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Effect of integrated nutrient management on the yield performance of T. *Aman* rice

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ABSTRACT

The present experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University (BAU), Mymensingh during from July to December 2021 with a view to find out the effect of integrated nutrient management on the yield performance of T. aman rice. The experiment comprised of twelve integrated nutrient management practices viz. control (no fertilizers), recommended doses (Urea=120, TSP=70, MoP=100, Gypsum=70 kg ha^{-1}) of fertilizers for amanrice, 75% of recommended doses,50% of recommended doses,25% of recommended doses, cowdung @ 10 tha^{-1},25% of recommended doses + cowdung @ 7.5 t ha^{-1}, 50% of recommended doses + cowdung @ 5.0 tha^{-1},75% of recommended doses + cowdung @ 2.5 t ha^{-1}, Vermicompost @ 5.0 t ha^{-1}, 50% of recommended doses + vermicompost @ 2.5 t ha^{-1}, 75% of recommended doses + vermicompost @ 1.5 t ha^{-1}.BRRI dhan34 was used as test crop in the experiment. The experiment was laid out in a Randomized Complete Block Design (RCBD) design with three replications. The results revealed that the highest plant height (138.11 cm), total number of tillers hill^{-1} (13.25), number of effective tillers hill^{-1} (9.21), panicle length (23.57 cm), number of grains panicle^{-1} (115.84),grain yield (3.47tha^{-1}), straw yield (8.83 tha^{-1}) was obtained from the treatment with 50% of recommended doses + cowdung @ 5 t ha^{-1}. From the above results it is evident that treatment with 50% of recommended doses + cowdung @ 5 t ha^{-1} appeared to be the best among the integrated nutrient management practices.

Key words: nutrient management, yield, T. *aman*, rice

INTRODUCTION

Rice (*Oryza sativa* L.) is the primary food source of carbohydrates on the Indian subcontinent, accounting for 21% of the dietary calories consumed by more than half of the world's population. Bangladesh is third among the nations that grow rice in the globe in terms of area and production, after China and India (FAO, 2022). Around 11,705,263 hectares of Bangladesh's cropland are used for the production of rice. Three distinct growing seasons, known as *aus* (April to August), *aman* (June to December), and *boro* (November to May), respectively, are covered by 9%, 49%, and 42% of the total region (BBS, 2020). Although the average yield of *boro* is the highest but it can't fulfil the demand of the country, thus *aman* is important to fulfill the demand of rice production. In the 2020-2021 financial year, total area under *aman* crop has been estimated 55, 59, 964 hectares which is 0.87% higher than that of last year. Total *aman* production of Financial Year 2020-2021 has been estimated 1,44,37763 metric tons which is 1.65% higher than the previous year (BBS, 2021). Inorganic fertilizer application has always been viewed as one of the more expensive inputs for crop development, particularly in a poor nation like Bangladesh. Nitrogen fertilizer is anticipated to become much more expensive in the near future. This might pose a severe threat to the nation's enormous population of millions of people who rely on food security (Shrestha, 2020). Chemical

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fertilizers can degrade soil health by disrupting its natural nutrient balance and reducing organic matter, leading to a decline in soil fertility over time. They often cause soil acidification, harming beneficial microorganisms and reducing biodiversity (Pahalvi *et al*., 2021). Additionally, chemical runoff from fields contaminates nearby water bodies, causing eutrophication, which depletes oxygen levels and severely impacts aquatic ecosystems (Bashir *et al*., 2020).

