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Effect of Integrated Use of Banana Leaves as a Supplement of Potassium in BRRI Dhan29

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Abstract: Sustainable crop production could be possible through the integrated use of organic manure and chemical fertilizers. Day by day, fertilizers become limiting factor and also deteriorate soil health by using it to crop field. Therefore, now our concern is on integrated plant nutrient system to maintain long term soil fertility. To investigate the integrated use of banana leaves with MoP on the growth, yield and nutrient uptake status of BRRI dhan29, the study was carried out at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh during January to June, 2010. The experiment encompassed 7 different combinations of fertilizer doses and the treatments were T_1: control, T_2: RFD (Recommended Fertilizer Dose), T_3: 20% K from banana leaves (equivalent 0.28 t ha^{-1}) + 80% K from MoP, T_4: 40% K from banana leaves (equivalent 0.57 t ha^{-1}) + 60% K from MoP, T_5: 60% K from banana leaves (equivalent 0.86 t ha^{-1}) + 40% K from MoP, T_6: 80% K from banana leaves (equivalent 1.15 t ha^{-1}) + 20% K from MoP and T_7: 100% K from banana leaves (equivalent 1.5 t ha^{-1}). The highest grain yield and straw yield were recorded in T_4 as compare to other treatments. The maximum K content and K uptake also noticed in T_4 treatment. The recommended fertilizer produce second better results and all the case the control treatment gave the lowest values for all parameters under study. The results revealed that combined application of organic and inorganic source of potassium gave the higher yield and the banana leaves could be used as supplement of potassium fertilizer for economic and profitable cultivation of BRRI dhan29.

Key words: Potassium • Banana leaves • Yield • Nutrient content • Nutrient uptake • BRRI dhan29

INTRODUCTION

Rice (*Oryza sativa* L.) is the premier food crop of Bangladesh and therefore, our national food security systems largely depend on the productivity of rice ecosystem. Agriculture in Bangladesh is dominated by intensive rice cultivation covering about 80% of arable land and the most dominant cropping pattern is *Boro*- *T. Aman*. In respect of area and production of rice, Bangladesh ranks fourth following China, India and Indonesia [1]. The area and production of rice in the country in 2010 were 11.58 million ha and 33.90 million tons, respectively with an average yield of 2.92 t ha^{-1} under the diverse ecosystems subject to irrigated, rainfed and deep water conditions in three distinct seasons namely *Aus*, *Aman* and *Boro* with production of 2.63, 12.74 and 18.53 million tons, respectively [2]. So, emphasis should be given to explore the possibilities of increasing food production per unit area through proper fertilization and soil management with organic manuring that can help to meet up our national food demands.

The soil fertility status is gradually declining. Nambiar [3] indicated that integrated use of organic manures and chemicals NPK fertilizers would be quite promising not only in providing greater stability in production but also in maintaining higher soil fertility status. Sufficient potassium is important to increase efficiency of nitrogen and phosphatic fertilizer. Adequate K is required for photosynthesis and enzyme activation increasing water use efficiency, including disease/ pest and stress resistance in plants. K increases strength of

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rice stalk and thus prevents lodging and reduces sterility. Potassium is often described as the "quality element" for crop production [4]. K is removed from soil by plant uptake and also lost by leaching and erosion. Less amount of K is added to the soil compared to crop removal and hence native K in soil is declining day by day and therefore, it has become a concerning element in Bangladesh. As K deficiency has already been shown in different soils of Bangladesh, it is now headache to recover its deficiency. Most of the north-western parts of Bangladesh are deficient in K [5]. Light texture soil of these areas has low exchangeable K and the farmers use low amount of K fertilizer. As a result, soils which are not deficient in past, are likely to become deficient in K in near future.

Potassium deficiency in wetland rice has so far received limited attention. Hidden K deficiency in rice may limit its yield seriously. Generally our farmers apply potassium through chemical fertilizers like muriate of potash (MoP). But many organic materials may be used as sources of K such as banana leaves, acacia tree leaves, farm yard manure (FYM), ash, water hyacinth etc. So, it is needed to pay more attention to conduct more research with these materials.

