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Applied on Various Inorganic Fertilizers in Soil and to Evaluate the Effect of Nutrient Content and Uptake of T. Aman Rice (BRRI dhan49)

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Abstract: The experiment was conducted at the research field of Bangladesh Rice Research Institute (BRRI), Gazipur during Aman season of 2012 in applied on various inorganic fertilizers in soil and to evaluate the effect of nutrient content and uptake of T. Aman rice. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. There were seven treatments such as control, Recommended Fertilizer Dose (RFD), 50% reduced rate of N, 50% reduced rate of P, 50% reduced rate of K, 50% reduced rate of S and 50% reduced rate of Zn. The highest grain yield of 6.16 t ha^{-1} was observed in the treatment 50% reduced rate of N which was statistically identical to those recorded in the treatments 100% recommended fertilizer dose and 50% reduced rate of P. effective tillers hill^{-1}, filled grains panicle^{-1}, 1000-grains weight had also higher in the treatment T_3 and unfilled grains panicle^{-1} lower in the treatment T_3. However, plant height and panicle length had higher in 50% reduced rate of P. It was observed that application of 50% reduction of N fertilizers from RFD affected non-significantly both in yield contributing traits, nutrient content and nutrient uptake by grain and straw of BRRI dhan49 compared to RFD. Grain yield was increased with increasing nutrient uptake by BRRI dhan49. Therefore, the treatment 50% reduced rate of N fertilizer performed better than RFD and other treatments.

Key words: Inorganic fertilizer · Yield · Nutrient content · Nutrient uptake

INTRODUCTION

Rice (*Oryza sativa* L.) is the leading cereal crop in the world and staple food crop in Bangladesh. Rice, as the single most important human energy source, feeds about half of the world's population [1]. A crop production system with high yield targets cannot be sustainable unless nutrient inputs to soil are at least balanced against nutrient removal by crops [2, 3]. Proper soil fertility management, therefore, is one of the prime importance's in an endeavor to increase crop productivity. Available data indicated that the fertility of most of our soils has deteriorated over the years [4, 5], which is responsible for stagnating and in some cases; even declining crop yields [6, 7]. Soil is the principal supplier of plant nutrients. Plant derives 13 essential nutrients out of 17 from the soil. In most soils in Bangladesh, severe deficiency of nutrients like N, P and K has been indentified [8, 9, 10]. A few years back the deficiency of S, Zn and B have also been found in some soil in the country whose area is increasing day by day [11-15]. Fertilizers are essential parts of modern farming, with about 50% of the world's production being attributed to fertilizer use [16]. During the past few years, total fertilizer nutrient use in Bangladesh has remained static [17]. A further increase in fertilizer use has to occur in those countries including Bangladesh where more production has to be realized from the limited areas of land.

Even the most fertile soils can do so only for certain years and finally shows nutrient deficiency. Nitrogen, phosphorus and potassium are the primary macronutrients and can play key roles to increase the production of rice to a great extent. Nitrogen has a positive influence on growth, yield and yield components

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of rice process of photosynthesis, N-fixation, flowering, fruiting and maturation. Nitrogen is the nutrient element limiting growth in most of the rice soils [18] and there have been indications that many rice soils of Bangladesh are becoming deficient in P, K, S and Zn [19]. Phosphorus is widely deficient in Bangladesh soils. The decline in productivity of rice deficiency of P, K, S, Zn and imbalanced nutrition [20,21]. Potassium is one of the primary nutrient elements for plant. Potassium is necessary for several basic physiological functions, such as the synthesis of protein and starch, normal cell division and growth [22]. Its deficiency may greatly reduce crop yield. Continuous application of chemical fertilizers accelerates the depletion of soil organic matter and impairs physical and chemical properties of soil in addition to micronutrient deficiencies. The actual recommended rates of N, P, K, S and Zn not only maintain soil health for sustainable agriculture but also save part of the cost of crop production. Considering the above points, the present study was undertaken to find out the effects of reduced rates of N, P, K, S and Zn on the nutrient content and uptake by BRRI dhan49.