Integrated Nutrient Management (INM) a strategy for enhancing soil fertility, raising crop yield, and assuring sustainable agriculture, has been offered as a solution to these problems. INM is a comprehensive approach to nutrient management that includes, among other techniques, the use of organic and inorganic fertilizers, bio fertilizers, and vermicomposting. These techniques are meant to enhance crop growth and output while also enhancing soil health and nutrient use efficiency (Mia *et al.,* 2023). The application of INM to soil increases the status of plant-available nutrients and enhances the physical, chemical and biological characteristics of soil, both of which have a direct impact on soil fertility (Sannathimmappa *et al*., 2015). On a long-term basis, using both chemical and organic fertilizers together can improve soil quality and increase crop output (Baradhan and Kumar, 2018). The idea of integrated nutrient supply systems is the most sensible one to adopt in order to control the soil's production and long-term fertility (Puli *et al*., 2017). Vermicompost as a soil additive increase both cation exchange and water-retention capacities and provides nutrients in the required amounts as it reduces the use of mineral fertilizers (Tejada and Gonzalez, 2008). Vermicompost is rich in micronutrients, beneficial soil bacteria, and macronutrients such NKPS (nitrogen 23%, potassium 1.85-2.25%, phosphorus 1.55-2.25%, and sulphur 0.4-0.5%) (P-solubilizers, cellulose decomposing microflora etc.). Because vermicomposting encourages soil microbial activity and growth, which leads to the mineralization of plant nutrients and increases soil fertility and quality, it is regarded as a good management practice in any agricultural production system (Arancon *et al*., 2006; Ferreras *et al*., 2006).

Optimizing the advantages from all potential sources of plant nutrients in an integrated manner allows for the maintenance or adjustment of soil fertility and plant nutrient supply to an optimal level for maintaining the target production. This idea is crucial since it calls for the sustainable use of both organic and inorganic fertilizers to soil in order to improve plant quality and production without endangering the surrounding ecology. The total responses on the grain crop have improved with the application of integrated of nutrient management in rice, which results in maximum growth characteristics and yield attributes. Therefore, the objective of the study is to investigate the relationship between integrated nutrition management and T. *aman* rice yield performance.

MATERIALS & METHODS

Experimental site

The experimental was conducted at Agronomy field, Bangladesh Agricultural University, Mymensingh which is located at 24.75° N latitude and 90.50° E longitude at an average altitude of 18 m above the mean of sea level. The experimental site belongs to the Old Brahmaputra Floodplain Agroecological Zone (AEZ-9). The region occupies a large area of Brahmaputra sediments which are laid down before the river shifted into its present Jamuna channel 200 years ago.

Experimental design

The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. Each block was divided into 12-unit plots of 2m× 2.5 m size. Thus, the total number of unit plots was 36 (12 × 3). The distance maintained between two-unit plots was 0.5 m and between blocks was 1 m. The bunds around individual plots were made to control water movement among the plots. BRRI dhan34 was used as test crop variety in the experiment. The seed were collected from Agronomy field laboratory, Bangladesh Agricultural University, Mymensingh, Bangladesh.

Experimental treatments

Integrated nutrient management practices: Control (no fertilizers) (T_1), Recommended doses (Urea=120, TSP=70, MoP=100, Gypsum=70 kg ha^{-1}) of fertilizers for *aman* variety (T_2), 75% of recommended doses (T_3), 50% of recommended doses (T_4), 25% of recommended doses (T_5), Cowdung @ 10 t ha^{-1} (T_6), 25% of recommended doses + cowdung @ 7.5 t ha^{-1} (T_7), 50% of recommended doses + cowdung @ 5.0 tha^{-1} (T_8), 75% of recommended doses + cowdung @ 2.5 t ha^{-1}(T_9), Vermicompost @ 5.0 t ha^{-1} (T_{10}), 50% of recommended doses + vermicompost @ 2.5 t ha^{-1} (T_{11}), 75% of recommended doses + vermicompost @ 1.5 t ha^{-1} (T_{12}).

Preparation of seedling nursery and seed sowing

A piece of high land as nursery bed puddled well with a tractor followed by cleaning and levelling with ladder. Pre germinated seeds were sown in the wet nursery bed on 5 July 2021. Proper care was taken to raise the seedlings in the bed. Weeds were removed and irrigation was given in the nursery bed as and when necessary.

Land preparation

The land was opened in 1 August 2021 with a tractor. Then the land was cleaned and levelled by a ladder. Subsequently the land was puddled with a country plough. Weeds and stubbles were removed from the field. The layout of the experimental field was done on 5 August 2021 in accordance with the experimental design.

Application of fertilizers and manures

Both organic and inorganic fertilizers were applied according to the experimental treatments. Triple super phosphate (TSP), muriate of potash (MoP), gypsum cowdung and vermicompost were applied at the time of land preparation. Urea was top dressed in three equal splits at 15, 35 and 55 DATs as per treatments. Cowdung and vermicompost were applied as basal dose (as per treatment) on 5 August 2021 as per experimental specification.

