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Role of Chemical Fertilizers (NPKSZn) and Missing of Major Nutrients (NPK) on Rice Yield

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ABSTRACT

A field experiment was carried out with two varieties of rice (BR 11 and BRRI dhan 31) during Transplanted Aman season of 2018 in K. bearing deep grey terrace soil of Madhupur tract (AEZ 28) under Bangladesh Rice Research Institute (BRRI), Joydebpur. Gazipur. The objective of the study was to know the effect of NPKSZn on the growth and yield of BR 11 and BRRI dhan 31. There were ten treatment combinations with three replications. The treatments were complete (+NPKSZn), reverse complete (-NPKSZn), +N (+PKSZn), -N (+PKSZn), +P (+NKSZn), -P (+NKSZn), +K (+NPSZn) and -K (+NPSZn). The parameters under study were dry matter production, contents and uptake of N, P, K, S and Zn at active and maximum tillering stages, panicle number m’ and grain yield in both the varieties. All the parameters were positively influenced by the treatments under study. Growth and yield of both the varieties were largely affected by the missing nutrient treatment. The highest performance was found with the complete and reverse control treatments whereas the lowest was found with missing element treatments and of course, with control. BR 11 was found to be a better variety than BRRI dhan 31 in respect of yield and yield contributing characters under the treatments. It was also observed that recently fertilized reverse control plot behaved statistically the same as the long term fertilized complete treatment plot. Yield of rice was positively related to K uptake in both the varieties.

***Keywords*:** Chemical fertilizer, rice production, chemical properties of soil, soil fertility, soil productivity, *Oryza sativa*

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1. INTRODUCTION

Rice (*Oryza sativa* L.) is one of the top most food item in the world [1]. Rice is the staple food of Bangladesh and most of the people eat rice at least three times in a day. It is considered as a major item of Bangladesh economy [2]. In Bangladesh, it is grown in a huge area of lands all over the country. It has genetic potential to improve the yield that is an urgent matter to feed a huge population now and in future [3]. Average yield of rice is below than its production potential. Few factors are usually responsible for poor yield like infertile soil, low nutrient content in soil etc. But yield increase has no alternative to feed huge people, all possible initiative should be taken by the researchers, policy makers and farmers to obtain expected production of rice [4].

The demand for rice continues to increase owing to continued growth of population [5]. It is predicted that a 50% to 60% increase in rice production will be required to meet demand for population growth by 2025 [6]. Proper crop management practices should be adopted by farmers to get desired yield [7]. Urea fertilized are extensively using by the farmers to achieve rapid vegetative growth of rice plant [8]. So, N supply can be ensured by the application of urea fertilizer [9]. Environmental pollution by nutrient leaching or runoff from rice fields has become another concern [10, 11]. Application of chemical fertilizers are a regular practices of almost all rice farmers of Bangladesh [12, 13]. As a costly item, fertilizer should be used only when it is urgent to apply in rice field [14]. Major nutrients are not available in the soils of Bangladesh that requires a huge amount of N, P, K, and Zn [15]. Fertilizers are very costly in Bangladesh and always shortage than expected amount [16]. Even, when the fertilizer supply is satisfactory, importance of increasing its use efficiency cannot be underestimated [17]. The application of nitrogen fertilizer either in excess or less than optimum rate affects both yield and quality of rice to a remarkable extent [18-20]. There are considerable uncertainties about crop N, P and K requirements because the internal efficiencies vary greatly depending on variety, nutrient supply, crop management and climatic conditions [21]. Many scholars argue that rice has ggentic potential to enhance yield by optimum application of N, P, K and Zn but specific focus are few [22-26]. The extent of this effect on growth is related to the degree of nutrient deficiency or imbalance [27-29]. Therefore, it is necessary to determine the effects of nitrogen, phosphorus and potassium along with S and Zn as well as other micronutrients for proper recommendation of fertilizers under different soil fertility conditions. The objectives of the research were to measure the magnitude of dry matter yield increase or decrease in their respective nutrient level, and to determine the major nutrient content and its effect on the distribution, growth and grain yield in sufficient and deficient rice plant.

2. MATERIALS AND METHODS

2. 1. Experimental Site and Soil

The piece of land on which the experiment was laid out was a typical rice growing medium high land in topography belonging to low K bearing deep grey terrace soil under Madhupur Tract (AEZ 28). The site of the experiment is located at about 24.75° North latitude and 90.5° East longitude having sub-tropical climate characterized by moderately high temperature and heavy rainfall during the Kharif season (April to September) and scanty rainfall with moderately low temperature during the Rabi season (October to March).

