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INFLUENCE OF DIFFERENT AGRONOMIC MANAGEMENT ON THE YIELD OF RICE

M.M. RAHMAN^{*1,2}, M.S. HOSSAIN^{1,3}, S.B. SHAHID⁴, S.M. BOKHTIAR⁵ AND J.C. MALAKER^{6,7}¹Laboratory of Interdisciplinary Research for Future Agriculture (IRFA), Faculty of Agriculture, Sylhet Agricultural University, Sylhet Bangladesh; ²Associate Professor, Department of Crop Botany and Tea Production Technology, Sylhet Agricultural University, Sylhet, Bangladesh; ³Associate Professor, Department of Agronomy and Haor Agriculture, Sylhet Agricultural University, Sylhet, Bangladesh;⁴Assistant Professor, Department of Plant and Environmental Biotechnology, Sylhet Agricultural University, Sylhet, Bangladesh;⁵Executive Chairman, Bangladesh Agricultural Research Council (BARC), Dhaka; ⁶Deputy Director (LR),Department of Agricultural Extension, Khamarbari, Dhaka, Bangladesh; ⁷Lead facilitator, SLToT,

Horticulture Centre, Kallyanpur, Chapainawabganj, Bangladesh.

^{*}Corresponding author & address: Md. Masudur Rahman, E-mail: masudur.cbot@sau.ac.bd

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ABSTRACT

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An experiment was conducted at Horticulture Centre, Kallyanpur, Chapainawabganj, Bangladesh during *Boro* season (December 2018-May 2019), to observe the effect of different agronomic management practices on the yield potentiality of BRRI dhan28. The results showed positive relationship of improved agronomic practices on rice yield. Defoliation has no negative effect on the yield of BRRI dhan28, moreover, 25% defoliation gives maximum yield ($5.08 \pm 0.03 \text{ t ha}^{-1}$) as compared to the nil. Similar response was observed in detillering, where 10% gives maximum yield ($5.38 \pm 0.02 \text{ t ha}^{-1}$) as compared to the 0%. Higher yield ($5.43 \pm 0.04 \text{ t ha}^{-1}$) with less amount of urea was recorded in case of placement method of Urea Super Granule (USG) than that of side dressing method of prilled urea ($4.98 \pm 0.02 \text{ t ha}^{-1}$). Integrated Plant Nutrition System was maximum yielder ($5.43 \pm 0.10 \text{ t ha}^{-1}$) as compared to the farmer's practice. Finally, the result revealed that improved agronomic practices plays pivotal role to the increased production with less cost.

Key words: rice, nutrient management, fertilization, defoliation and detillering

INTRODUCTION

Bangladesh is an agro based country and 80% of the total population directly or indirectly involved in Agriculture (Raihan *et al.* 2018). Average higher yield is the major concern of present-day agriculture to meet up the food demand of increasing population (Kader *et al.* 2015). Rice (*Oryza sativa*) is the most important cereal grain in the world and used as a staple food (Raihan *et al.* 2018; Pinson *et al.* 2015). Rice is the main food of Bangladesh which is directly involved with the economy of Bangladesh (Brolley 2015). There are about more than ten thousand rice germplasm found in Bangladesh. But Bangladesh rice research institute has released 98 inbreds (HYVs) and 7 hybrid varieties (BRRI 2020). Now a day, private organizations also trying to introduce hybrid rice varieties (Mustari *et al.* 2013). Local, modern and hybrid rice varieties in different areas of Bangladesh showing distinguished performance for their characteristics (AIS 2020; Mustari *et al.* 2013). All the varieties do not show the equal performance in a specific location. The yield of different varieties, pest and disease tolerance, rice quality, life span etc. also differ from variety to variety. Our farmers are reluctant to cultivate more hybrid rice because it is observed that hybrid rice cultivation comparatively requires more fertilizer, irrigation etc. than the conventional rice either local or HYV which ultimately increase the cost of production (Chowdhury *et al.* 2019; Mahalder 2018; Kader *et al.* 2015; Mustari *et al.* 2013). Fertility status of different soil varies due to topography, organic matter content, parent materials, soil pH etc. Moreover, due to hot and humid climate, fertility status of Bangladesh soil depleting day by day. Generally, it is desirable to higher productivity from fertile soil and vice-versa. But a poor soil can be converted into higher productive by adjusting modern agricultural practices like soil test-based fertilizer application, use of adequate organic matter, Integrated Plant Nutrition System (IPNS) practice, water and pest management etc. (Chowdhury *et al.* 2019; Kader *et al.* 2015; FRG 2018). The farmers of Bangladesh use excessive urea fertilizer in their field in prilled form. In this way they make wastage of urea as well as they pollute the environment. To reduce the excessive use of urea, prilled urea can be applied by the form of urea super granule (USG). Farmers of Bangladesh have a common tendency of using pesticides where they find leaves and tillers damaging pest infestation in the field. They never consider the degree of infestation and stage of crop when infestation occurred by leaves and tiller damaging pests. Farmers become very much worried with the damage of tillers mainly for subsequent yield loss. To minimize all the problems, we can emphasize on the agronomic practices for gaining the maximum production with minimum cost. A combination of high-yielding rice varieties and good management practices is prerequisite to enhance the productivity of rice in Bangladesh. BRRI dhan28 is a high yielding early variety grown in *Boro* season. The study was undertaken to observe the effect of different agronomic management practices on the yield potentiality of BRRI dhan28 and build up the confidence of farmers about the compensation ability of rice plant against the damage of tiller and leaf damage naturally up to certain stage of rice up to certain level of infestation.

