Original Research Article

Comparative performance of different fertilizer Recommendation methods on growth and yield of rice in Old Brahmaputra Floodplain soils

ABSTRACT

The experiment was conducted at the Soil Science Field Laboratory of Bangladesh Agricultural University, Mymensingh, Bangladesh from February 2020 to May 2020to study the comparative performance of different fertilizer recommendation methods in rice (BRRI dhan29) in Old Brahmaputra Floodplain Soils (AEZ 9). The experiment was laid out in a randomized complete block design with three replications. There were six treatments namely, T1 (Control-no fertilizer), T2 (Farmers' Practice), T3 (Fertilizer Recommendation Guide-2018), T4 (BAU Soil Testing Kit), T5 (Soil Test Basis) and T6 (Rice Crop Manager). The results revealed that all the treatments showed better performances over control (T1). Treatment T4 (BAU Soil Testing Kit) produced the highest value of plant height (90.18 cm), panicle length (24.90), filled grains panicle^{-1} (122.60) and 1000-grain weight (26.67g) while T5 (Soil Test Basis) produced maximum effective tillers hill^{-1} (12.80). The highest grain yield (6.29 t ha^{-1}) and straw yield (7.73 t ha^{-1}) were recorded in treatment T4 (BAU Soil Testing Kit). Treatment T4 (BAU Soil Testing Kit) also showed the highest grain yield increase (61.49%) and straw yield increase (90.49%) over control. The highest total N, P and K uptake (108.84 kg ha^{-1}, 24.54 kg ha^{-1} and 128.17 kg ha^{-1}) were obtained in the treatment T4 (BAU Soil Testing Kit). Control treatment T1 (No fertilizers) showed minimum performances in all the cases compared to other treatments. The overall result demonstrate that the application of NPK fertilizers following BAU Soil Testing Kit method of fertilizer application system is a better option for **maximum** and **eco-friendly**rice production.

Keywords: Fertilizer recommendation, methods, rice, Bangladesh

1. INTRODUCTION

Bangladesh is heavily reliant on intensive rice cultivation, ranking third globally in both area and production of rice. Rice serves as a staple for over three billion people worldwide. In 2019, Bangladesh produced 37.4 million tons of rice, contributing significantly to the national economy and food security. However, the country faces challenges such as a low average rice yield of 3.92 t ha^{-1} compared to other nations like China and Japan (FAO, 2014).

With an annual per capita consumption of 198 kg, rice is a vital commodity in Bangladesh, utilizing 84.67% of total cropped land. Despite the country's efforts to increase production to meet the growing population's demands, challenges such as diminishing cultivable land persist. Experts anticipate a potential increase in rice production to 46.7 million tons by 2050 (Kabir et al., 2021).

Comment [d1]: Include the scientific name of the crop.

Comment [d2]: The experimet must be two year to check the validaty of the research result.

Comment [d3]: Please calcualte the Economic Analysis to know the net return. To check the feasiblity of the research include the cost benefit analysis.

Comment [d4]: Why it can be eco-friendly ? You are appling chemical fertilizer ?? So, how it can be eco-friendly ??. Chemical have direct effect on enviroment and on soil. So, you haven't any evidence to say eco-friendly .

Comment [d5]: Please write about rice frist. Then write about world rice production and the write about Bangladesh rice production then write your stament of problem (fertlizer).

Fertilizer plays a crucial role in sustaining high crop production. But the heavy dependence on NPKS fertilizers pose environmental and food safety concerns. Continuous use accelerates soil degradation, affecting physical and chemical properties. Constituting 20% of rice production costs, fertilizer expenses prompt substantial government subsidies, reaching 119 billion Taka in 2012–2013 (MoF, 2015). Crop scientists around the world are searching for sustainable farming techniques to keep the soil healthy and decrease the amount of fertilizer needed for per kg of rice produced (Betteridge et al., 2008).

This study aims to compare different fertilizer recommendation methods to enhance **fertilizer use efficiency**, **preserve soil health, protect the environment,** and achieve maximum production in the current agricultural landscape of Bangladesh. The objectives include:

1. Compare fertilizer recommendation methods and identify the best.

2. Assess the impact of methods on rice growth and yield.

3. Examine the effect of different fertilizer treatments on nutrient uptake by the rice crop.

2. MATERIAL AND METHODS / EXPERIMENTAL DETAILS / METHODOLOGY

The experiment was conducted at Bangladesh Agricultural University's Soil Science Field Laboratory in Mymensingh (24.75º N latitude, 90.45º E longitude, 18.978m above the sea level) during the boro season (February-May, 2020) on BRRI dhan29, a widely used HYV boro rice variety in Bangladesh. The climate is sub-tropical with distinct seasonal variations. The soil, categorized as non-calcareous Dark Grey Floodplain under AEZ9, is moderately well-drained silt loam.