Transplanting of seedlings

35-days old seedlings were uprooted carefully. The nursery beds were made wet by application of water both in the morning and evening on the previous days of uprooting the seedlings to reduce mechanical injury and the seedlings were kept in soft mud in shade. Seedlings were transplanted on 9 August 2021 at 25 cm × 15 cm spacing give 3 seedlings $hill^{-1}$.

Sampling, harvesting, processing and data recording

The crop was harvested at full maturity. Maturity of crops was determined as the time when about 90% of the seeds become golden yellow in color. Five hills (excluding border hills) were randomly selected from each plot and data were recorded on plant height (cm), number of total tillers $hill^{-1}$, number of effective tillers $hill^{-1}$, panicle length (cm), 1000-grain weight (g). Rest of the crop was harvested on 2 December 2021 and was separately bundled, properly tagged and then brought to the threshing floor. The grains were then threshed, cleaned, sun dried and weighed to record the grain yield. The grain yield was adjusted to 14% moisture content. Straws were also sun dried and weighed to record the straw yield. Grain and straw yields were finally expressed in t ha^{-1}.

Statistical analysis

The recorded data on various plant characters were analyzed following statistical procedure and the difference among treatment means was compared by Duncan's Multiple Range Test (Gomez and Gomez, 1984) at 5% level of significant.

RESULTS AND DISCUSSION

Effect of integrated nutrient management on plant height and yield contributing characters at harvest

Plant height

The plant height of BRRI dhan34 was significantly impacted by integrated nutrient management. The treatment with 50% of the BRRI recommended doses plus cowdung@ 5 t ha^{-1} produced the tallest plant (138.11 cm), whereas 25% of the BRRI recommended doses plus cowdung@ 7.5 t ha^{-1}

produced the shortest plant (131.89 cm) of BRRI dhan34 (Fig. 1A). Increased plant height following cowdung treatment and urea application may be the result of insufficient nitrogen supply for the rice plant throughout its life cycle. In a study of INM the plant height of rice was significantly higher due to the integrated application organic manure in combination with chemical fertilizer. Crop characters and yield contributing characters such as plant height, effective tillers hill^{-1}, panicle length and grains panicle^{-1} and 1000-grain weight were influenced significantly due to application of cowdung, compost and poultry manure and NPKS fertilizers (Hoque *et al*., 2014)

Number of total tillers hill^{-1}

The integrated nutrient management had a substantial impact on the number of total tillers hill^{-1} of BRRI dhan34. The highest total number of tillers hill^{-1} (13.25) was observed in T_8 (50% of BRRI recommended doses + cowdung @ 5t ha^{-1}), while the lowest number of total tillers hill^{-1} (9.11) was recorded from T_1 (no fertilizers) treatment of BRRI dhan34 (Fig. 1B). Hoque *et al*. (2018) found that organic and chemical fertilizers increase the number of tillers hill^{-1}.

Number of effective tillers hill^{-1}

At a 1% level of probability, it was determined that the impact of integrated nutrient management on the number of productive tillers hill^{-1}of BRRI dhan34 was substantial. The T_8 treatment (50% of BRRI approved doses + cowdung @ 5tha^{-1}) resulted in the greatest number of successful tillers hill^{-1} (9.21). The maximum number of effective tillers hill^{-1} was likely produced by this treatment, which likely provided the plants with enough nutrients. Control (no fertilizers) treatment had the fewest effective tillers hill^{-1} (6.77) (No fertilizers) (Fig. 1C).