2. 2. Crop

BR 11 and BRR1 dhan 31, two high yielding varieties of rice, were used as the test crops in this experiment. The variety BR 11 was released from Bangladesh Rice Research Institute (BRRI), Joydebpur. Gazipur in 1980. Life cycle of this variety ranges from 140-150 days in Aman season. Seedlings grow to a height of 30-35 cm within 30 days and can he transplanted on land having 20-25 cm standing water. It is resistant to tungro, leaf blast, leaf blight and sheath rot diseases. The variety BRRI dhan 31 was released from BRRI in 1994. Life cycle of this variety is 140 days. Seedlings grow to a height of 30-35 cm within 30 days and can be transplanted on land having 20-25 cm standing water.

2. 3. Layout of the Experiment

Randomized Complete Block Design (RCBD) was adopted with 3 replications. There were 10 treatments with 3 replications and randomly selected plot. The total number of plots was 60. The unit plot size was 6.6 m × 3.2 m. The spacing between hills was 20 cm. Seedlings were raised in well prepared seed bed at the Soil Science Field Laboratory, Bangladesh Rice Research Institute, Gazipur. The weeds and other debris were removed from nursery bed. Clean rice seeds were used. After uniform levelling, the experimental plots were laid out according to the requirement of treatment and design.

2. 4. Experimental Treatments

This experiment was a part of long-term missing element programme of BRRI which was initiated in 1985 at BRRI Farm. This experiment was initiated with a view to evaluating the fertility status of soil after long time. The complete treatment involving the application of NPKSZn was assumed to have the potential of achieving optimum crop yield under the given soil and crop management practices, while the other treatments which consisted of the elimination of one or more were expected to occur nutrient deficiency after certain crop cycles which was measured through yield loss. The T. Aman, 2005 crop was the 44th and Boro, 2006 was the 45th crop on a long term basis and the reverse application of a particular treatment was the 10th and 11th crop number.

N, P, K, S and Zn Fertilizers were used in the experimental field @ 100-25-34-20-25 kg/ha. Nitrogen as Urea was applied in three splits, one-third during land preparation and one-third at 30 days of transplanting i.e. at active tillering stage and rest one-third at 60 days of transplanting i.e. maximum tillering stage [30].

30 days-old plant were nurtured for transplanting. Water was supplied in the nursery regularly [31]. The uprooted seedlings were graded and thereafter healthy and equal sized seedlings were selected for transplanting [32]. The seedlings were transplanted in the experimental plots on 18 July 2018. Plant spacing was 20 cm × 20 cm.

The number of rows and hill plot-1 were equal in all plots [33]. Diazinon 60 EC was used to protect insects [34].

2. 5. Data Collection

To calculate the dry matter production. straw was harvested from randomly selected consecutively four hills of each plot at active tillering stage (30 DAT) and at maximum tillering stage (60 DAT).The straw collected at different tillering stages was dried in the oven at 65-70 °C and weighed to record the final dry matter production plot-1 and then converted to t ha^{-1}.

Consecutively four hills were randomly selected from each plot and panicle number m-2 was calculated respectively for each plot. The crop was harvested on 14 November. 2007 plot wise. The harvested crop was then threshed. Dry weight of grain yield was calculated in t ha^{-1}.

Total nitrogen of soil was estimated by Micro-Kjeldahl method where soil was digested with 30% H_2O, conc. H_2SO_4 and catalyst mixture (K_2SO_4; $CuSO_4$. H_2O; Se powder in the ratio 100: 10: 1). Nitrogen in the digest was estimated by distillation with 40% NaOH followed by titration of the distillate trapped in H3B03 with 0.01 N H_2SO_4. P was determined by using 0.5 M $NaHCO_3$ solution at pH 8.5 according to Olsen method [35].

Exchangeable potassium of soil was determined with 1 N NH_4OAc (pH 7.0) extract of the soil in Flame Photometer at 766.5 nm wavelength. S was calculated by using 0.15% $CaCl_2$ solution. The S content in the extract was determined turbid metrically and the intensity of turbidity was measured by spectrophotometer at 420 nm wavelength [36]. Zn was calculated by using spectrophotometer at 213.8 nm wave length.