MATERIALS AND METHODS

Experimental site and duration: The experiment was conducted at Horticulture Centre, Kallyanpur, Chapainawabganj, Bangladesh during *Boro* season (December 2018-May 2019).

Planting material: Rice seedlings of BRRI dhan28 were used for this experiment and seeds of BRRI dhan28 were collected from Bangladesh Rice Research Institute (BRRI), Joydebpur, Gazipur.

Treatment and design: Randomized complete block (RCBD) was used as the experimental design. The size of each plot was 2m x 2m. Around the plot bunds were sufficiently raised to stop the overflow of water from one plot to another. Same aged (30 days) seedlings of BRRI dhan28 variety were transplanted on the same date. Three hills were randomly selected from each plot and marked by pegging sticks for data collection. Data on plant height, number of tillers per hill and number of leaves per hill were collected monthly at different crop stages and yield was collected finally at harvest. Insect pest and diseases infestation were also recorded at different time. Data collected from all (12 for each treatment combination) plot were compiled and made average for compare results and performance according to the treatments.

Case I: Defoliation trial had three (3) treatments with four (4) replications. The treatments were 0%, 25% and 50% leaf cutting by scissors artificially. Each plot size was 4 m². The plots were enclosed and marked by using four bamboo sticks at four corners connected with thread. Fertilizer and other intercultural operation were same for three treatments. The leaf cutting operation was done at 34 days after transplanting.

Case II: Detillering trial had 3 treatments with four (4) replications. The treatments were 0%, 25% and 50% detillering by hand artificially. Each plot size was 4 m². The plots were enclosed and marked by using four bamboo sticks at four corners connected with thread. Fertilizer and other intercultural operation were same for three treatments. The tiller cutting operation was done at 34 days after transplanting. According to the treatments the tillers were cut off from the base of the plants with scissors.

Case III: Different urea application methods were used as treatment. Recommended fertilizer dose was applied based on fertilizer recommendation guide (FRG 2018). Three methods of urea fertilizer application were used as treatment with four replications. Except urea all fertilizers were applied as a basal dose. Urea was applied into three splits in two forms: prilled urea by side dressing method @ 225 kg ha⁻¹ and urea super granule (USG) by placement method @ 168 kg ha⁻¹.