MATERIALS AND METHODS

The experiment was conducted at the west beyd of BRRI farm, Gazipur during the period of Aman season of 2012. The area belongs to the Agro-ecological Zone (AEZ- 28) Madhupur Tract. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. The soil of the experimental field was silty clay loam in texture and neutral in reaction. Organic C, total N, available P (Modified Olsen's) and exchangeable K (N NH_4OAc) of the soil were 1.45%, 0.10%, 13 ppm and 0.23 meq/100 g soil, respectively. The available S (calcium dihydrogenphosphate) and Zn (DTPA) were 20 ppm and 5 ppm, respectively. The climate of the experimental site is sub-tropical, wet and humid. There were 21 (7 x 3) unit plots. The unit plot size was 2.5 m x 4 m. The spacing between blocks was 1m and between plots was 0.5 m. The treatments were randomly distributed to unit plots in each block. Twenty five day old seedlings were transplanted in the experimental plots on 20 August 2012. A distance of 20 cm from row to row and 20 cm from plant to plant was maintained. Two seedlings were used in each hill. The crops were harvested at a time due to 80% maturity of grains.

Treatments: There were 7 treatments including one control treatment. The treatment combinations for the experiment were as follows:

T_1:	Control
T_2:	Recommended fertilizer dose (RFD)
T_3:	RFD -50% N
T_4:	RFD- 50% P
T_5:	RFD -50% K
T_6:	RFD -50% S
T_7:	RFD -50% Zn

Recommended Fertilizer Dose (RFD) = 100 kg N ha^{-1}, 15 kg P ha^{-1}, 50 kg K ha^{-1}, 15 kg S ha^{-1} and 1.5 kg Zn ha^{-1}.

The sources of N, P, K, S and Zn nutrients were Urea, MoP, Gypsum and Zinc sulphate, respectively.

RESULTS AND DISCUSSION

The present study was conducted to determine the effect of 50% reduced rate of N, P, K, S and Zn on different yield and yield contributing characters of high yielding rice variety namely BRRI dhan49.

Yield and Yield Contributing Character of BRRI Dhan49: Yield and yield contributing characters such as plant height (cm), number of effective tillers $hill^{-1}$, panicle length (cm), filled and unfilled grains $panicle^{-1}$, 1000–grain weight (g), grain yield (t ha^{-1}) and straw yield (t ha^{-1}) were recorded at the time of harvest and the detailed results are described under the following sub–headings:

Plant Height: Plant height varied from 54.13 cm in T_1 (control) to 81.37 cm in T_4 (50% reduced rate of P). The tallest plant (81.37 cm) was recorded in the treatment T_4 (50% reduced rate of P) which was statistically similar with all other treatments (T_2, T_3, T_5, T_6, T_7), except control (T_1) (54.13 cm) with the values of 79.90, 80.27, 76.80, 78.70 and 78.43 cm, respectively (Table 1). Plant height is a key yield contributing trait since grain yield is also directly related with straw yield. The results are also in agreement with the findings of Moreno *et al*. [23] and Mishra *et al*. [24].

Number of Effective Tillers $Hill^{-1}$: The maximum number of effective tillers $hill^{-1}$ (9.333) was found from the both T_2 (100% recommended dose) and T_3 (50% reduced rate of N) which was statistically similar to those recorded in the all other treatments except $T_{1\,(}$ control) (7.13) (Table 1). There was a significant effect of different fertilizer treatments on the production of effective tillers $hill^{-1}$ of BRRI dhan49. Similar results were also obtained by Balakrisnan and Natarajaratnan [25].

Length of Panicle: Among the treatments, the longest panicle (22.70 cm) was observed in 50% reduced rate of P (T_4) which was statistically identical (22.27 cm) to that the treatment T_3 (50% reduced rate of N) and closely followed (22.13 cm) by T_6 (50% reduced rate of S) (Table 1).

Table 1: Effects of reduced rates of fertilizers on the morphological and yield contributing characters of BRRI dhan49