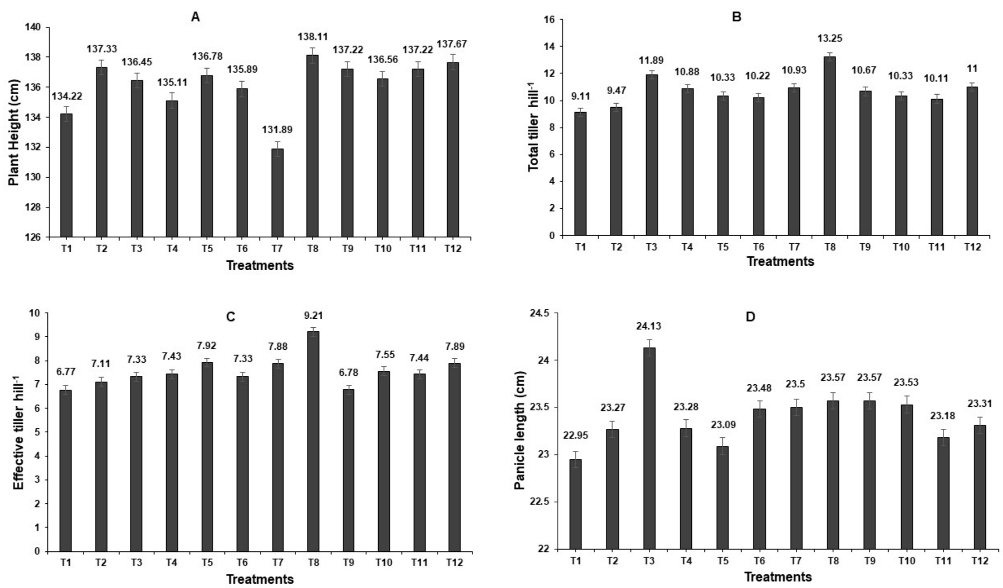

Figure 1: Effect of integrated nutrient management on plant height, total tiller hill^{-1}, effective tiller hill^{-1} and panicle length. Control (no fertilizers) (T_1), Recommended doses of fertilizers for *aman* variety (T_2), 75% of recommended doses (T_3), 50% of recommended doses (T_4), 25% of recommended doses (T_5), Cowdung @ 10 t ha^{-1}(T_6), 25% of recommended doses + cowdung @ 7.5 t ha^{-1} (T_7), 50% of recommended doses + cowdung @ 5.0 t ha^{-1}(T_8), 75% of recommended doses + cowdung @ 2.5 t ha^{-1}(T_9), Vermicompost @ 5.0 t ha^{-1}(T_{10}), 50% of recommended doses + vermicompost @ 2.5 t ha^{-1} (T_{11}), 75% of recommended doses + vermicompost @ 1.5 t ha^{-1} (T_{12})

Panicle length

Integrated nutrient management had no significant effect on panicle length of BRRI dhan34. Numerically the longest panicle (24.13 cm) was found in T_3 (75% of BRRI recommended doses) and the shortest panicle (23.18cm) was found in T_{11} (50% of BRRI recommended doses + vermicompost @2.5 t ha^{-1}) (Fig. 1D). Farhat ***et al.*** (2023) found that organic and chemical fertilizers increase the number of panicle length.Results of this study indicate that *E. atropurpurea* and *F. dichotoma* residue showed potentiality to inhibit weed growth and it has a significant effect on yield of *aman* rice.

Number of grains panicle^{-1}

There was significant difference due to integrated nutrient management in respect of number of grains panicle^{-1}of BRRI dhan34. The highest number of grains panicle^{-1} (115.84) was obtained from T_8 treatment (50% of recommended doses + cowdung @ 5.0 t ha^{-1}). The lowest number of grains panicle^{-1} (100.16) was found in treatment 75% of recommended doses + vermicompost @1.5tha^{-1} (Fig. 2A). Islam *et al.* (2023) and Oo *et al.* (2010) also found that combination of organic manure along with inorganic fertilizers increases grains panicle^{-1}.