The representative straw were dried at 60 °C for 2 days and grinded by machine. Exactly 0.1 g of oven dry ground plant sample (straw) collected at active and maximum tillering stages was taken in a microkjeldahl flask. 1.1 g of catalyst mixture (K_2SO_4; $CuSO_4 \cdot 5H_2O$; Se = 100: 10: 1). 2 ml of 30% H_2O and 3 ml concentrated H_2SO_4 added and heated until the digest become clear and colorless. After cooling, the digest was transferred into a 100 ml volumetric flask and volume was made up to the mark with distilled water.

About 0.5 gm of oven dry ground plant sample (straw) collected at active and maximum tillering stage was taken in a microkjeldahl flask. 5 ml of di-acid mixture (HNO_3 and $HClO_4$ in the ratio 2:1) was added into the flask and kept for some time. Then the flask was heated at a temperature gradually raised to 200 °C in Hot plate. The digest was used for the determination of P, K, S and Zn. Phosphorus content was determined as done in soil analysis by using 2ml of digest from 50 ml extract. Potassium content was determined by using 5 ml the plant extract directly with Flame photometer at 766.5 nm wavelength. Sulphur content was determined as done in soil analysis by using 5 ml of digest from 50 ml extract and 5 ml distilled water. Zinc content was determined by using 5 ml of digest from 50 ml plant extract and reading was taken using atomic absorption spectrophotometer at 213.8 nm wave-length.

2. 6. Statistical Analysis

The statistical analysis of variance for nutrient content and uptake at both stages (active and maximum) and panicle no. m-2 and grain yield were done based on ANOVA technique and F-value test.

3. RESULTS AND DISCUSSION

This field experiment was carried out to study the effect of N, P, K, S and Zn fertilizers on the growth and yield components of BR 11 and BRRI dhan 31. The growth and yield components included dry matter production, nutrient content and nutrient uptake at active and maximum tillering stages, panicle number m-2 and grain yield. The dry matter production obtained at 30 DAT with Reverse Complete (Table 1). When fertilizer added in reverse control plot, the production was significantly higher than complete treatments [37] and similar production level was also found with +N and +P treatments. Such dry matter increase might be the probable nutrient additive effect over complete fertilizer treatment.

Table 1. Different treatments on dry matter production of rice at active tillering stage (30 DAT)

Treatments	Dry matter production (t ha^{-1})
Complete treatment (+NPKSZn)	1.20b
Reverse complete (-NPKSZn)	l.00bc
+N(+PKSZn)	1.71a
-N(+PKSZn)	1.20b
+P(+NKSZn)	1.41ab
-P(+NKSZn)	1.26b
+K(+NPSZn)	1.23b
-K(+NPSZn)	1.15bc
Control	0.78c
Reverse Control (+NPKSZn)	1.69a
CV (%)	25.95

The N content of rice plant was lowest in fertilizer control treatment of both the varieties but the content at -N plot was comparatively higher due to other fertilizer applied (PKSZn) which might be the additive effect even this values were less than complete treatment [32]. The complete fertilizer treatment was always having higher N content in both the varieties meaning balance fertilization was created and congenial environment for plant favourable nitrogen uptake (Table 2).

The highest N content was found 3.05% in BR 11 with -P treatment which indicated the antagonistic effect between P and N. The lowest N content was found in control in both the varieties which was statistically similar to reverse complete treatment. In case of BRRI dhan 31 the highest was obtained with +N treatment which was statistically similar to complete, reverse control and –P treatment. Antagonistic effect was also found in BRRI dhan 31. Only treatment effect was significant. Application of either P or K in their respective sufficient plots significantly, increases their content than their respective P or K deficient plot. It meant application of deficient element in soil improved their nutrient content in plant which might help to obtain higher dry mater yield (Table 3). S and Zn content of rice plant at active tillering stage did not vary because of its higher availability in the soil (Sun, Mi, Su, Shan, & Wu, 2019).

Total nutrient uptake by rice plant at active tillering stage did not show any interaction between varieties and for this reason only treatment effect was presented in Table 5. The highest N uptake was 46.14 kg ha^{-1} which was found in reverse control treatment which was statistically similar with +N, +P. and –P treatments. Due to antagonistic relationship N uptake was high in

-P treatment. On the other hand, P, K. S and Zn uptakes were highest in case of +N treated plants which might be the results of nutrient additive effect.