Case IV: Different fertilizer management techniques were used as treatment. Recommended dose of chemical fertilizer and manure was applied based on fertilizer recommendation guide (FRG 2018). Inorganic Fertilizer Practice (IFP), Integrated Plant Nutrition System (IPNS) and Farmers Practice (FP) as control were three fertilizer management techniques used as treatment with four replications. Considering the soil topography of Horticulture Centre, Kallyanpur, Chapainawabganj soil of fertility grade-2 was detected, and the area of plot size was demarked as ten decimals. Then the three-grade plot was divided into three sub plots *viz.* IFP, IPNS and FP. Fertilizer doses were calculated based on soil test result for highest yield goal. IFP plot was fertilized with balanced dose of chemical fertilizers only while IPNS plot was fertilized with both chemical and Organic manures. Fertilizer of IPNS plot was rationalized as organic manure were added, but in FP plot, farmers fertilizer dose was used (which was 10% more urea and TSP, considered as control plot).

Statistical analysis

Effect of defoliation, detillering, method of urea application and nutrient management on the growth and yield attributing characters of rice variety BRRI dhan28 were analyzed using one-way ANOVA. In case of significant effect, means were separated through post hoc test (using LSD value). Plant height, tiller number per hill and leaves per tiller were analyzed separately for each sampling date. Values were reported as significant at *p* values <0.05. All the analysis was performed in R (R Core Team, 2020).

RESULTS AND DISCUSSION

Effect of defoliation

Plant height increases gradually with time in all treatments (Fig. 1). Defoliation affected plant height only in February where the plants were significantly shorter at 25% defoliation compared to 50% and no defoliation (Fig. 1, top). Number of tillers per hill were maximum in March where it reaches around 15 tillers per hill (Fig. 1 middle). Defoliation significantly affected the number of tillers in January and February (Fig. 1 middle). At that two-point, tiller numbers were lower in 50% defoliation than others. Like number of tillers per hill, number of leaves per tiller were also higher in March (Fig. 1, bottom). Defoliation did not affect the number of leaves per tiller at any sampling date.