Land preparation involved ploughing, cross ploughing with a power tiller, and laddering. After levelling and puddling, experimental plots were arranged per treatments. Soil sampling, conducted at 0-15 cm depth before ploughing, produced composite samples from 10 spots in each plot. These samples underwent meticulous cleaning and were stored in plastic containers for subsequent physical and chemical analyses.

The experiment was comprised of six treatments including control.

T1: Control (No fertilizer)

T2: Farmers practice

T3: Fertilizer Recommendation Guide (FRG)-2018

T4: BAU soil testing kit

T5: Soil Test Basis (STB)

T6: Rice crop manager

Fertilizer rates of NPKS fertilizers for 10 m2 area following different recommendation methods are presented in table .1

Comment [d6]: It is not included in the result. Where did you calculate? It is quite different from nutrient up take. So, Calcualte it ??

Comment [d7]: **This objective is not clearly addresed in the result.**

Comment [d8]: **The soil analysis result must be included here. How much N, P, K,S amount have before planting in the soil?**

Comment [d9]: **So, include the soil physical and chemical analyses result.**

Table .1 Fertilizer rates of the treatments following different recommendation methods used for the experiment

Treatments	Name of the fertilizers				
	Urea (g 10 m^{-2} $split^{-1}$)	TSP (g 10 m^{-2})	MoP (g 10 m^{-2})	Gypsum (g 10 m^{-2})	ZnO (g 10 m^{-2})
T_1	0.00	0	0	0.00	0.00
T_2	82.00	100	86	61.00	0.00
T_3	103.68	105	120	44.40	1.92
T_4	130.00	20	226	44.40	1.92
T_5	135.00	35	180	94.00	1.92
T_6	90.00	80	36	31.00	1.30

Comment [d10]: Why you include this nutrient ?? Your objective **NPKS, not Zn**.

So, no need to include this nutrient.

Table .2 Nutrients and their sources used for the experiment

Nutrient	Sources
Nitrogen (N)	Urea
Phosphorus (P)	Triple super phosphate
Potassium (K)	Muriate of potash
Sulphur (S)	Gypsum

Seedlings of BRRI dhan29 rice were carefully uprooted from the seedbed before transplanting, with the transplantation occurring on February 13, 2020. Thirty-five-day-old seedlings were transplanted into the plots. The experiment employed a randomized complete block design with three replications, incorporating six treatments, including a control. Each block was subdivided into unit plots, resulting in a total of 18 plots. The unit plot size was 4×2.5 m, with 1 m spacing between blocks and 0.5 m between plots. To ensure proper crop growth, various intercultural operations were undertaken such as weeding, pest control, irrigation, drainage etc.

Harvesting occurred at full maturity, with crops bundled, threshed, cleaned, and processed. Grain and straw yields were recorded based on 14% moisture content. Sample analysis involved collecting 100 grams from each plot, oven drying, and grinding for chemical analysis. Various plant characteristics, including plant height, panicle length, number of effective tillers, number of filled grains per panicle, weight of 1000 grains, and grain and straw yields, were measured and recorded. After sun drying, straw and grain samples underwent digestion and analysis for nitrogen, phosphorus, potassium, and sulfur content using specified methods. To calculate nutrient uptake with grain and straw the following equation was used.

Comment [d11]: Good. But, Caculate the agronomic Effeciency ?

Nutrient uptake (kg ha-1) = (Gy x Ngr) /100 + (Sty x Nst)/100

Where,

Gy= Grain yield (kg ha^{-1}), Sty= Straw yield (kg ha^{-1}), Ngr= Nutrient content in grain (%), Nst = Nutrient content in Straw (%)

Data were analysed statistically by ANOVA to examine whether treatment effects were significant (Gomez and Gomez, 1984). Mean values were compared by **Duncan's Multiple Range Test (DMRT)**. Software package, Statistix10 was followed for statistical analysis.

Economic Analysis??