Table 2. Treatments on nitrogen content (%) in rice plant at active tillering stage (30 DAT)

Treatments	N (%)	
	BR 11	BRRI dhan 31
Complete treatment (+NPKSZn)	2.33	2.68
Reverse complete (-NPKSZn)	2.12	2.22
+N(+PKSZn)	2.50	2.81
-N(+PKSZn)	2.27	2.43
+P(+NKSZn)	3.01	2.36
-P(+NKSZn)	3.05	2.70
+K(+NPSZn)	2.57	2.63
-K(+NPSZn)	2.46	2.47
Control	2.03	2.10
Reverse Control (+NPKSZn)	2.85	2.60
LSD(0.05)	0.23	
CV (%)	5.41	

The highest P uptake was 7.25 kg ha^{-1} which was found to be in agreement with the findings of BRRI. Obviously lowest uptake of all five nutrients was found in fertilizer control and -N. -P and -K treatments. In contrast, nutrient uptake in reverse control treatment gave statistically similar or little bit higher than continuously NPK fertilizer treatment i.e. complete treatment. When a soil fertilized with complete fertilizer, the plant response behavior was same as longer period fertilized plots in terms of dry matter production (Table 3) as well as nutrient uptake hints the previous assumption was that unfertilized soil cannot behave as continuously fertilized soil. It was not true as experimental results were found. It meant when an unfertilized soil fertilized with balance fertilizer dose, the response behavior may reach same as continuously fertilized soil [38]. With the advancement of rice plant as significant interaction effect on dry matter production between treatment and varieties was observed. The addition of omitted nutrient in their respective plot drastically increased the dry matter yield at maximum tillering stage of both varieties, but the rate of increase was comparatively higher with BR 11.

It meant BR 11 was more responsive than BRRI dhan 31. At this stage N and K showed interaction effect in rice plant.

Table 3. Effect of different treatments on total nutrient uptake in rice plant at active tillering stage (30 DAT)

Treatments	N (kg ha^{-1})	P (kg ha^{-1})	K (kg ha^{-1})	S (kg ha^{-1})	Zn (kg ha^{-1})
Complete treatment (+NPKSZn)	29.83 bed	4.72 bed	14.77 b	2.65 be	48.01bede
Reverse complete (-NPKSZn)	24.77cd	3.25 ede	11.80 be	2.05 cd	37.26de
+N(+PKSZn)	44.72a	7.25 a	20.37 a	3.73 a	64.81 ab
-N(+PKSZn)	28.28 bed	4.17 ede	15.67 ab	2.53 be	43.80 ede
+P(+NKSZn)	37.45ab	5.18 be	15.45 ab	2.98 abc	60.10 abc
-P(+NKSZn)	36.23abc	3.06 de	14.47 b	2.63 be	54.36 abed
+K(+NPSZn)	32.13bc	5.22 be	14.27 b	2.68 be	56.73 abed
-K(+NPSZn)	28.34 bed	4.88 bed	8.167 c	2.45 bed	51.12 abed
Control	19.98 d	2.53 e	8.000 c	1.55 d	30.84 e
Reverse Control (+NPKSZn)	46.14 a	6.57 ab	20.33 a	3.32 ab	68.11 a
CV (%)	27.34	32.58	28.76	28.09	28.76

Table 4 showed that the N content of BRRI dhan 31 was comparatively higher than BR 11 in most of the treatments, but in case of K content some of the treatments were less than that of BR 11. Such effect might be the cause of dry mater yield variation between varieties i.e. dilution effect and for this reasons in total nutrient uptake such interaction effect was not observed. Here only treatment effect was significant (Table 4). The nutrient uptake behavior followed the same trend as active tillering stage (Table 4). Significant interaction effect of treatment and varieties were observed on panicle number m-2 and grain yield during T. Aman season. Application of N, K or complete fertilizer significantly increases the panicle no. m-2 of BR 11 than BRRI dhan 31 indicating BR1 1 is a fertilizer responsive variety than BRRI dhan 31. However the addition of omitted nutrient in their respective plot increases panicle number than their respective minus plot. In other words, the mode of response behavior to increase panicle no. m-2 of both the varieties was similar in case of grain yield in fertilized condition (Table 5). BR11 gave a little bit higher yield than that of BRRI dhan 31.

The striking feature was that in P deficient condition BRRI dhan 31 gave significantly lower yield than BR 11 and in K deficient condition BR11 gave lowest yield than BRRI dhan 31. From these results it may be concluded that BR 11 was more sensitive to K deficient condition whereas, BRRI dhan 31 was more sensitive to P deficient condition. So, care should be taken if someone cultivate these two varieties in field condition, otherwise they will get low yield (Table 6).

Table 4. Treatments on dry matter production (t ha^{-1}) of rice plants at maximum tillering stage (60 DAT).