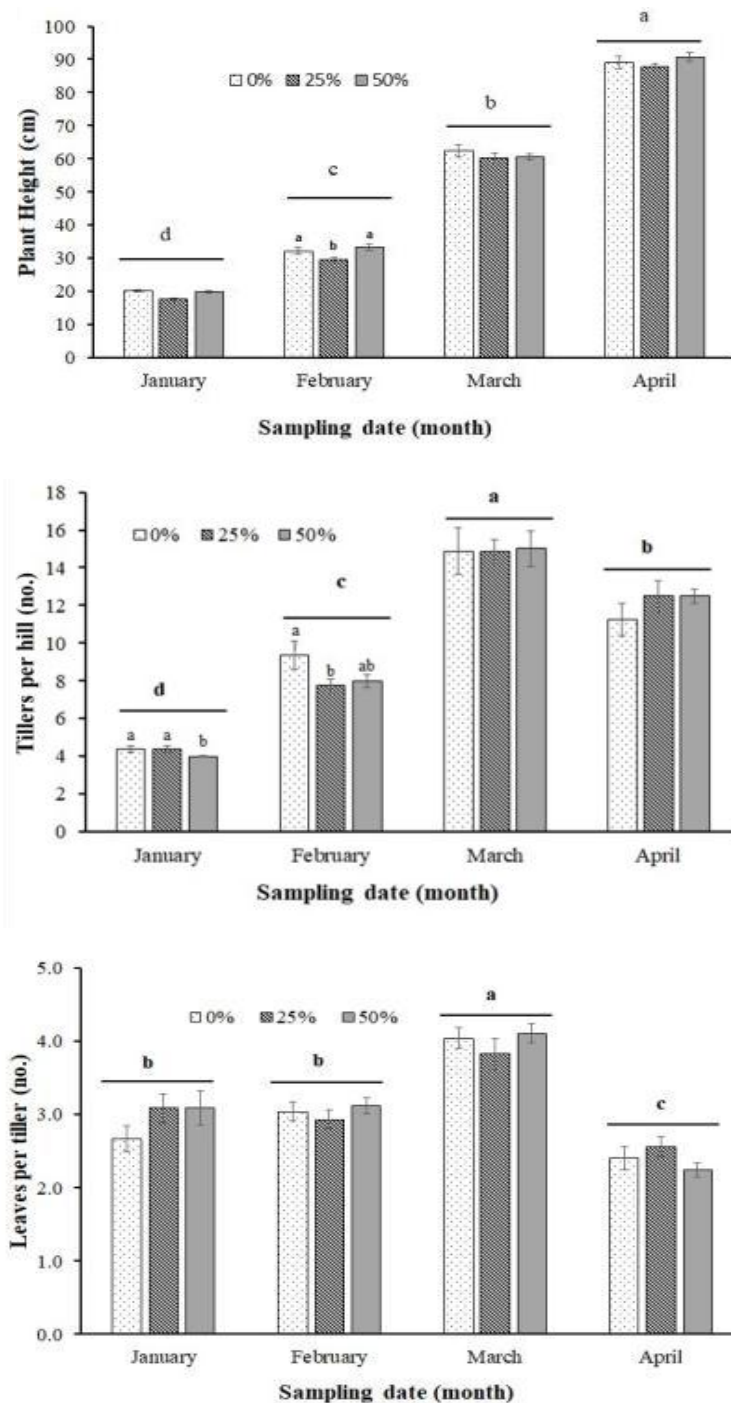


Fig. 1. Effect of defoliation on plant height (top), tiller per hill (middle) and leaves per tiller (bottom). Columns bearing same letters does not differ statistically. Error bars represent 1 SEM, n=4.

Defoliation significantly affected the yield attributing characters of BRRI dhan28. Number of filled spikelet, total number of spikelets per panicle was higher while the number of unfilled spikelets per panicle was lower in 25% defoliation than others treatment (Table 1). The highest yield (5.08 t ha^{-1}) was also obtained in 25% defoliation (Table 1). Leaf damage of rice plant is not major threat in yield performance. It depends on different stages of rice and degree of damage. But according to this study there is no need to apply preventive measures up to 50% of leaf damage within the period of 21-28 DAT. So, the farmers should take right decision to use measures in the rice field. Because, leaf damage up to 50% within the period of 21-28 DAT does not affect the yield of the crop. Shao *et al.* (2010) reported that mild defoliation did not affect grain yield. Kraus and Stout (2019) reported increased yield of rice due to defoliation which was in line with our findings.

Table 1. Effect of defoliation on yield and yield contributing characters of BRR1 dhan28

| Defoliation | Spikelet per panicle (no.) | | | Yield (t ha ⁻¹) |
|--------------------|----------------------------|-------------------|----------------|-----------------------------|
| | Filled spikelet | Unfilled spikelet | Total spikelet | |
| 0% | 138.75±1.3b | 16.00±0.4a | 154.75±1.4b | 4.83±0.03b |
| 25% | 168.00±4.8a | 13.37±0.5b | 171.37±4.9a | 5.08±0.03a |
| 50% | 142.37±3.2b | 16.25±0.8a | 158.62±3.3b | 4.90±0.02b |
| Significance level | *** | * | *** | *** |

*, ** and *** represent p values <0.05, <0.01 and <0.001, respectively

Effect of detillering

Plant height increases gradually with time in all treatments (Fig. 2). Detillering did not affect plant height at any time point (Fig. 2, top). Number of tillers per hill were maximum in March and April where it reaches around 14 tillers per hill (Fig. 2, middle). The number of tillers per hill did not vary significantly among the treatments at any sampling date. Number of leaves per tiller were higher in March (Fig. 2, bottom). The number of leaves per tiller were statistically similar among the treatments at all sampling date.

Detillering significantly affected the number of filled spikelet per panicle, total spikelet per panicle and yield while the number of unfilled spikelets per panicle were unaffected. Number of filled spikelet, total number of spikelets per panicle was lower at 25% detillering compared to other two treatments while the number unfilled spikelet per panicle did not vary among the treatments (Table 2). The highest yield (5.38 tha⁻¹) was obtained in 25% detillering while lowest yield was found in control treatment (Table 2). Rice plant shows the ability to compensation of the detillering at early crop stage does not hamper yield. This finding was in line with the findings of Paul *et al.* (2002) in BR23.