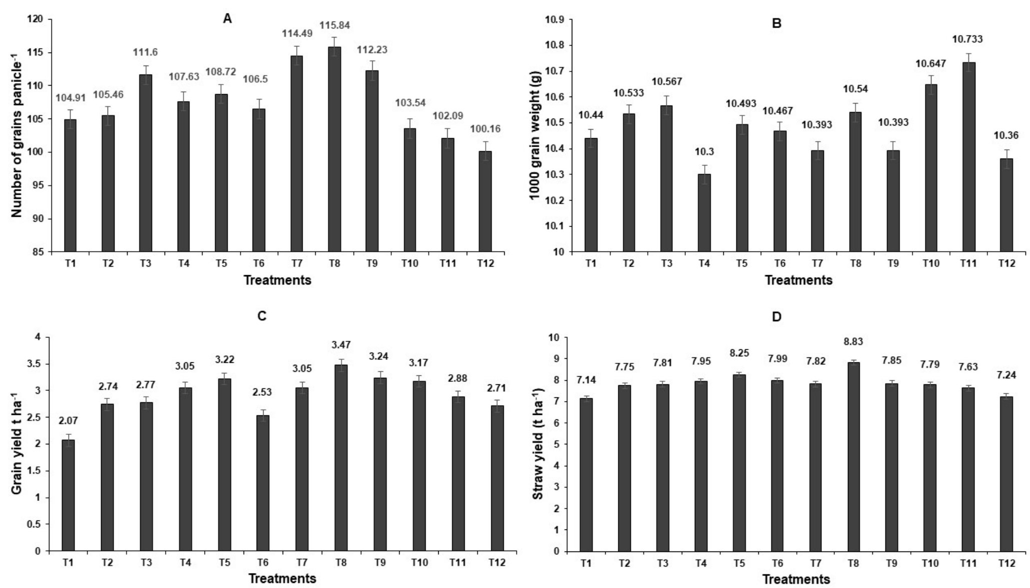

Figure 2: Effect of integrated nutrient management on number of grains panicle^{-1}, weight of 1000-grains weight, grain yield and straw yield. Control (no fertilizers) (T_1), Recommended doses of fertilizers for *aman* variety (T_2), 75% of recommended doses (T_3), 50% of recommended doses (T_4), 25% of recommended doses (T_5), Cowdung @ 10 t ha^{-1}(T_6), 25% of recommended doses + cowdung @ 7.5 t ha^{-1} (T_7), 50% of recommended doses + cowdung @ 5.0 t ha^{-1}(T_8), 75% of recommended doses + cowdung @ 2.5 t ha^{-1}(T_9), Vermicompost @ 5.0 t ha^{-1}(T_{10}), 50% of recommended doses + vermicompost @ 2.5 t ha^{-1} (T_{11}), 75% of recommended doses + vermicompost @ 1.5 t ha^{-1} (T_{12})

Weight of 1000-grains

Integrated nitrogen management have no significant effect on weight of 1000 grains of BRRI dhan34. However, numerically the highest weight of 1000 grains (10.73g) were obtained from treatment 50% of BRRI re commended doses + vermicompost@ 2.5tha^{-1} and the lowest weight of 1000 grains (10.30 g) was found from 50% of BRRI recommended doses (Fig. 2B).

Grain yield

Grain production of BRRI dhan34 significantly varied when organic matter and inorganic fertilizers were combined. The treatment 50% of BRRI recommended doses + cowdung @ 5 tha^{-1} crop produced the best grain yield (3.47 tha^{-1}). However, the T_1 treatment had the lowest grain yield (2.07 t ha^{-1}) (no fertilizers given) (Fig. 2C). The maximum number of productive tillers hill^{-1} and highest number of grains panicle^{-1}, which both contributed to grain yield, were present in the T_8 treatment, which resulted in the greater grain output. Banik *et al.* (2008) also found that combined application of 40% recommended dose of N as vermicompost + 60% recommended dose of N as urea produced the higher grain yield (5.27 tha^{-1}) as compared to 100% recommended dose of N alone through urea at Mohanpur in transplanted *kharif* rice.

Straw yield

Different combinations of organic matter and inorganic fertilizers had significant effect on straw yield of BRRI dhan34.The highest straw yield (8.83 tha^{-1}) was obtained in T_8 (50% of BRRI recommended doses + cowdung @5 t ha^{-1}). On the other hand, the lowest straw yield (7.14 t ha^{-1}) was found in treatment no fertilizers given. 50% of BRRI recommended doses + cowdung @ 5 t ha^{1} treatment produced the higher straw yield due to highest number of tillers hill^{-1} and highest number of grains panicle^{-1} which ultimately contributed to grain yield (Fig. 2D). Balasubramanian and Wahab (2012) observed that straw yields were favorably influenced by combined application of inorganic fertilizers and organic manures.

CONCLUSIONS

From the study it can be concluded that the highest grain yield (3.47 t ha^{-1}) was obtained from 50% of BRRI recommended doses + cowdung@ 5t ha^{-1} and the lowest grain yield (2.07 t ha^{-1}) was found in no fertilizer application. Therefore, it can be concluded that 50% of BRRI recommended dose with cowdung@ 5 t ha^{-1} could be the best possible combination for the better yield of T. *aman* rice variety *viz*. BRRI dhan34.

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