Treatments	Dry matter production (tha-1)	
	BR 11	BRRI dhan 31
Complete treatment (+NPKSZn)	3.13	2.57
Reverse complete (-NPKSZn)	2.70	2.07
+N(+PKSZn)	2.90	3.23
-N(+PKSZn)	2.10	2.80
+P(+NKSZn)	2.83	3.06
-P(+NKSZn)	1.87	2.27
+K(+NPSZn)	3.03	3.23
-K(+NPSZn)	2.60	2.03
Control	1.83	1.43
Reverse Control (+NPKSZn)	3.07	3.00
LSD(o.o5)	0.96	
CV (%)	22.37	

Table 5. Treatments on nitrogen and potassium contents in rice at maximum tillering stage (60 DAT)

Treatments	N(%)		K (%)	
	BR 11	BRRI dhan 31	BR 11	BRRI dhan 31
Complete treatment (+NPKSZn)	1.66	1.72	1.41	1.40
Reverse complete (-NPKSZn)	1.56	1.29	1.31	0.99
+N(+PKSZn)	1.62	1.89	1.28	1.50

-N(+PKSZn)	1.52	1.40	1.53	1.09
+P(+NKSZn)	1.56	1.63	1.17	1.19
-P(+NKSZn)	0.69	1.58	1.53	0.95
+K(+NPSZn)	1.62	1.65	1.20	1.07
-K(-t-NPSZn)	1.57	1.85	1.07	0.85
Control	1.59	1.52	1.39	1.20
Reverse Control (+NPKSZn)	1.61	1.78	1.44	1.36
1-SD) 0.05)	0.12		0.29	
CV (%)	4.49		14.06	

Table 6. Different treatments on phosphorus, sulphur and zinc contents in rice at maximum tillering stage (60 DAT).

Treatments	P (%)	S (%)	Zn (µgg-1)
Complete treatment (+NPKSZn)	0.26abc	0.22a	67.50a
Reverse complete (-NPKSZn)	0.27ab	0.23a	60.50a
+N(+PKSZn)	0.31a	0.24a	60.50a
-N(+PKSZn)	0.28ab	0.23a	53.50a
+P(+NKSZn)	0.31a	0.26a	64.00a
-P(+NKSZn)	0.21c	0.21a	60.50a
+K(+NPSZn)	0.29ab	0.25a	67.50a
-K(+NPSZn)	0.29ab	0.23a	57.00a
Control	0.24bc	0.22a	46.50a
Reverse Control (+NPKSZn)	0.30ab	0.21a	60.50a
CV (%)	15.99	15.75	29.91

The striking feature was that in P deficient condition BRRI dhan 31 gave significantly lower yield than BR 11 and in K deficient condition BR11 gave lowest yield than BRRI dhan 31. From these results it may be concluded that BR 11 was more sensitive to K deficient condition whereas, BRRI dhan 31 was more sensitive to P deficient condition. So, care should be taken if someone cultivate these two varieties in field condition, otherwise they will get low yield (Table 6).

Table 7. Different treatments on total nutrient uptake at maximum tillering stage (60 DAT)

Treatments	N (kg ha^{-1})	P (kg ha^{-1})	K (kg ha^{-1})	S (kg ha^{-1})	Zn (g ha^{-1})
Complete treatment (+NPKSZn)	48.18 ab	7.45 abc	40.00 ab	6.11 abed	186.8 ab
Reverse complete (-NPKSZn)	34.27 de	6.45 c	27.79 bed	5.61 bede	143.2 abc
+N(+PKSZn)	54.31 a	9.49 a	43.70 a	7.27 abc	185.0 ab
-N(+PKSZn)	35.69 cde	6.88 be	32.40 abed	5.62 bede	135.0 be
+P(+NKSZn)	47.09 abc	9.11 ab	35.09 abc	7.48 ab	191.3 ab
-P(+NKSZn)	24.20 e	4.19 d	25.09 cd	4.27 de	123.8 be
+K(+NPSZn)	50.84 ab	9.29 ab	34.89 abc	7.92 a	213.5a
-K(+NPSZn)	39.59 bed	6.87 be	22.30 cd	5.19 cde	125.3 be
Control	25.41 e	4.05 d	21.29 d	3. 73 e	72.50 c
Reverse Control (+NPKSZn)	51.25 ab	9.08 ab	41.72 a	6.40 abed	186.2 ab
CV (%)	23.71	25.95	30.46	27.73	37.59

The results on the correlation of total nutrient uptake, dry matter, panicle no. m-2 and grain yield of both the varieties (BR 11 and BRRI dhan 31) at active tillering stage was shown in Table 7. The Table shows significant positive correlation between N and K uptake in both the varieties.