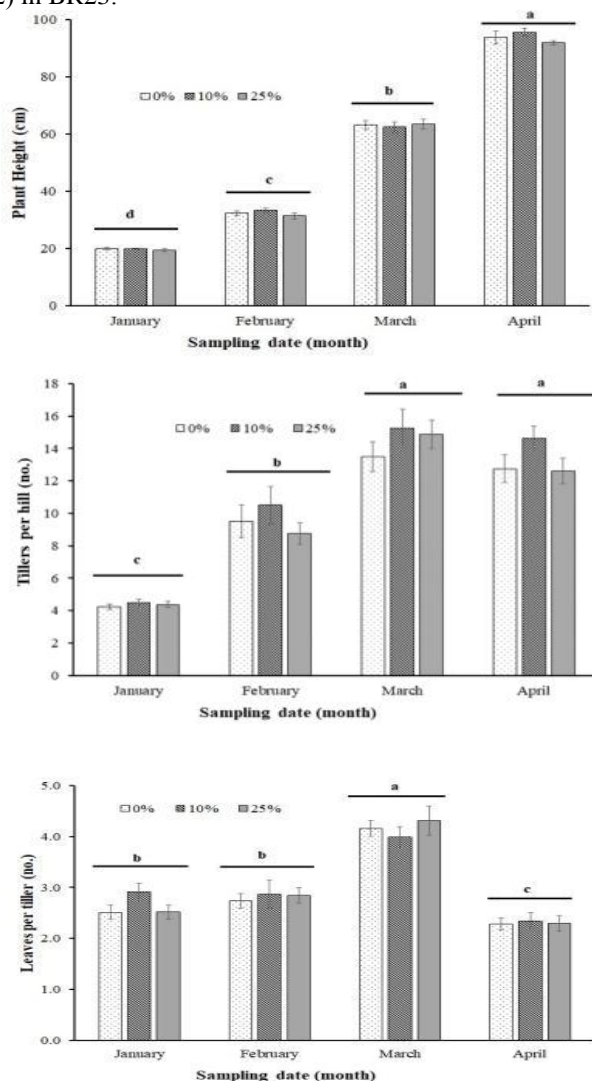


Fig. 2. Effect of detillering on plant height (top), tiller per hill (middle) and leaves per tiller (bottom). Columns bearing same letters does not differ statistically. Error bars represent 1 SEM, n=4

So, the farmers should not apply unnecessary pesticide due to infestation of tiller damaging pests at the early crop stage and up to certain level of infestation.

Table 2. Effect of detillering on yield and yield contributing characters of BRR1 dhan28

| Level of de-tillering | Spikelet per panicle (no.) | | | Yield (t ha ⁻¹) |
|-----------------------|----------------------------|-------------------|----------------|-----------------------------|
| | Filled spikelet | Unfilled spikelet | Total spikelet | |
| 0% | 148.25±3.12ab | 14.75±0.72 | 163±3.27ab | 4.89±0.04c |
| 10% | 152.75±3.88a | 14.87±0.47 | 167.62±3.52a | 5.38±0.02a |
| 25% | 144.12±1.02b | 15.12±0.51 | 159.25±1.16b | 5.04±0.04b |
| Significance level | * | ns | * | *** |

*, ** and *** represent p values <0.05, <0.01 and <0.001, respectively. ns stands for non-significant

Effect of urea application method

Plant height increases gradually with time in all treatments (Fig. 3). Both side dressing and USG application did not affect plant height at any time point (Fig. 3, top). Number of tillers per hill were maximum in March where it reaches around 16 tillers per hill (Fig. 3 middle). The number of tillers per hill were significantly higher in USG application in April. Number of leaves per tiller were higher in March (Fig. 3, bottom). The number of leaves per tiller were statistically similar in both treatments at all sampling date.

USG placement method significantly increased the number of filled spikelet per panicle, total spikelet per panicle and yield. Number of filled spikelet, total number of spikelets per panicle was higher in USG placement than broadcasting but the number unfilled spikelet per panicle did not vary between the treatments (Table 3). The yield (5.43 t ha⁻¹) was significantly higher in USG placement than broadcasting of urea (Table 3). As higher yield was recorded and less amount of urea was applied in case of USG placement method than that of prilled urea method, the farmers should be suggested to adopt either USG placement method for having higher yield with lower cost of rice production. Regarding USG placement method, similar result was described in BR11 by Mohammad *et al.* (2014).