3. RESULTS AND DISCUSSION

Yield contributing characteristics of rice consists of plant height, effective tillers $hill^{-1}$, panicle length, filled grains $panicle^{-1}$, and 1000-grain weight. The effects of NPK fertilizers on the plant height of BRRI dhan29 has been ranked in order of $T_2 > T_6 > T_3 > T_4 > T_5 > T_1$, the number of effective tillers $hill^{-1}$ has been ranked in order of $T_5 > T_4 > T_3 > T_6 > T_2 > T_1$,panicle length has been ranked in order of $T_4 > T_6 > T_5 > T_3 > T_2 > T_1$, filled grains $panicle^{-1}$ has been ranked in the order of $T_4 > T_5 > T_3 > T_2 > T_6 > T_1$ and the values of 1000-grains weight for treatments T_1, T_2, T_3,T_4, T_5 and T_6 has been recorded as 25.00g, 26.00g, 26.50g, 26.67g, 26.67g and 26.133g respectively.

List 1 :Effect of different fertilizer application methods on several plant characteristics of BRRI dhan29

Treatments	Plant height(cm)	No. of effective tillers $hill^{-1}$ (No.)	Panicle length(cm)	Filled grains $panicle^{-1}$ (No.)	1000- grain weight (g)
T_1	78.47b	9.27c	20.20b	83.07c	25.00b
T_2	90.97a	10.87bc	22.84a	122.53ab	26.00ab
T_3	90.63a	12.13ab	23.43a	114.77ab	26.50a
T_4	90.18a	12.14ab	24.90a	122.60a	26.67a
T_5	90.17a	12.80a	23.50a	116.5ab	26.67a
T_6	90.64a	11.53ab	23.60a	111.53b	26.13a
SE ±	2.03	0.86	1.04	3.96	0.497
CV (%)	2.81	9.2	5.54	4.41	2.33

Comment [d12]: Why did you use this ? As you have **planned comparison**, you must use LSD or Tukey Test not **DRMT**. DRMT is used for Unplanned Comparsion, If you havn't control treatment. But in your experiment there is a control treatment (0) fertilizer rate. You must use LSD, the planned comparsion.

Comment [d13]: **Use the Partial Budget Analysis Formula.**
To calculate Marginal Rate of Return ??

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Please include discussion here….
Add any supporting ideas or opposing ideas from references

The figure (s) having common letter (s) in a column do not differ significantly at 5% level of significance. SE (±) = Standard Error of Means, CV (%) = Co-efficient of variance

T_1: Control (No fertilizer), T_2: Farmers practice, T_3: Fertilizer Recommendation Guide (FRG)-2018, T_4: BAU soil testing kit, T_5: Soil Test Basis (STB) and T_6: Rice crop manager (RCP)

The grain yield has been recorded in the rank of T_4> T_5> T_3> T_2> T_6> T_1. The results indicated that all the treatments with fertilizer recommendation methods gave significantly higher value over the control (T_1) and in terms of straw yield the treatment has been ranked in order of T_4> T_5> T_3> T_6> T_2>T_1.

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Please include discussion here….
Add any supporting ideas or opposing ideas from references

List 2 :Influence of different fertilizer recommendation methods on grain and straw yields of BRRI dhan29

Treatments	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})
T_1	4.01c	4.07d
T_2	5.18b	6.15c
T_3	5.50ab	6.96b
T_4	6.29a	7.73a
T_5	5.81ab	7.08ab
T_6	5.17b	6.43bc
SE ±	0.4412	0.3373
CV (%)	10.15	6.45

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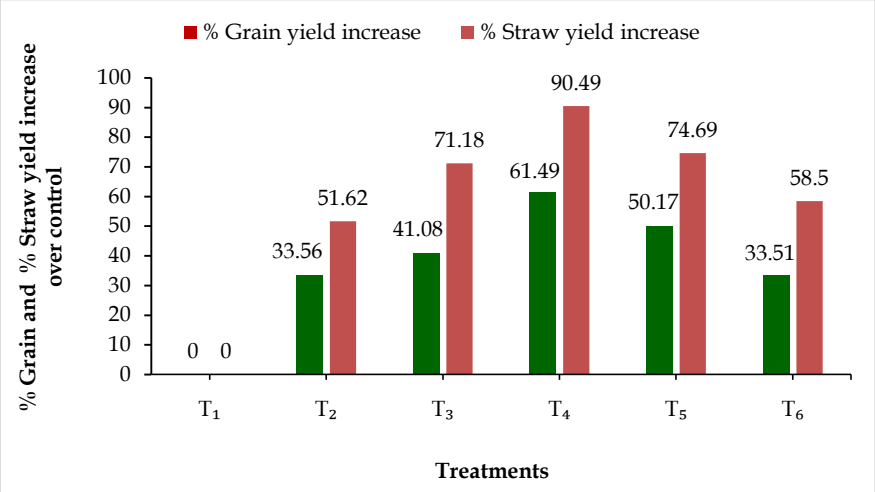

