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# INTEGRATION OF ORGANIC AS WELL AS INORGANIC FERTILIZERS FOR BUILDING NUTRIENT BALANCING IN RICE BASED CROPPING PATTERN AT AEZ 9 OF BANGLADESH

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**ABSTRACT**

Intensification of agricultural land use along with cultivation of new cultivars has substantially expanded in Bangladesh. This has consequently led to a decline in soil fertility and the establishment of both macro and micronutrient deficiencies in crops. In light of this, a study was conducted to determine the best combination of organic and inorganic fertilizers to supplement micronutrient application for maximizing yield for the T. Aman - Boro cropping pattern in AEZ 9. The study also aimed to assess the effects of organic and inorganic fertilizers on the growth, yield, and yield attributes of T. Aman and Boro rice. The findings indicate that, for Aman rice, 100% NPKS with Zn @ 2 kg $ha^{-1}$ and B application @ 1 kg $ha^{-1}$, and again 100% NPKS with Zn @ 4 kg $ha^{-1}$ and B application @ 2 kg $ha^{-1}$ to the Boro rice ensured the maximum grain yield in rice based cropping pattern. Regarding Aman- Boro rice cropping pattern, applying 100% NPKS+1t $ha^{-1}$ Vermicompost to the Aman rice and 75% NPKS + 2 t $ha^{-1}$ vermicompost to the Boro rice ensured the good rice yield in AEZ 9 of Bangladesh.

**Key words:** Inorganic fertilizers, vermicompost, nutrient balance, rice.

## Introduction

In Bangladesh, deficiencies in nitrogen, phosphorus, potassium, sulfur, zinc, and boron have been documented chronologically (Islam, 2008). Among these micronutrients, boron deficiency, following zinc, is particularly notable in the soils of Dinajpur, Rangpur, Bogra, Sirajganj, Mymensingh, Comilla, and Sylhet districts. Due to inadequate and imbalanced fertilizer application, farmers are not able to harness the full yield potential of rice crop. There is an apprehension that the use of chemical fertilizers over the years might may impair the soil fertility. In continuous cropping, use of imbalanced nutrients (N or NP alone) through inorganic fertilizers only cannot sustain the desired level of crop production (Kumar *et al*., 2021; Muhr *et al*., 1965, Olsen *et al*., 1954). The integrated use of inorganic fertilizers with vermicompost enhance rice productivity (Thakur *et al*., 2021). Sarvade *et al*. (2017) found the balance fertilization through integrated use of manure, fertilizer and biofertilizer along with micronutrients is useful in rice crop. Regarding the aspects, a study needs to be formulated to assess the micronutrient requirements (specifically Zn and B) for specific crops as well as the cropping pattern (T. Aman-Boro) . A baseline survey revealed that the levels of zinc (Zn) and boron (B) in the soils were classified as 'low'. In the first year, field trials were carried out with four treatments for T. Aman and six treatments (with residual effect of T. Aman treatments) for Boro rice. The study hence investigated the use of micronutrients (zinc and boron) along with vermicompost to evaluate the impact of both organic and inorganic fertilizers on yield and nutrient uptake of T. Aman and Boro rice, aiming to attain maximum yields in the Old Bhahmaputra Floodplain (AEZ 9) of Bangladesh.

## Materials and Methods

For T. Aman - Boro rice cropping pattern, experiment soil samples were collected and analyzed for some basic properties, macronutrients and micronutrients. The basic properties of soils included pH and organic matter contents, macronutrients included N, P, K, S contents and micronutrients included Zn and B contents. All analysis was done following standard methods. There were six treatments for the T. Aman

($T_1$: Control, $T_2$: 100% NPKS+$Zn_2B_1$, $T_3$: 50% NPKS+ 1 t VC, $T_4$: 100% NPKS + 1 t VC, $T_5$: 50% NPKS+ 4 t VC, $T_6$: 100% NPKS+ 4 t VC and six treatments for Boro rice as $T_{1.1}$ (Control), $T_{2.1}$ (100% NPKS+$Zn_4B_2$), $T_{3.1}$ (75% NPKS+ 2 t VC), $T_{4.1}$ (100% NPKS+ 1 t VC), $T_{5.1}$ (75% NPKS+ 4 t VC), $T_{6.1}$ (100% NPKS+ 2 t VC). The recommended fertilizer dose for T. Aman was 130-100-50-35 and for Boro rice 260-127-170-112 kg/ha of urea, TSP, MoP and Gypsum, respectively. Subscripts of Zn and B represent kg $ha^{-1}$, and VC as vermicompost. Each treatment replicated three times. Nitrogen, P, K, S were applied as the recommended rates for both crops. The Zn was added as $ZnSO_4$ and B was as $H_3BO_3$. After completion of 1-year crop cycle, effects of treatments on the yield of crops and nutrient uptake were recorded.