Treatment	Plant height (cm)	Number of effective tillers hill^{-1}	Panicle length (cm)	Number of filled grains panicle^{-1}	Number of unfilled grains panicle^{-1}	1000- grain weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})
T_1	54.13 b	7.133 b	16.90 d	61.70 b	13.17 a	27.70 d	3.070 c	4.390 d
T_2	79.90 a	9.333 a	21.07 bc	93.63 a	10.17 c	30.87 bc	5.010 a	6.450 a
T_3	80.27 a	9.333 a	22.27 a	95.77 a	9.500 c	33.20 a	5.160 a	6.300 a
T_4	81.37 a	9.033 a	22.70 a	94.93 a	11.17 bc	32.50 a	5.090 a	6.370 a
T_5	76.80 a	8.767 a	20.77 c	85.57 a	12.33 ab	30.57 c	4.000 b	5.030 c
T_6	78.70 a	9.233 a	22.13 ab	89.60 a	12.47 ab	29.93 ab	4.130 b	5.590 b
T_7	78.43 a	9.200 a	20.73 c	93.67 a	13.03 ab	30.53 c	4.020 b	5.410 bc
SE(±)	3.63	0.30	0.74	4.56	0.54	0.40	0.29	0.30

Figures in a column having common letters do not differ significantly at 5% level of significance

SE = Standard error of means

T_1: Control

T_2: 100% recommended dose (RD)

T_3: 50% reduced rate of N

T_4: 50% reduced rate of P

T_5: 50% reduced rate of K

T_6: 50% reduced rate of S

T_7: 50% reduced rate of Zn

Number of Filled Grains Panicle^{-1}: The maximum number of filled grains panicle^{-1} (95.77) was found in the treatment T_3 (50% reduced rate of N) which was statistically similar to those recorded in the treatments T_2: 100% recommended dose (93.63), T_4: 50% reduced rate of P (94.93), T_5: 50% reduced rate of K (95.57), T_6: 50% reduced rate of S (89.60) and T_7: 50% reduced rate of Zn (93.67) Table 1. The lowest number of filled grains panicle^{-1} (61.70) was found in the treatment T_1 (control). Analysis of variance data on number of filled grains panicle^{-1} of BRRI dhan49 showed significant differences due to the effect of reduced rate of fertilizers supplied. These results were supported by the findings of Mondal *et al*. [9] and Halder *et al*. [26].

Number of Unfilled Grains Panicle^{-1}: The maximum number of unfilled grains panicle^{-1} (13.17) was produced by the treatment T_1 (control). It was indicated that no use of fertilizers produces the highest number of unfilled grains. The lowest number of unfilled grains panicle^{-1} (9.50) was produced by the treatment T_3 (50% reduced rate of N) which was statistically identical with T_2 (100% recommended fertilizer dose) and closely (11.17) followed by T_4 (50% reduced rate of P) (Table 1).

Thousand-Grain Weight: Analysis of variance of data showed significant variation regarding thousand–grain weight which was shown in Table 1. All the treatments showed increased 1000–grain weight over control. The highest 1000–grain weight (33.20 g) was recorded from T_3 (50% reduced rate of N), while the lowest 1000–grain weight (27.70 g) was obtained in the treatment T_1 (control) (Table 1).

Grain Yield (t ha^{-1}): The highest grain yield (5.16 t ha^{-1} which was 68.08% higher increase over control) was obtained in the treatment T_3 (50% reduced rate of N) (Table 1). The lowest grain yield (3.07 t ha^{-1}) was obtained in the control (T_1) (Table 1). This implies that these nutrients had significant role on grain yield. The highest percentage (68.08%) of increased grain yield over control was recorded in the treatment T_3 (50% reduced rate of N). The lowest percentage (30.94%) of increased grain yield over control was recorded in the treatment T_7 (50% reduced rate of Zn). The grain yield for either kg or t ha^{-1} obtained from different treatments ranked in the order of T_3> T_4> T_2> T_6> T_7> T_5> T_1. The results revealed that 50% reduced rate of N was more pronounced in producing more grain yield than other treatments under study.

Straw Yield (t ha^{-1}): All the treatments gave higher straw yield over control (Table 1). It was observed that the treatments T_2 (100% recommended fertilizer dose) gave the highest straw yield (6.45 t ha^{-1}). The lowest straw yield (4.39 t ha^{-1}) was recorded in the treatment T_1 (control). The highest percentage (46.92%) of increased straw yield over control was noted in the treatment T_2 (100% recommended fertilizer dose). The lowest percentage (14.58%) of increased straw yield over control was recorded in the treatment T_5 (50% reduced rate of K). The straw yield due to different treatments ranked in the order of T_2> T_4> T_3> T_6> T_7> T_5> T_1. The results revealed that 100% recommended fertilizer dose was more pronounced in producing more straw yield than other treatments under study.