Correlation was found to be significant between dry matter and N uptake, dry matter and N uptake in both the varieties, but panicle no. m -2 was found to be significantly correlated with P uptake only in BR 11. Grain yield was significantly correlated with K uptake in both the varieties at active tillering stage. It showed significant correlation between N and P, P and K and between dry matter production and K uptake in BR 11 at maximum tillering stage. Significant correlation was also found between panicle no. m-2 and N, P uptakes.

Grain yield was only significantly correlated with K uptake and dry matter yield in BR 11. In case of BRRI dhan 31, N was positively related to production (Table 8) [39].

When fertilizer was added in reverse control plot the yield was significantly higher [40] than complete treatment and similar yield level was also found in +N and +P treatments [41]. The highest N content (3.05 t ha^{-1}) was obtained with -P treatment which was the result of antagonistic effect in BR 11 and in BRRI dhan 31. Highest N content (2.81 t ha^{-1}) was obtained with +N treatment. The lowest N content was obtained with reverse complete and control treatments in both the varieties. However, minimum intake of essential nutrients was seen in control, reverse complete and each of the -N, -P and -K application [42]. The interaction effect on dry matter production was found significant between varieties. The addition of element (N and K) increased the dry matter production significantly than the omitted element [43-47]. The nutrient uptake behavior at maximum tillering stage was similar as that of active tillering stage. Significant effect of NPKSZn fertilizers on panicle number m^{-2} and grain yield was found in both the varieties and significant interaction effect was found between varieties as well. BR 11 was found more responsive than BRRI dhan 31 when N, K and complete fertilizers were applied. The most important feature was that in P deficient condition BRRI dhan 31 gave lower yield than BR 11. On the other hand, in K deficient condition BR 11 gave lower yield than BRRI dhan 31.

Table 8. Different treatments on panicle on number m -2 and grain yield of BR 11 and BRRI dhan 31.

Treatments	Panicle no. m-2		Grain yield (t ha^{-1})	
	BR 11	BRRI dhan 31	BR 11	BRRI dhan 31
Complete treatment (+NPKSZn)	239	203	3.53	3.27
Reverse complete (-NPKSZn)	175	175	2.90	2.83
+N(+PKSZn)	228	172	3.37	3.03
-N(+PKSZn)	214	159	2.83	2.80
+P(+NKSZn)	220	213	3.40	3.03
-P(+NKSZn)	205	183	3.27	2.87
+K(+NPSZn)	241	184	3.23	3.00
-K(+NPSZn)	248	180	1.83	2.47
Control	192	173	2.13	2.47
Reverse Control (+NPKSZn)	241	180	3.23	3.13
LSD(0.05)	21		0.42	
CV (%)	10.06		8.17	

4. CONCLUSION

The highest dry matter was obtained with +N treatment at active tillering stage (30 DAT). The reverse control treatment gave higher dry matter production compared to complete treatment. Nitrogen content at active tillering stage was found to be highest with –P treatment in case of BR 11 which might be better to conclude as antagonistic effect between P and N. BRRI dhan 31 showed the same trend. Interaction effect was not significant in case of P. K. S and Zn contents between the varieties at active tillering stage. Application of P and K increased their contents compared to their respective deficient plots indicating positive interaction effect of nutrients. S and Zn contents did not respond to the treatments because of their higher availability in experimental soil. In case of total nutrient uptake, interaction between varieties was non-significant. The highest nutrient uptake was observed in reverse control so as in +N treated plot. This incident established the fact that when a soil is fertilized with fertilizer, it can respond same as soil which is fertilized for a longer period. Total nutrient uptake at maximum tillering stage showed the same trend as that of an active tillering stage. Al maximum tillering stage (60 DAT), dry matter production of both the varieties increased compared Io that at active tillering stage. Dry matter production of BR 11 was higher than that of BRR1 dhan 31 which made BR 11 superior to BRR1 dhan 31. Interaction between varieties was found to be significant in case of N and K contents at maximum tillering stage. Positive effect was found in reverse and complete treatments because of nutrient additive effect. But K content was antagonistic with -N treatment. BR 11 was found more sensitive to K deficient condition whereas BRRI dhan 31 was more sensitive to P deficient condition. Grain yield was found directly correlated with K uptake in both the varieties i.e. if K uptake increases in rice plants, grain yield will be increased.

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