Organic matter depletion is a serious problem that must be addressed to restore and maintain soils in Bangladesh. A continuing energy crisis, high fertilizers costs and growing ecological concerns have renewed interest in alternative K sources. Generally annual K rich crops like banana plants are used as green manure throughout the world. Green manuring can also be practiced through application of leaves and twigs from perennial plants. The banana leaves is a moderately quick growing, high K fixing and biomass producing plants. It is very common in Bangladesh and their leaves contain substantial amounts of K and other nutrients too. Litters of banana leaf contain 4.5% K [6]. This K can be used by annual crops like rice fertilized by green manuring through the fresh pruning of these plants. If it is used these types of organic source of K it will be economically profitable to the farmers and eco-friendly for the soil condition. In the light of above fact it is utmost necessary to conduct an experiment taking different combinations of MoP with banana leaves to find out the best suitable combinations of fertilizer with organic manures for economic and profitable rice cultivation. Therefore, the present investigation was undertaken to study the integrated effect of banana leaves with K fertilizer on the yield and yield contributing characters, nutrient content and uptake by BRRI dhan29 and also to find out suitable combination of them for economic and profitable cultivation.

MATERIALS AND METHODS

A field experiment was carried out at Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh, Bangladesh during the *boro* season of 2010 to evaluate the effect of different organic sources of K with inorganic fertilizers on the growth and yield of boro rice (cv. BRRI dhan29). The soil belongs to Sonatola series under the AEZ of Old Brahmaputra Floodplain. The experiment was laid out in Randomized Complete Block Design (RCBD) with 3 replications. The size of unit plot was (4 m × 2.5 m) and plots were separated from each other by 1 m drains and 30cm *ail.* There were 7 treatments and the treatments were T_1: control(no fertilizer), T_2: RFD (Recommended Fertilizer Dose), T_3: 20% K from banana leaves (equivalent 0.28 t ha^{-1}) + 80 % K from MoP, T_4: 40% K from banana leaves(equivalent 0.57 t ha^{-1}) + 60 % K from MoP, T_5: 60% K from banana leaves (equivalent 0.86 t ha^{-1}) + 40 % K from MoP, T_6: 80% K from banana leaves (equivalent 1.15 t ha^{-1}) + 20 % K from MoP and T_7: 100 % K from banana leaves (equivalent 1.5 t ha^{-1}). The total numbers of unit plots were 21.

Recommended fertilizer dose for the experimental plot was N_{120} P_{25} K_{65} S_{15} Zn_3 kg ha^{-1}. The N, P, K, S and Zn were applied from urea, TSP, MoP, gypsum and zinc oxide @ 260, 70, 116, 45 and 1.3 kg ha^{-1}, respectively. The organic source of K was banana leaves. The required amount of banana leaves were incorporated in the plots 7 days before transplanting and full dose of TSP, MoP, gypsum and zinc oxide were applied as basal during final land preparation. Urea was applied in 3 equal installments at 15, 30 and 60 days after transplanting of rice seedlings, respectively. Fourty day old seedlings were uprooted and transplanted on 15 January 2010. Spacing was 20 cm × 20 cm and three seedlings were transplanted in each hill. After a week of transplanting all plots were checked for any missing hill which was filled up with extra seedlings wherever necessary. Five hills were randomly selected from each plot at maturity to record the yield contributing characters like plant height, number of effective tillers $hill^{-1}$, panicle length, filled grains $panicle^{-1}$, 1000-grain weight. The grain and straw yields were recorded plot-wise and expressed at 14% moisture basis. Grain and straw samples were collected, dried, ground, sieved and kept for chemical analysis for N, P, K and S. Total N content of plant samples was determined following micro-kjeldahl method, P by olsen method and K and S by Flame Photometer and Spectrophotometer, respectively. The collected data were statistically analyzed to test the level of significance and the means were ranked by DMRT at p # 5% [7].