Table 2: Effects of reduced rates of fertilizers on N, P, K, S content and uptake by BRRI dhan49

	N content (%)		N uptake (kg ha^{-1})		
Treatments	Grain	Straw		Grain	Straw
T_1	0.827 d	0.4233 c	25.40 d	18.61 c	44.01 e
T_2	1.153 a	0.6400 ab	57.78 a	41.27 a	99.04 a
T_3	1.180 a	0.6700 a	60.88 a	42.18 a	103.1 a
T_4	1.183 a	0.6133 ab	60.21 a	39.07 a	99.28 a
T_5	0.877 cd	0.4200 c	35.08 c	21.14 c	56.21 d
T_6	1.013 b	0.5633 ab	41.80 b	31.52 b	73.32 b
T_7	0.910 c	0.5367 b	36.59 c	29.03 b	65.62 c
SE(±)	0.06	0.04	5.37	3.60	8.90
	P content (%)		P uptake (kg ha^{-1})		
Treatments	Grain	Straw	Grain	Straw	Total
T_1	0.157 e	0.1667 b	4.800 d	7.297 d	12.10 e
T_2	0.207 bc	0.2500 a	10.35 a	16.12 a	26.47 a
T_3	0.190 cd	0.1833 b	9.803 a	11.57 bc	21.37 bc
T_4	0.210 b	0.1867 b	10.70 a	11.89 b	22.59 b
T_5	0.177 d	0.1567 b	7.073 c	7.880 d	14.95 de
T_6	0.230 a	0.1533 b	9.497 ab	8.587 cd	18.08 cd
T_7	0.197 bc	0.1733 b	7.907 bc	9.393 bcd	17.30 d
SE(±)	0.01	0.01	0.80	1.16	1.84
	K content (%)		K uptake (kg ha^{-1})		
Treatments	Grain	Straw	Grain	Straw	Total
T_1	0.147 b	0.677 c	4.500 c	29.68 d	34.18 d
T_2	0.270 a	0.773 ab	13.53 a	49.87 a	63.39 a
T_3	0.253 a	0.807 a	13.07 a	50.82 a	63.88 a
T_4	0.250 a	0.750 ab	12.74 a	47.78 a	60.51 a
T_5	0.220 a	0.713 bc	8.820 b	35.89 c	44.71 c
T_6	0.210 a	0.730 bc	8.650 b	40.79 b	49.44 b
T_7	0.227 a	0.717 bc	9.117 b	38.77 bc	47.89 bc
SE(±)	0.02	0.02	1.23	2.98	4.19
	S content (%)		S uptake (kg ha^{-1})		
Treatments	Grain	Straw	Grain	Straw	Total
T_1	0.100 c	0.077 bc	3.067 e	3.353 d	6.420 d
T_2	0.127 ab	0.077 bc	6.343 b	4.943 b	11.29 b
T_3	0.127 ab	0.133 a	6.537 b	8.410 a	14.95 a
T_4	0.143 a	0.073 bc	7.290 a	4.670 bc	11.96 b
T_5	0.123 b	0.090 b	4.923 cd	4.530 bc	9.453 c
T_6	0.110 bc	0.070 c	4.540 d	3.907 cd	8.447 c
T_7	0.127 ab	0.070 c	5.090 c	3.793 cd	8.883 c
SE(±)	0.01	0.01	0.54	0.64	0.95
	Zn content (%)		Zn uptake (kg ha^{-1})		
Treatments	Grain	Straw	Grain	Straw	Total
T_1	0.050 b	0.040 ab	1.537 d	1.753 c	3.287 d
T_2	0.060 ab	0.050 ab	3.007 a	3.223 a	6.227 a
T_3	0.050 b	0.053 a	2.577 b	3.367 a	5.943 a
T_4	0.060 ab	0.040 ab	3.057 a	2.550 b	5.603 ab
T_5	0.057 ab	0.050 ab	2.260 c	2.520 b	4.780 bc
T_6	0.053 ab	0.047 ab	2.210 c	2.610 b	4.823 bc
T_7	0.070 a	0.033 b	2.817 ab	1.800 c	4.617 c
SE(±)	0.001	0.001	0.20	0.24	0.38

Figures in a column having common letters do not differ significantly at 5% level of significance

Nutrient Content and Uptake in Grain and Straw

Nitrogen Content and Uptake

Nitrogen Content: Nitrogen content in grain varied from 0.827 to 1.183% (Table 2). The treatment T_4 (50% reduced rate of P) resulted in the maximum N content in grain (1.183%). The minimum content of N (0.827%) was recorded in the control (T_1). The N content in straw due to different fertilizer reduced treatments ranged from 0.4233 to 0.6700% (Table 2). The highest N content value (0.6700%) was found in the treatment T_3 (50 reduced rate of N). The lowest N content value (0.4200%) was observed in T_7 (50% reduced rate of Zn). These results revealed that the 50% reduced rate of P and N increased N content in the grain and straw of BRRI dhan49.