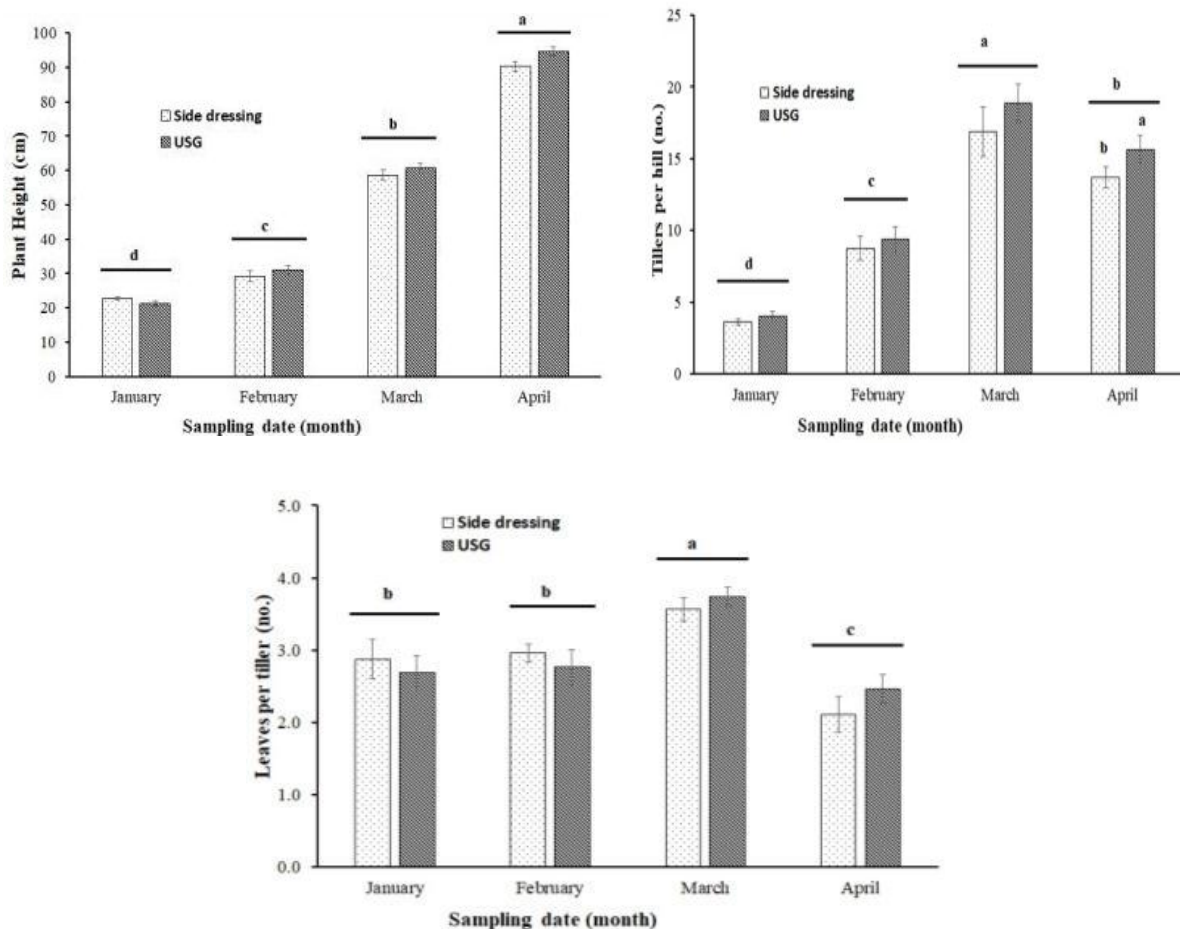


Fig. 3. Effect of urea application method on plant height (top), tiller per hill (middle) and leaves per tiller (bottom). Columns bearing same letters does not differ statistically. Error bars represent 1 SEM, n=4.