Table 1. Characteristics of initial soil in the experimental field at BINA farm Mymensingh

| Properties | Value | Interpretation class |
|---|---|---|
| Sand (%) | 27.06 | |
| Silt (%) | 63.3 | Silt loam |
| Clay (%) | 9.64 | |
| pH | 6.5 | Slightly acidic |
| OM (%) | 1.53 | Medium |
| Total N (%) | 0.097 | Low |
| Available P (mg $kg^{-1}$ soil) | 12.8 | Low |
| Exchangable K (meq 100 $g^{-1}$ soil) | 0.10 | Low |
| Available S (mg $kg^{-1}$ soil) | 12.0 | Low |
| Available Zn (mg $kg^{-1}$ soil) | 0.80 | Low |
| Available B (mg $kg^{-1}$ soil) | 0.25 | Low |

The T. aman rice (Binadhan-17) was transplanted on 2 August and harvested on 30 September 2023 again the Boro rice was transplanted on 23 January and harvested on 5 May 2024 in the same plot as the test crops. Table 1 lists the chemical characteristics of the experimental soil. Yield attributes like plant height (cm), tillers $hill^{-1}$ panicle length (cm), number of seed $panicle^{-1}$, 1000 grain weight (g), grain yield (t $ha^{-1}$) and straw yield (t $ha^{-1}$) were noted. Plant and soil samples were analyzed following standard methods. Data recorded on crop characters and plant analysis were subjected to statistical analysis through computer based statistical program Mstat-C.

## Results and Discussion

**Grain and stray yield of T. Aman rice:** Significant effect of treatments on the grain yield of T. Aman (var. Binadhan-17) was observed (Table 2). The grain yield varied from 2.71 to 5.21 t $ha^{-1}$ across the treatments. The maximum grain yield was observed (5.21 t $ha^{-1}$) in $T_2$ (100% NPKS + $Zn_2B_1$) treatment followed by treatment $T_4$ (100% NPKS + 1 t VC, 5.05 t $ha^{-1}$), $T_5$ (50% NPKS+ 4 t VC, 5.01 t $ha^{-1}$) were found statistically identical yield. Looking at the effects of Zn-B treatments on the 1st crop (T. Aman rice) appeared that the Zn application at Zn @ 2 kg $ha^{-1}$ and B @ 1 kg $ha^{-1}$ with 100% NPKS showed superior yield performances. The control treatment (without fertilizer) had the lowest yield (2.71 t $ha^{-1}$). The straw yield of T. Aman rice (Binadhan-17) was also significantly influenced by the treatments ranging from 3.51 t $ha^{-1}$ by control $T_1$ (control) to 6.49 t $ha^{-1}$ by $T_6$ treatment. Treatment $T_6$ (100% NPKS + 4 t VC) performed superior straw yield (6.49 t $ha^{-1}$).

**Grain and straw yield of Boro rice:** There was a significant effect of treatments on the grain yield of Boro rice (BINA Dhan25). The grain yield ranged from 2.89 - 6.64 t $ha^{-1}$ (Table 3). The maximum grain yield (6.64 t $ha^{-1}$) was observed in the treatment $T_{2.1}$ (100% NPKS+$Zn_2B_1$ to the T. Aman and 75% NPKS+ 2 t VC to the Boro rice). Treatment $T_{3.1}$ (50% NPKS+ 1 t VC to the T. Aman and 75% NPKS+ 2 t VC to the Boro rice, 6.19 t $ha^{-1}$), $T_{5.1}$ (50% NPKS+ 4 t VC to the T. Aman and 75% NPKS+ 4 t VC to the Boro rice, 6.19 t $ha^{-1}$) and treatment $T_{6.1}$ (100% NPKS+ 4 t VC to the T. Aman and 100% NPKS+ 2 t VC to the