Nitrogen Uptake: The N uptake by grain varied from 25.40 to 60.88 kg ha^{-1} (Table 2).The highest N uptake (60.88 kg ha^{-1}) by grain was recorded in the treatment T_3 (50% reduced rate of N). The lowest N uptake (25.40 kg ha^{-1}) by grain was obtained in the treatment T_1 (control). In straw, the N uptake ranged from 18.61 to 42.18 kg ha^{-1} (Table 2). The highest N uptake (42.18 kg ha^{-1}) by straw was observed in the treatment T_3 (50% reduced rate of N). The lowest N uptake (18.61 kg ha^{-1}) by straw was recorded in the treatment T_1 (control). The uptake of total Nitrogen due to different treatments ranged from 44.01 to 103.10 kg ha^{-1} Table 2. The highest total N uptake (103.10 kg ha^{-1}) was recorded in the treatment T_3 (50% reduced rate of N). The lowest total uptake of N (44.01 kg ha^{-1}) was noted in the treatment T_1 (control) (Table 2).

Phosphorus Content and Uptake

Phosphorus Content: The P content in grain ranged from 0.157 to 0.230%. The highest P value (0.230%) was recorded in the treatment T_6 (50% reduced rate of S).The lowest P value (0.157%) was noted in the treatment T_1 (control). The phosphorus content in straw varied from 0.1533 to 0.2500% Table 2. The highest P value (0.2500%) was found in the treatment T_2 (100% recommended fertilizer dose).The lowest P value (0.1553%) was observed in the treatment T_6:(50% reduced rate of S) which was statistically similar to those recorded in all the treatments *viz.* T_1, T_3, T_4, T_5 and T_7 (0.1667, 0.1833, 0.1867, 0.1567 and 0.1733, respectively) except T_2: 100% recommended fertilizer dose (0.2500%). It indicated that 50% reduced rate of S in grain and 100% recommended fertilizer dose in straw had pronounced effect on P content. The phosphorus content in both grain and straw of BRRI dhan49 was significant by the effect of different treatments of inorganic fertilizer. Similar results were also obtained by Kadu *et al.* [27].

Phosphorus Uptake: The ranges of P uptake in grain were 1.800 to 10.700 kg ha^{-1}. The maximum P uptake (10.700 kg ha^{-1}) by grain was recorded in the treatment T_4 (50% reduced rate of N). The minimum P uptake (4.800 kg ha^{-1}) by grain was observed in the treatment T_1 (control). In case of straw, the P uptake varied from 7.297 to 16.12 kg ha^{-1} (Table 2). The highest P uptake in straw (16.12 kg ha^{-1}) was recorded in the treatment T_2 (100% recommended fertilizer dose). The lowest P uptake (7.297 kg ha^{-1}) was found in the treatment T_1 (control). The total P uptake by BRRI dhan49 varied from 12.10 to 26.47 kg ha^{-1}. The highest total P uptake (26.47 kg ha^{-1}) was recorded in the treatment T_2 (100% recommended fertilizer dose). The lowest value of total P uptake (120.10 kg ha^{-1}) was noted in the treatment T_1 (control).

Potassium Content and Uptake

Potassium Content: The P content in grain varied from 0.147 to 0.253%. The highest K content (0.253%) was found in the treatment T_3 (50% reduced rate of N). The lowest K content (0.147%) was recorded in the treatment T_1 (control). The K content in straw was varied from 0.677 to 0.807% Table 2. The highest K content in straw (0.807%) was found in the treatment T_3 (50% reduced rate of N). The lowest K content (0.677%) was observed in the treatment T_1 (control). It is also observed that K content in straw was higher than that of grains in all the treatments. It indicates that 50% reduced rate of N had pronounced effect on K content in both grain and straw. The results were also in agreement with the findings that K content in straw was higher than that of grains in all the treatments. It indicates that 50% reduced rate of N had pronounced effect on K content in both grain and straw of Sachdev *et al.* [28].