RESULTS AND DISCUSSION

Crop Performance at Harvest: Yield contributing characters like plant height, effective tillers hill^{-1}, panicle length and filled grains panicle^{-1} differed significantly due to various treatments in the experiment (Table 1). The highest value of plant height (83.83 cm) was recorded in treatment T_4 (40% K from banana leaves + 60 % K from MoP). Results indicated that application of organic sources with chemical potassium fertilizer produce highest plant height. Similar results also reported by Babu *et al*. [8]. The maximum effective tiller hill^{-1} (13.66) was recorded in treatment T_4. These results supported by Ahmed and Rahman [9] and found that the combined application of organic matter and chemical fertilizer increase the tiller number of rice. The highest panicle length (24.13 cm) was found in treatment T_2 (recommended fertilizer dose). Umarah *et al*. [10] and Ahmed and Rahman [9] noted that application of organic manure with chemical fertilizers increased the panicle length of rice. The highest number of filled grains panicle^{-1} (111.00) was recorded in treatment T_2. Shi *et al*. [11] also reported that application of K increase the number of filled grains panicle^{-1}. The performance of organic sources of K with chemical fertilizer was superior in respect of these yield contributing characters. The lowest values of all characters were obtained in treatment T_1 (control). Thousand grain weights were not significant by different treatments. Mitra *et al*. [12] reported that application of K increased 1000 grain weight of rice. Application of organic manures and chemical fertilizers exerted significant influenced on grain and straw yields of BRRI dhan29 (Table 2). The highest grain yield (5.40 t ha^{-1}) was obtained in treatment T_4 which was statistically similar with that found in treatment T_2 and the lowest value was recorded in treatment T_1. However, the maximum grain yield was recorded with combined use of organic manure such as banana leaves and inorganic fertilized plot. The maximum straw yield (6.50 t ha^{-1}) was found in treatment T_4 and the lowest straw yield (4.53 t ha^{-1}) was recorded in treatment T_1. Grain and straw yields were increased by different treatments ranging from 25.76 to 49.58% and 20.30 to 43.48%, respectively over control. Both grain and straw yields were comparatively lower in organic manures treated plot only than those plots were treated with combined use of organic manures and chemical fertilizer (MoP). These results supported by Dwivedi and Thakur [13] and reported that grain yield was significantly increased due to application of organic manure and chemical fertilizers. Abedin [14] also reported that incorporation of organic manure and chemical fertilizers in preceding crop significantly increased grain yield up to 52.22% over control. Singh *et al*. [15] found that application of K enhanced the grain yield of rice.

Nutrient Content in BRRI Dhan29: Nitrogen content both in grain and straw in BRRI dhan29 were varied significantly due to different treatments. The highest nitrogen content in grain (1.267%) and straw (0.589%) were obtained in T_2. The lowest value (0.850%) in grain and straw (0.482%) were obtained in treatment T_1. Nabi *et al.* [16] reported that the N content in shoot was increased with the combined application of organic and inorganic fertilizer. The P and S contents in BRRI dhan29 were not significantly affected by different treatments under study.

Potassium content in grain varied significantly due to different treatments. The highest potassium content in grain (0.274%) was found in treatment T_4 (40% K from banana leaves + 60% K from MoP) and the lowest value (0.171%) was found in treatment T_1 (control). Potassium content in straw was not significantly affected by different treatments. Maximum K content value (1.265%) in straw was found in treatment T_4 (40% K from banana leaves + 60% K from MoP). It was found that K content in straw was higher than that in grain. Singh *et al*. [17] revealed that K content both in grain straw were increased due to combined application of organic and inorganic fertilizers. Verma [18] reported that incorporation of organic manures increased the concentration of K in grain and straw of rice.