Boro rice, 6.26 t $ha^{-1}$) were found statistically identical yield. The significant influence of the treatments established a residual effect on the following crop. The straw yield of Boro rice was also significantly influenced by the residual and renewal application of treatments ranging from 2.98 - 6.78 t $ha^{-1}$ (Table 3). The $T_{2.1}$ (100% NPKS+$Zn_4B_2$ to the T. Aman and 100% NPKS + $Zn_4B_2$ to T. Aman) treatment gave the maximum straw yield (6.78 t $ha^{-1}$) followed by the treatment $T_{6.1}$ (100% NPKS+ 4 t VC to the 1st crop and 100% NPKS+ 2 t VC to the 2nd crop, Boro rice, 6.44 t $ha^{-1}$), $T_{5.1}$ (50% NPKS+ 4 t VC to the 1st crop and 75% NPKS+ 4 t VC to 2nd crop, 6.44 t $ha^{-1}$) and $T_{3.1}$ (50% NPKS+ 4 t VC to the 1st crop and 75% NPKS+ 4 t VC to 2nd crop, 6.44 t $ha^{-1}$) over control $T_{1.1}$ (control). $T_{1.1}$ showed the minimum straw yield (2.98 t $ha^{-1}$).

Table 2. Effect of organic (VC) and inorganic fertilizers on the yield of T. Aman rice (Binadhan-17) as a 1st crop in the Boro- T. Aman rice cropping pattern

| Treatments | Treatment code | Plant height (cm) | Tiller (no.) | Panicle length (cm) | Seed/ panicle (no.) | 1000 Seed weight (gm) | Grain yield (t/ha) | Straw yield (t/ha) |
|---|---|---|---|---|---|---|---|---|
| Control | $T_1$ | 95 b | 7.1 c | 19.6 c | 97.4 b | 20.19 | 2.71 c | 3.51 d |
| 100% NPKS+$Zn_2B_1$ | $T_2$ | 102 a | 8.1 b | 20.7 ab | 124.2 a | 21.69 | 5.21 a | 5.61 c |
| 50% NPKS+ 1 t VC | $T_3$ | 100 a | 8.1 b | 20.1 bc | 119.4 a | 20.73 | 4.55 b | 5.18 c |
| 100% NPKS + 1 t VC | $T_4$ | 102 a | 8.7 a | 21.5 a | 123.6 a | 21.64 | 5.05 a | 5.67 bc |
| 50% NPKS+ 4 t VC | $T_5$ | 102 a | 8.4 ab | 20.4 bc | 122.0 a | 22.13 | 5.01 a | 6.17 ab |
| 100% NPKS+ 4 t VC | $T_6$ | 102 a | 8.3 ab | 21.3 a | 119.4 a | 21.24 | 4.72 b | 6.49 a |
| Level of significance | | ** | ** | ** | ** | NS | * | * |
| CV | | 1.53 | 3.84 | 2.18 | 2.58 | 3.71 | 5.71 | 5.20 |

Table 3. Effects of residual and renewed application of organic (vc) and inorganic fertilizers on the yield of Boro rice (Binadhan-25) as a 2nd crop in the T. Aman - Boro rice cropping pattern

| Treatments | Treatment code | Plant height (cm) | Tiller (no.) | Panicle length (cm) | Seed/ panicle (no.) | 1000 Seed weight (gm) | Grain yield (t/ha) | Straw yield (t/ha) |
|---|---|---|---|---|---|---|---|---|
| Control | $T_{1.1}$ | 101.7 b | 6.13 b | 25.3 | 114.9 e | 17.47 | 2.89 c | 2.98 c |
| 100% NPKS+$Zn_4B_2$ | $T_{2.1}$ | 117.0 a | 9.20 a | 26.2 | 144.1 bc | 18.37 | 6.64 a | 6.78 a |
| 75% NPKS+ 2 t VC | $T_{3.1}$ | 117.6 a | 9.13 a | 25.8 | 151.3 b | 18.87 | 6.19 ab | 6.27 b |
| 100% NPKS+ 1 t VC | $T_{4.1}$ | 116.2 a | 9.07 a | 26.5 | 161.5 a | 18.08 | 5.99 b | 6.69 ab |
| 75% NPKS+ 4 t VC | $T_{5.1}$ | 117.0 a | 8.87 a | 26.1 | 135.1 d | 18.67 | 6.23 ab | 6.44 ab |
| 100% NPKS+ 2 t VC | $T_{6.1}$ | 116.6 a | 9.80 a | 26.0 | 136.4 cd | 18.39 | 6.26 ab | 6.44 ab |
| Level of significance | | ** | ** | NS | ** | NS | * | * |
| CV | | 5.57 | 8.02 | 2.55 | 5.28 | 4.67 | 6.16 | 4.57 |