Potassium Uptake: The K uptake by grain was varied from 4.500 to 13.53 kg ha^{-1} (Table 2). The highest K uptake (13.53 kg ha^{-1}) by grain was noted in the treatment T_2(100% recommended fertilizer dose). The lowest uptake values of K (4.500 kg ha^{-1}) by grain were obtained in the treatment T_1 (control). In straw, uptake values of K ranged from 29.68 to 50.82 kg ha^{-1} (Table 2). The highest K uptake value of 50.82 kg ha^{-1} was observed in the treatment T_3(50% reduced rate of N). The lowest K uptake (29.68 kg ha^{-1}) by straw was obtained in the treatment T_1 (control). These result revealed that the K uptake by rice straw was much higher than that of K uptake by rice grain. The total K uptake ranged from 34.18 to 63.88 kg ha^{-1} (Table 2). The highest total K uptake (63.88 kg ha^{-1}) was observed in the treatment T_3 (50% reduced rate of N). The lowest total K uptake (34.18 kg ha^{-1}) was obtained in the treatment T_1 (control) which was statistically different from other fertilizer reduced treatments.

Sulphur Content and Uptake

Sulphur Content: Sulphur content in grain ranged from 0.100 to 0.143% (Table 2). The maximum S content (0.143%) in grain was found in the treatment T_4 (50% reduced rate of P). The lowest S content (0.100%) was recorded in the treatment T_1 (control). The highest S content (0.133%) was recorded in the treatment T_3 (50% reduced rate of N) which was statistically different from all other treatments. The lowest S content (0.070%) was noted in both the treatment T_6 (50% reduced rate of S) and T_7 (50% reduced rate of Zn). It indicates that 50% reduced rate of P and N had pronounced effect on S content in grain and straw, respectively but the smaller reduction of the fertilizers from the recommended fertilizer dose did not affect significantly in S content.

Sulphur Uptake: The S uptake in grain varied from 3.067 to 7.290 kg ha^{-1} (Table 2). The highest S uptake by grain (7.290 kg ha^{-1}) was obtained in the treatment T_4 (50% reduced rate of P). The lowest S uptake (3.067 kg ha^{-1}) by grain was observed in the treatment T_1 (control). In straw, S uptake ranged from 3.353 to 8.410 kg ha^{-1} (Table 2). The maximum S uptake (8.410 kg ha^{-1}) was observed in the treatment T_3 (50% reduced rate of N). The minimum S uptake (3.353 kg ha^{-1}) by straw was recorded in the treatment T_1 (control). In case of total S uptake, S uptake ranged from 6.420 to 14.95 kg ha^{-1} (Table 2). The maximum total S uptake (14.95 kg ha^{-1}) was recorded in the treatment T_3 (50% reduced rate of N). The lowest total S uptake (6.420 kg ha^{-1}) was observed in the treatment T_1 (control) Sakal [29] reported that concentration of S in grain and straw and its corresponding uptake was increased with increasing rates of sulphur.

Zinc Content and Uptake

Zink Content: The Zn content in grain was varied from 0.050 to 0.070% (Table 2). The highest Zn content (0.070%) was found in the treatment T_7 (50% reduced rate of Zn). The lowest Zn content (0.050%) was recorded in the treatment T_1 (control) which was statistically similar to those recorded in the treatment T_3: 50% reduced rate of N with similar value (0.050%). The Zn content in straw varied from 0.033 to 0.053% (Table 2). The highest Zn content in straw (0.053%) was found in the treatment T_3 (50% reduced rate of N). Similarly, the lowest Zn content in straw (0.033%) was observed in the treatment T_7

(50% reduced rate of Zn). It also indicates that 50% reduced rate of Zn and N had pronounced effect on K content in grain and straw, respectively. The results were also in agreement Zn content in grain and straw were more or less similar in all the treatments. It also indicates that 50% reduced rate of Zn and N had pronounced effect on K content in grain and straw, respectively. Zinc content in both grain and straw was affected significantly by the effect of different does of inorganic fertilizer treatments. The results were also in agreement with the findings of Sachdev *etal*. [25].