Nutrient Uptake by Grain and Straw: The NPK and S uptake by both rice grain and straw were affected significantly due to various treatments (Table 4 & 5). The maximum N uptake (65.943 kg ha^{-1}, 38.157 kg ha^{-1} and 104.100 kg ha^{-1} by grain, straw and total, respectively) were found in treatment T_2. Senger *et al*. [19] observed

Table 1: Yield contributing characters of BRRI dhan29 as influenced by different treatments

Treatment	Plant height (cm)	Effective tillers hill^{-1} (no.)	Panicle length (cm)	Filled grains panicle^{-1} (no.)	1000 grain wt. (g)
T_1	63.40^{e}	8.33^{d}	16.4^{c}	57.00^{d}	20.407
T_2	81.73^{a}	13.160^{ab}	24.13^{a}	111.00^{a}	21.99
T_3	80.43^{ab}	11.40^{bc}	21.00^{ab}	105.3^{a}	21.203
T_4	83.80 ^{a}	13.66^{a}	23.83^{a}	109.00^{a}	22.05
T_5	77.56^{bc}	13.33^{ab}	21.36^{ab}	100.66^{ab}	21.73
T_6	74.76^{cd}	13.03^{ab}	20.50^{ab}	88.00^{bc}	21.95
T_7	72.4^{6c}	10.93^{c}	19.26^{bc}	72.66^{c}	21.89
SE(±)	0.7063	0.3863	0.7265	3.2824	NS

The figure(s) having common letter(s) in a column do not differ significantly at 5% level of significance by DMRT. SE (±) = Standard error of means. NS = Non significant at 5% level of significance.

Table 2: Grain and straw yields of BRRI dhan29 as influenced by different treatment

Treatment	Grain yields (t ha^{-1})	Increase over control (%)	Straw yields (t ha^{-1})	Increase over control (%)
T_1	3.61^{d}	-	4.53^{c}	-
T_2	5.22^{a}	44.59	6.47^{a}	42.82
T_3	4.95^{b}	37.20	5.95^{ab}	31.34
T_4	5.40^{a}	49.58	6.50^{a}	43.48
T_5	4.86^{b}	34.70	5.81^{b}	28.25
T_6	4.73^{bc}	31.02	5.72^{b}	26.27
T_7	4.54^{c}	25.76	5.50^{b}	20.30
SE(±)	0.0494	-	0.1258	-

The figure(s) having common letter(s) in a column do not differ significantly at 5% level of significance by DMRT. SE (±) = Standard error of means.

Table 3: N, P, K and S content in grain and straw of rice (BRRI dhan29) as influenced by different treatments

	N content (%)		P content (%)		K content (%)		S content (%)	
Treatments	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw
T_1	0.850^{c}	0.482^{d}	0.201	0.109	0.171^{c}	0.993	0.103	0.105
T_2	1.267^{a}	0.589^{a}	0.232	0.125	0.239^{ab}	1.250	0.114	0.089
T_3	1.180^{ab}	0.558^{b}	0.226	0.119	0.232^{abc}	1.231	0.109	0.086
T_4	1.200^{a}	0.577^{a}	0.247	0.127	0.274^{a}	1.265	0.112	0.094
T_5	1.137^{ab}	0.543^{b}	0.223	0.118	0.212^{bc}	1.214	0.107	0.084
T_6	1.123^{ab}	0.521^{c}	0.216	0.115	0.198^{bc}	1.194	0.108	0.082
T_7	0.993^{bc}	0.504^{c}	0.203	0.113	0.185^{bc}	1.46	0.105	0.076
SE(±)	0.388	0.0047	NS	NS	0.0115	NS	NS	NS

The figure(s) having common letter(s) in a column do not differ significantly at 5% level of significance by DMRT. SE (±) = Standard error of means. NS = Non significant at 5% level of significance.

Table 4: Nitrogen and Phosphorus uptake by rice (BRRI dhan29) grain and straw as influenced by different treatments.