Figure 1 Effect of applying fertilizers through different fertilizer recommendation methods on %grain and %straw yield increase over control of BRRI dhan29

In rice grain, the highest content (1.288%) was observed with BAU Soil Testing Kit (T4), while all treatments showed significantly higher nitrogen content compared to the control. In case of rice straw, the highest N content of 0.364% was recorded in the treatment T_5 which wasstatistically similar with T_4. The highest nitrogen uptake in grain and straw was in T_4 (80.86 kg $ha^{-1}$and 27.98 kg ha^{-1}). The highest total nitrogen uptake by rice has also found in treatment T_4 (108.84 kg ha^{-1}).

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Please include discussion here….
Add any supporting ideas or opposing ideas from references

List 3 :Effect urea fertilizer through different fertilizer recommendation methods on nitrogen concentration and uptake by BRRI dhan29

Treatments	Content		Uptake (kg ha^{-1})		
	% N (Grain)	% N (Straw)	N (Grain)	N (Straw)	Total
T_1	1.101d	0.328c	44.20c	13.35e	57.54d
T_2	1.128c	0.352b	58.37b	21.70d	80.07c
T_3	1.176b	0.352b	64.82b	24.52bc	89.34bc
T_4	1.288a	0.362a	80.86a	27.98a	108.84a
T_5	1.178b	0.364a	68.50b	25.74ab	94.23b
T_6	1.176b	0.353b	60.76b	22.69cd	83.45bc
SE ±	0.0026	0.0013	4.97	1.22	5.51
CV (%)	0.27	0.44	9.69	6.59	7.89

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

Phosphorus content varied at different ranges with the application of P fertilizer through different fertilizer recommendation methods in rice grain of BRRI dhan29. The highest phosphorus content in grain and straw of was recorded in the treatment T_3 (0.258% and 0.123%). Phosphorus (P)uptake by rice grain, straw and total uptake has been recorded in the treatment T_4 (15.57 $kgha^{-1}$, 8.965 $kgha^{-1}$ and 24.54 $kgha^{-1}$). All the treatments with fertilizer recommendations gave significantly higher value over the control (T_1).

Comment [d17]: Please include discussion here….
Add any supporting ideas or opposing ideas from references

List 4 :Effect of P fertilizer through different fertilizer recommendation methods on phosphorus concentration and uptake by BRRI dhan29

Treatments	Content		Uptake (kg ha^{-1})		
	% P (Grain)	% P (Straw)	P (Grain)	P (Straw)	Total
T_1	0.242f	0.115d	9.714c	4.679c	14.39c
T_2	0.255b	0.121b	13.196ab	7.458b	20.65b
T_3	0.358a	0.123a	14.220ab	8.566a	22.79ab
T_4	0.248e	0.116d	15.570a	8.965a	24.54a
T_5	0.249d	0.116d	14.477ab	8.201ab	22.68ab
T_6	0.254c	0.119c	13.123b	7.650b	20.77b
SE ±	0.00045	0.00052	1.082	0.405	1.273
CV (%)	0.22	0.53	9.9	6.54	7.44

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

SE (±) = Standard Error of Means, CV (%) = Co-efficient of variance

T_1: Control (No fertilizer), T_2: Farmers practice, T_3: Fertilizer Recommendation Guide (FRG)-2018, T_4: BAU soil testing kit, T_5: Soil Test Basis (STB) and T_6: Rice crop manager (RCP)

Potassium content varied at different ranges with the application of K fertilizer through different fertilizer recommendation methods in rice grain of BRRI dhan29. The highest potassium content in grain and straw of was recorded in the treatment T_4 (0.339% and 1.383%). Potassium (k)uptake by rice grain, straw and total uptake has been recorded in the treatment T_4 (21.282 kgha^{-1}, 106.89 kgha^{-1} and 128.17 kgha^{-1}). All the treatments with fertilizer recommendations gave significantly higher value over the control (T_1).