Zinc Uptake: The Zn uptake by grain varied from 1.537 to 3.057 kg ha^{-1} (Table 2). The highest Zn uptake (3.057 kg ha^{-1}) by grain was noted in the treatment T_4 (50% reduced rate of P). The lowest uptake value of Zn (1.537 kg ha^{-1}) by grain was obtained in the treatment T_1 (control). In straw, uptake values of Zn ranged from 1.753 to 3.367 kg ha^{-1} Table 2. The highest Zn uptake value of 3.367 kg ha^{-1} was observed in the treatment T_3 (50% reduced rate of N). The lowest Zn uptake (1.753 kg ha^{-1}) by straw was obtained in the treatment T_1 (control). Table 2 also indicated that the total Zn uptake ranged was from 3.287 to 5.643 kg ha^{-1}. The highest total Zn uptake (5.943 kg ha^{-1}) was observed in the treatment T_3 (50% reduced rate of N). The lowest total K uptake (3.287 kg ha^{-1}) was obtained in the treatment T_1 (control) which was statistically different from other fertilizer reduced treatments.

SUMMARY AND CONCLUSION

Yield contributing characters like plant height, effective tillers $hill^{-1}$, panicle length, filled and unfilled grains $panicle^{-1}$ and 1000-grains weight were significantly influenced by treatments on reduced fertilizer. Among the treatment, treatment T_4: produced the tallest plant (81.37 cm) and longest panicle (22.70 cm). The shortest plant and panicle were observed in the treatment T_1 (54.13 cm and 16.90 cm). Number of effective tillers $hill^{-1}$, filled grains $panicle^{-1}$ and 1000-grain weight was higher (9.33, 95.77 and 33.20 g, respectively) in the treatment T_3. Unfilled grains production observed the highest (13.17) in control and lowest (9.50) in T_3. The maximum grain yield (5.16 t ha^{-1}) was observed in the treatment T_3. The lowest grain yield (3.07 t ha^{-1}) was obtained in the control treatment T_1. The treatment T_4 gave the highest straw yield (6.37 t ha^{-1}) while it was statistically similar to those recorded in the treatments T_2 (6.45 t ha^{-1}) and T_3. The lowest straw yield (4.39 t ha^{-1}) was produced from the control treatment (T_1). In the experiment 50% reduced rate of N from recommended fertilizer dose performed better than other treatments.

The treatment T_4 gets the maximum N and S contents of grain (1.183 and 0.143%, respectively) while the minimum content values (0.827 and 0.100%, respectively) were recorded in the treatment T_1 (control). Nutrient content of P, K and Zn by grain had higher (0.239, 0.253 and 0.070%, respectively) were recorded in the treatments T_6, T_3 and T_7, respectively while they were lowest (0.157, 0.147 and 0.050%, respectively) in control treatment (T_1). Nutrient content of N, K, S and Zn by straw had also higher (0.6700, 0.807, 0.133 and 0.053%, respectively) were found in the treatment T_3 while treatment T_7: recorded the lowest content of S and Zn (0.0700 and 0.033%, respectively). The lowest nutrient content by straw of N (0.4200%) and K (0.677%) were observed in the treatments T_5 and T_1, respectively. Nutrient content by straw of P had higher (0.2500%) in T_2 and lowest (0.1533%) in T_6. The maximum P, S and Zn uptake by grain (10.700, 7.290 and 3.057 kg ha^{-1}, respectively) were recorded in the treatment T_4 where as the minimum uptake of them (1.800, 3.067 and 1.537 kg ha^{-1}, respectively) were recorded in the treatment T_1. However, treatment T_3 recorded the maximum uptake of N (60.88 kg ha^{-1}) and treatment T_2 observed the maximum uptake of K (13.53 kg ha^{-1}) by grain but they produced the lowest uptake (25.10 and 1.500 kg ha^{-1}, respectively) in the control (T_1). The highest nutrient uptake of P by straw and total (16.12 and 26.47 kg ha^{-1}) were found in T_2 while control treatment (T_1) showed the lowest nutrient uptake by straw and total (7.297 and 12.10%, respectively). A close relationship between nutrient uptake and grain yield was observed. Grain yield increased with increasing nutrient uptake by BRRI dhan49.

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