	N uptake (kg ha^{-1})			P uptake (kg ha^{-1})		
Treatment	Grain	Straw	Total	Grain	Straw	Total
T_1	30.680 ^{e}	21.843 ^{d}	52.523 ^{e}	7.256 ^{d}	4.943 ^{c}	12.199 ^{d}
T_2	65.943 ^{a}	38.157 ^{a}	104.100 ^{a}	12.053 ^{ab}	8.040 ^{a}	20.093 ^{ab}
T_3	58.433 ^{bc}	33.217 ^{b}	91.650 ^{b}	11.203 ^{abc}	7.093 ^{ab}	18.297 ^{abc}
T_4	64.730 ^{ab}	37.490 ^{a}	102.220 ^{a}	13.327 ^{a}	8.260 ^{a}	21.587 ^{a}
T_5	55.190 ^{c}	31.590 ^{b}	86.780 ^{c}	10.823 ^{abc}	6.837 ^{ab}	17.660 ^{bc}
T_6	53.080 ^{c}	29.877 ^{bc}	82.957 ^{c}	10.230 ^{bc}	6.563 ^{b}	16.793 ^{bc}
T_7	45.117 ^{d}	27.477 ^{c}	72.590 ^{d}	9.210 ^{c}	6.167 ^{bc}	15.377 ^{c}
SE(±)	1.497	0.790	1.375	0.5346	0.2897	0.7027

The figure(s) having common letter(s) in a column do not differ significantly at 5% level of significance by DMRT. SE (±) = Standard error of means.

Table 5: Potassium and Sulphur uptake by rice grain and straw as influenced by different treatments

	K uptake (kg ha^{-1})			S uptake (kg ha^{-1})		
Treatment	Grain	Straw	Total	Grain	Straw	Total
T_1	6.183^{e}	44.890^{c}	51.070^{d}	3.707^{e}	3.377^{d}	7.083^{e}
T_2	12.467^{ab}	80.637^{ab}	93.103^{ab}	5.970^{a}	5.473^{ab}	11.44^{ab}
T_3	11.537^{bc}	73.273^{ab}	84.803^{abc}	5.417^{b}	5.120^{b}	10.53^{bc}
T_4	14.787^{a}	81.923^{a}	96.707^{a}	6.067^{a}	6.120^{a}	12.19^{a}
T_5	10.317^{bcd}	70.520^{ab}	80.837^{abc}	5.220^{bc}	4.883^{bc}	10.10^{c}
T_6	9.400^{cd}	67.740^{ab}	77.14^{bc}	5.093^{c}	4.710^{bc}	9.807^{cd}
T_7	8.400^{de}	62.610^{b}	71.010^{c}	4.757^{d}	4.153^{cd}	8.910^{d}
SE(±)	0.5903	3.5637	3.3822	0.082	0.289	0.332

The figure(s) having common letter(s) in a column do not differ significantly at 5% level of significance by DMRT