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Please include discussion here....
Add any supporting ideas or opposing ideas from references

List 5 :Effect of K fertilizer through different fertilizer recommendation methods on potassium concentration and uptake by BRRI dhan29

Treatments	Content		Uptake (kg ha^{-1})		
	% K (Grain)	% K (Straw)	K (Grain)	K (Straw)	Total
T_1	0.308f	1.227d	12.363d	49.96e	62.32e

T_2	0.329d	1.290c	17.026bc	79.51d	96.54d
T_3	0.333c	1.295c	18.354abc	90.19bc	108.54bc
T_4	0.339a	1.838a	21.282a	106.89a	128.17a
T_5	0.337b	1.352b	19.594ab	95.60b	115.20b
T_6	0.315e	1.274c	16.274c	81.90cd	98.18cd
SE ±	0.00067	0.0125	1.405	4.39	5.11
CV (%)	0.25	1.17	9.85	6.40	6.17

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SE (±) = Standard Error of Means, CV (%) = Co-efficient of variance

T_1: Control (No fertilizer), T_2: Farmers practice, T_3: Fertilizer Recommendation Guide (FRG)-2018, T_4: BAU soil testing kit, T_5: Soil Test Basis (STB) and T_6: Rice crop manager (RCP)

Sulphur content and uptake varied at different ranges with the application of S fertilizer through different fertilizer recommendation methods in rice grain of BRRI dhan29. The highest Sulphur (S)uptake by rice grain, straw and total uptake has been recorded in the treatment T_4 (14.124 kgha^{-1}, 17.466 kgha^{-1} and 31.590 kgha^{-1}). All the treatments with fertilizer recommendations gave significantly higher value over the control (T_1).

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Please include discussion here….
Add any supporting ideas or opposing ideas from references

List 6 :Effect of S fertilizer through different fertilizer recommendation methods on sulphur concentration and uptake by BRRI dhan29

Treatments	Content		Uptake (kg ha^{-1})		
	% S (Grain)	% S (Straw)	S (Grain)	S (Straw)	Total
T_1	0.201e	0.218d	8.068c	8.179e	16.25d
T_2	0.223c	0.225b	11.540b	13.867d	25.41c
T_3	0.225b	0.226b	12.401ab	15.739bc	28.14bc
T_4	0.225b	0.226b	14.124a	17.466a	31.59a

T_5	0.231a	0.230a	13.372ab	16.264ab	29.64ab
T_6	0.219d	0.223c	11.317b	14.336cd	25.65c
SE ±	0.00076	0.00051	0.9296	0.7641	1.377
CV (%)	0.42	0.29	9.65	6.54	6.46

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

SE (±) = Standard Error of Means, CV (%) = Co-efficient of variance

T_1: Control (No fertilizer), T_2: Farmers practice, T_3: Fertilizer Recommendation Guide (FRG)-2018, T_4: BAU soil testing kit, T_5: Soil Test Basis (STB) and T_6: Rice crop manager (RCP)

4. CONCLUSION

The experiment, conducted from February to May 2020, assessed the impact of different **NPK** fertilizer recommendation methods on rice (BRRI dhan29) in Old Brahmaputra floodplain soils. Employing a randomized complete block design with six treatments, BAU **Soil Testing Kit (T4) demonstrated superior performance**, significantly increasing plant height, effective tillers, panicle length, filled grains, 1000-grain weight, grain yield (6.29 t ha^{-1}), straw yield (7.73 t ha^{-1}), and nutrient uptake. The control (T1) exhibited inferior results in all aspects. Using BAU Soil Testing Kit for fertilizer application emerged as the most efficient and **eco-friendly approach**, contributing to higher rice yield and improved nutrient uptake compared to other methods, emphasizing the importance of adopting proper fertilizer recommendation methods in sustainable crop production in Bangladesh. Further studies are encouraged to validate these findings. [This should briefly state the major findings of the study.If you are using copy-paste option then select 'match destination formatting' in paste option OR use 'paste special' option and select 'unformatted Unicode text' option]

Comment [d20]: One year experiemt is not valid.

Comment [d21]: Where is S? NPKS

Comment [d22]: To say this you need to calculate Economic Analysis? How much amount of income the farmer can be by using the recommendation?

Comment [d23]: How it can be ? because you are using chemical fertilizer totaly? To say this at least you must use organic fertlizer ?

From eco-friendly approachpoint of view T2 (Farmer Practice) is best than your recommendation (T4)

Because the amount of fertilizer ysed in T4 is much greater than T2. So, the amount of fertizer increase the side effect on the environment and soil health is also increase.

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Comment [d24]: Check it. Some refereces are not in text citation. Check all ??

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