}) was observed in the treatment T_7 (RFD + 40% KS) which was statistically similar to those observed in the treatment T_6 (RFD + 20% KS). The lowest S uptake by grain was observed in the treatment T_1 (control) which was statistically different from all other treatments. In straw, the S uptake ranged from 3.64 to 9.16 kg ha^{-1}. The maximum S uptake (9.16 kg ha^{-1}) by straw was observed in the treatment T_7 (RFD + 40% KS) which was statistically superior and similar to that obtained in T_6 (RFD + 20% KS). The minimum S uptake (3.64 kg ha^{-1}) by straw was recorded in the treatment T_1 (control) which was also statistically similar to T_2 ($NPZnK_0S_0$). The total S uptake was also significantly affected by various treatments used in the experiment and total S uptake ranged from 6.54 to 18.96 kg ha^{-1}. The treatment T_7 (RFD + 40% KS) gave the highest total S uptake (18.96 kg ha^{-1}) which was statistically similar to that observed in the treatment T_6 (RFD + 20% KS) with value 18.46 kg ha^{-1}. The lowest S uptake (6.54 kg ha^{-1}) was observed in the treatment T_1 (control) which was statistically different from all other treatment. Sakal (1995) reported that concentration of S in grain and straw and its corresponding uptake increased with increasing rates of sulphur.

Conclusion

The treatment T_3 (RFD) produced statistically similar result with the treatment T_7 (RFD + 40% KS), T_6 (RFD + 20% KS) and T_4 (RFD - 20% KS). So, it is concluded from the present study that BINA dhan7 variety may be cultivated at BAU farm with recommended fertilizer dose for economic yield.

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