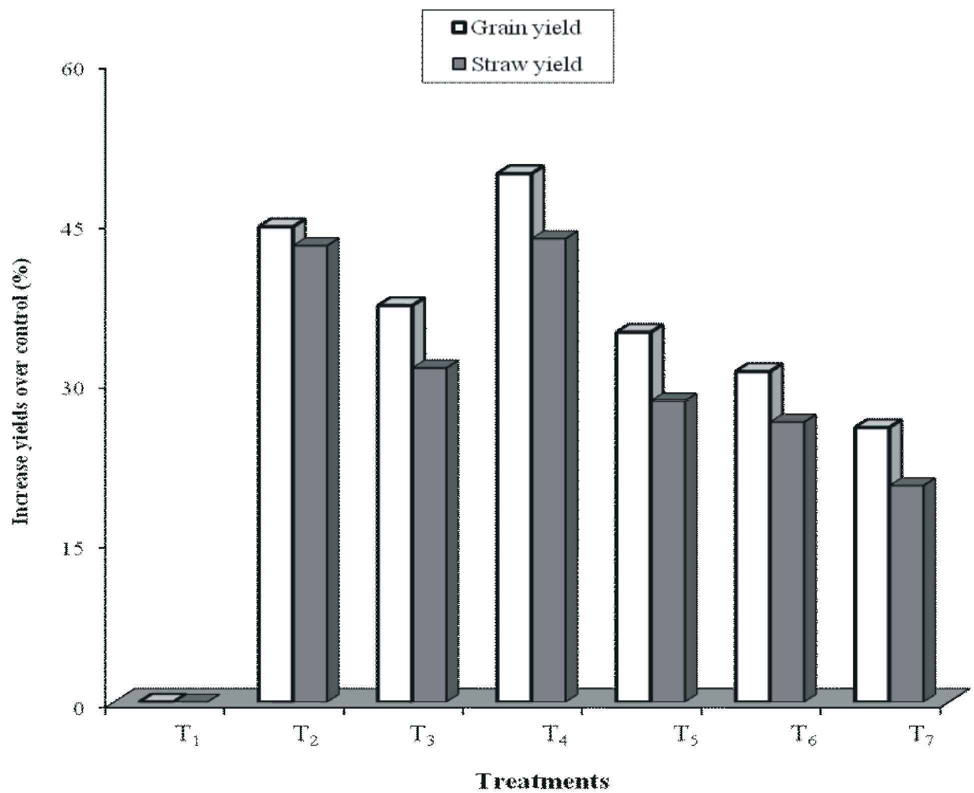

Fig. 1: Percent increased yields of grain and straw yields of BRRI dhan29 over control as influenced by different treatments

that N uptake by rice grain and straw increased significantly with organic manures and fertilizers and higher N uptake over control. The highest P uptake (13.327 kg ha^{-1}, 8.260 kg ha^{-1} and 21.587 kg ha^{-1} by grain, straw and total, respectively) were found in treatment T_4 which was statistically similar to treatment T_2. Baig *et al.* [20] stated the P uptake in rice was significantly increased by the application of different rates of organic manures. The maximum K uptake (14.787, 81.923 and 96.707 kg ha^{-1} by grain, straw and total, respectively) were recorded in treatment T_4 which was statistically identical to those found in treatment T_2. K uptake by grain varied from 6.183 to 14.787 kg ha^{-1}. The highest K uptake value (14.787 kg ha^{-1}) by grain was found in treatment T_4 followed by the treatment T_2 which was statistically similar. The lowest K uptake (6.183 kg ha^{-1}) by grain was found in treatment T_1. In case of straw, K uptake varied from 44.890 to 81.923 kg ha^{-1} (Table 5). The highest value was found in treatment T_4 which was statistically similar to those found in treatment T_2, T_3, T_5 and T_6 with values of 80.637, 73.273, 70.520 and 67.740 kg ha^{-1}, respectively. The lowest K uptake (44.890 kg ha^{-1}) by straw was noted in the treatment T_1 (Table 5). Sharma and Mitra [21] recorded the highest K uptake in organic manures and fertilizer treated plots. Baruah *et al*. [22] reported that combined application of organic and inorganic fertilizer significantly increased the uptake of NPK. Experimental result at BRRI [23] indicated that combination of rice straw with 45 kg N and 50 kg N ha^{-1} gave the highest yields of 3.8 kg ha^{-1}. The application of rice straw treated plot was 45 kg ha^{-1} computed to 36 kg ha^{-1} from without rice straw treated plots.

Sulphur uptake by grain varied from 3.707 to 6.067 kg ha^{-1}. The highest S uptake value was found in treatment T_4 which was statistically similar to those observed in treatment T_2. The lowest value was found in treatment T_1. In case of straw, S uptake varied from 3.377 to 6.120 kg ha^{-1}. The maximum S uptake in T_4 was statistically similar to those found in treatment T_2. The lowest S uptake by straw (3.377 kg ha^{-1}) was found in treatment T_1 (control). The total S uptake also varied significantly due to different treatment (Table 5). The highest total S uptake was found in treatment T_4 which was statistically similar to those found in treatment T_2 (recommended fertilizer dose). The lowest value of 7.083 kg ha^{-1} was observed in treatment T_1 (control). Azim [24] also observed that application of organic manures such as banana leaves, poultry manure with inorganic fertilizers enhanced the S uptake in rice crop.

CONCLUSIONS

From the results, it may be concluded that BRRI dhan29 significantly responded to integrated use of K fertilizer and banana leaves on yield and yield contributing characters. Combined use of K fertilizer (MoP) and banana leaves showed beneficial effect on the yield contributing characters that ultimately gave higher yield. Therefore, banana leaves with inorganic fertilizer will be rewarding as supplement of organic source of potassium in rice cultivation. The present study also revealed that external use of potassium fertilizer could be reduced through use of banana leaves which will be economical and eco-friendly for the sustainable agriculture.

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