Table 3. Effect of urea application method on the yield and yield contributing characters of BRR1 dhan28

| Method of Urea application | Spikelet per panicle (no.) | | | Yield (t ha ⁻¹) |
|----------------------------|----------------------------|-------------------|----------------|-----------------------------|
| | Filled spikelet | Unfilled spikelet | Total spikelet | |
| Side dressing | 145.00±2.12b | 14.5±1.19 | 159.50±2.47b | 4.98±0.02b |
| USG | 158.37±2.19a | 15.87±0.78 | 174.25±2.06a | 5.43±0.04a |
| Significance level | *** | ns | *** | *** |

*, ** and *** represent p values <0.05, <0.01 and <0.001, respectively. ns stands for non-significant

Effect of Nutrient management

Different nutrient management did not influence the plant height of BRR1 dhan28 while the effective tillers per hill were higher in IPNS than IFP and FP treatments (Table 4). Although total number spikelet per panicle did not differ significantly among the treatment, highest number of filled spikelet and lowest number of unfilled spikelets were found in IPNS treatment (Table 4). Consequently, highest yield was also obtained in IPNS treatment while lowest yield was found in FP (Table 4).

Table 4. Effect of different nutrient management on the yield and yield contributing characters of BRR1 dhan28

| Treatment | Plant height (cm) | Effective tillers per hill (no.) | Spikelet per panicle (no.) | | | Yield (t ha ⁻¹) |
|--------------------|-------------------|----------------------------------|----------------------------|------------|-----------|-----------------------------|
| | | | Filled | Unfilled | Total | |
| IPNS | 100±1.20 | 16.1±0.78a | 150.7±1.2a | 19.3±1.6c | 170.0±1.2 | 5.43±0.10a |
| IFP | 99.1±0.98 | 14.2±0.43b | 145.8±2.4b | 23.2±1.4b | 169.2±2.8 | 5.21±0.02b |
| FP (control) | 99.6±1.05 | 13.2±0.83b | 140.0±2.5c | 28.1±1.06a | 168.1±2.3 | 4.92±0.02c |
| Significance level | Ns | ** | ** | *** | ns | *** |

*, ** and *** represent p values <0.05, <0.01 and <0.001, respectively. ns stands for non-significant. IFP: Inorganic Fertilizer Practice, IPNS: Integrated Plant Nutrition System and FP: Farmer Practice.

By following soil test-based fertilizer recommendation, different fertility grade soil can be brought into similar productivity level. Considering other factor like soil health, cost-benefit ratio, environmental issue, the recommended doses of fertilizer should not provide from only chemical sources, rather it should meet up/provide from organic and in organic sources through IPNS adjustment. Better nutritional compensation to higher yield in BRR1 dhan29 was reported by Kader *et al.* (2015) and Jahan *et al.* (2009).

CONCLUSION

From the results of the study it could be concluded that improve agronomic practices of rice cultivation is advantageous in terms of yield of *Boro* rice under Bangladesh context. Leaf damage of rice plant is not major threat in yield performance. It depends on different stages of rice and degree of damage. But according to this study there is no need to apply preventive measures up to 50% of leaf damage within the period of 21-28 DAT, which does not affect the yield of the crop. So, the farmers should take right decision to use suitable measures in the rice field. Rice plant shows the ability to compensate the tiller damage at early crop stage and up to certain degree of detillering damage, it does not hamper yield. So, the farmers should be suggested not to apply unnecessary pesticide due to infestation of tiller damaging insects at the early crop stage and up to certain level of infestation. As higher yield was recorded and less amount of urea was applied in case of USG method than that of prilled urea method, the farmers can adopt USG method for having higher yield with lower cost of rice production. By considering different soil factors the recommended doses of fertilizer should not provide from only chemical sources, rather it should be provided from organic and in organic sources through Integrated Plant Nutrition System.

AUTHOR CONTRIBUTIONS

MMR and MSH contributed equally. JCM and SMB conceptualize the idea and supervise the whole experiment. JCM, MMR and MSH developed the experimental design and collected data. MMR and MSH analyzed and wrote the first draft of the manuscript. SBS created the figures and revised the manuscript. All authors edited and approved the final version of the manuscript. JCM was the team leader of the research work.

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