Table 4. Effect of organic (VC) and inorganic fertilizers on nutrient uptake by T. Aman rice (Binadhan-17) as a 1st crop in the Boro- T. Aman rice cropping pattern

| Treatments | Treatment code | N uptake (kg $ha^{-1}$) | P uptake (kg $ha^{-1}$) | K uptake (kg $ha^{-1}$) | S uptake (kg $ha^{-1}$) | Zn uptake (g $ha^{-1}$) | B uptake (g $ha^{-1}$) |
|---|---|---|---|---|---|---|---|
| Control | $T_1$ | 57.94 | 8.93 | 91.29 | 6.66 | 164.78 | 324.04 |
| 100% NPKS + $Zn_2B_1$ | $T_2$ | 103.00 | 19.24 | 160.33 | 12.34 | 346.70 | 662.33 |
| 50% NPKS + 1 t VC | $T_3$ | 95.51 | 17.86 | 148.15 | 11.44 | 260.29 | 594.05 |
| 100% NPKS + 1 t VC | $T_4$ | 101.85 | 18.92 | 161.50 | 12.23 | 279.70 | 620.88 |
| 50% NPKS + 4 t VC | $T_5$ | 108.57 | 19.82 | 182.54 | 13.12 | 304.48 | 624.74 |
| 100% NPKS + 4 t VC | $T_6$ | 102.77 | 18.73 | 173.49 | 12.43 | 288.63 | 588.80 |

Subscripts of in the treatments Zn & B represent kg $ha^{-1}$; VC= Vermicompost
Means followed by same letter in a column are not significantly different at 5 % level by DMRT; NS = Non significant CV= Coefficient of variation; *= Significant at 5% level

Table 5. Effects of residual and renewed application of organic (vc) and inorganic fertilizers on nutrient uptake by Boro rice (Binadhan-25) as a 2nd crop in the T. Aman - Boro rice cropping pattern

| Treatments | Treatment code | N uptake (kg ha$^{-1}$) | P uptake (kg ha$^{-1}$) | K uptake (kg ha$^{-1}$) | S uptake (kg ha$^{-1}$) | Zn uptake (g ha$^{-1}$) | B uptake (g ha$^{-1}$) |
|---|---|---|---|---|---|---|---|
| Control | $T_{1.1}$ | 61.18 | 8.75 | 81.91 | 33.24 | 157.4 | 341.4 |
| 100% NPKS+$Zn_4B_2$ | $T_{2.1}$ | 147.01 | 21.40 | 208.99 | 75.78 | 458.1 | 1104.6 |
| 75% NPKS+ 2 t VC | $T_{3.1}$ | 136.72 | 19.89 | 193.36 | 70.10 | 424.9 | 1029.6 |
| 100% NPKS+ 1 t VC | $T_{4.1}$ | 136.61 | 19.93 | 204.10 | 74.12 | 436.8 | 1002.8 |
| 75% NPKS+ 4 t VC | $T_{5.1}$ | 138.51 | 20.16 | 198.15 | 71.86 | 433.0 | 1037.7 |
| 100% NPKS+ 2 t VC | $T_{6.1}$ | 139.03 | 20.24 | 198.36 | 71.93 | 434.0 | 1042.9 |

In T. aman- Boro cropping sequence, cumulative nutrient uptake by the two crops in one year- crop cycle varied from 119.12- 250.01, 17.68- 40.64, 173.20- 380.69 and 39.90- 88.12 kg ha$^{-1}$ of N, P, K and S, against application of 390-227-220-147 kg ha$^{-1}$ N, P, K and S respectively, from Zn-B fertilizers. Zinc and B uptake of 327.17- 804.78 g Zn ha$^{-1}$ and 665.40- 1767 g B ha$^{-1}$ compared to application of Zn (0-6 kg ha$^{-1}$) and B (0-3 kg ha$^{-1}$).

## Conclusion

For the two rice crops in a pattern, 100% NPKS with Zn @2 kg ha$^{-1}$ and B application @ 1 kg ha$^{-1}$ to the Aman rice (1st crop) and again 100% NPKS with Zn @ 4 kg ha$^{-1}$ and B application @ 2 kg ha$^{-1}$ to the Boro rice (the 2nd rice crop) can give maximum grain yield in rice - rice cropping pattern. Regarding Aman-Boro rice cropping pattern, 100% NPKS + 1 t ha$^{-1}$ vermicompost to the Aman rice and again 75% NPKS with 2 t ha$^{-1}$ vermicompost to Boro rice can give the satisfactory yield.

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