ARTICLE HISTORY
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Abstract
An experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh to study the effect of integrated fertilizer and weed management on the growth performance of aromatic Boro rice (cv. BRRI dhan50). The experiment comprised six fertilizer managements viz., control (no manures and no fertilizers), recommended dose of inorganic fertilizers (i.e. Urea, TSP, MoP, Gypsum, ZnSO4 @ 250, 120, 120, 100, 10 kg ha⁻¹, respectively), 50% of recommended dose of inorganic fertilizers + cowdung @ 5 t ha⁻¹, 75% of recommended dose of inorganic fertilizers + cowdung @ 5 t ha⁻¹, 50% of recommended dose of inorganic fertilizers + poultry manure @ 2.5 t ha⁻¹, and 75% of recommended dose of inorganic fertilizers + poultry manure @ 2.5 t ha⁻¹ and four weed managements viz., control (no weeding), pre-emergence herbicide, Panida 33 EC @ 2.5 l ha⁻¹ + one hand weeding at 35 DAT, post-emergence herbicide, Granite 240 SC @ 93.70 ml ha⁻¹ + one hand weeding at 35 DAT, pre-emergence herbicide, Panida 33 EC @ 2.5 l ha⁻¹ + post-emergence herbicide, Granite 240 SC @ 93.70 ml ha⁻¹ + one hand weeding at 35 DAT, post-emergence herbicide, Granite 240 SC @ 93.70 ml ha⁻¹ + one hand weeding at 35 DAT. The experiment was laid out in a factorial randomized complete block design with three replications. Growth traits of aromatic Boro rice (cv. BRRI dhan50) were significantly influenced by integrated fertilizer and weed management. Plant height, number of tillers hill⁻¹, total dry matter, leaf area index (LAI) and crop growth rate (CGR) gave their highest values in 75% of recommended dose of inorganic fertilizers and poultry manure @ 2.5 t ha⁻¹ along with pre-emergence herbicide, Panida 33 EC @ 2.5 l ha⁻¹ + one hand weeding at 35 DAT, post-emergence herbicide, Granite 240 SC @ 93.70 ml ha⁻¹ + one hand weeding at 35 DAT, while their corresponding lowest values were found in control. So it can be concluded that, the interaction of 75% of recommended dose of inorganic fertilizers and poultry manure @ 2.5 t ha⁻¹ along with pre-emergence herbicide (Panida 33 EC @ 2.5 l ha⁻¹) + post-emergence herbicide (Granite 240 SC @ 93.70 ml ha⁻¹) appears as the promising combination in respect of growth performance of aromatic Boro rice (cv. BRRI dhan50).

Keywords
Aromatic Boro rice
Growth
Integrated fertilizer
Herbicides
Weed management

INTRODUCTION
Rice (Oryza sativa L.) is consumed as the staple food in Bangladesh and has been given the highest priority in meeting the demands of its ever-increasing population. It is the most important food crop and a primary food source for more than one-third of world's population (Singh and Singh, 2008; Aljumaili et al., 2018). Rice is the second most widely consumed cereal in the world next to wheat. About 74.85% of cropped area of Bangladesh is used for rice production, with annual production of 34.72 million ton from 11.52 million ha of land (BBS, 2019). Boro rice covers 4.79 million ha (41.94% of total

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rice area) of land with production of 19.56 million ton (BBS, 2019). Aromatic rice contributes a small but special group of rice which covers 2% of the national rice acreage of Bangladesh (Roy et al., 2018). Most of the aromatic rice varieties in Bangladesh are traditional photo-period sensitive type and grown during Aman season (Kabir et al., 2004) while BRRI dhan50 (Banglamati) recommended for only Boro season (Paul et al., 2020). Proper growth is prerequisite for higher yield of rice. Integrated fertilizer and weed management are directly influence the growth, yield and quality of aromatic rice. Continuous use of chemical fertilizers without organic sources will lead to gradual decline of organic matter content and change of native N status in the soils, which results in lower productivity (Amanullah and Hidayatullah, 2016). Judicious use of chemical and organic fertilizers can improve rice plant growth, and increase rice yield and quality (Sarkar et al., 2016; Jahan et al., 2017; Paul et al., 2020). Integrated use of chemical fertilizers along with organic manure has been widely recommended for sustaining agricultural production (Amanullah and Khalid, 2016). Weeds are major causes of yield loss in upland rice and its control is labour intensive. The climate as well as the edaphic condition of Bangladesh is favourable for the growth of weeds. So, the rice crops usually infested heavily with weeds resulting in the reduction in grain yield by 70–80%, 30–40% and 22–36% in Aus, Aman and Boro season, respective- ly in Bangladesh (Sarkar et al., 2017). Due to weed infestation aromatic rice lost its grain yield by 59.82% for BRRI dhan50 in Boro season (Sinha et al., 2018) and 28.16% for Binadhan-9 in Aman season (Zannat et al., 2014). There is no doubt that maximum benefit for costly inputs like fertilizers and pesticides in rice can be fully derived when the crop is kept free from weed infestation. The traditional method of weed control is hand weeding which is very much laborious and time consuming. Mechanical weeding and herbicides are the alternative to hand weeding. Japanese rice weeder are in use in some areas of the country. But due to some disadvantages to its use, it has not gained wide spread popularity. Herbicides are effective in con- trolling weeds alone or in combination with hand weeding. Weed competition at early growth stage can be eliminated through pre-emergence and post-emergence herbicides like Panida, Ronstar 25 EC, Rfit 50 EC, Granait 240 SC and 2, 4-D amine which are good selective, pre-emergence and post- emergence herbicides (Ahmed et al., 2005). The efficient fertiliz- er management increases the vegetative growth of crop and at the same time reduces fertilization cost. Therefore, the present study was undertaken to evaluate the effects of integrated fertilizer and weed management on the growth performance of aromatic Boro rice (cv. BRRI dhan50).

**MATERIALS AND METHODS**

**Experimental site and experimentation**

An experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University (24° 75’ N latitude and 90° 50’ E longitude and at an altitude of 18 meter above the sea level), Mymensingh during the period from December 2014 to May 2015 to study the effect of integrated fertilizer and weed management on the growth performance of aromatic Boro rice (cv. BRRI dhan50). The experimental site belongs to the Sonatola series of the dark grey floodplain soil type under Old Brahmaputra Floodplain Agro-Ecological Zone (AEZ-9). The field was a medium high land with well drained silty-loam texture having pH 6.5 and 1.29% organic matter content. The experiment comprised six fertilizer managements viz., control (no manures and no fertilizers), recommended dose of inorganic fertilizers (i.e. Urea, TSP, MoP, Gypsum, ZnSO₄@ 250, 120, 120, 10, 10 kg ha⁻¹, respectively), 50% of recommended dose of inorganic fertilizers + cowdung @ 5 t ha⁻¹, 75% of recommended dose of inorganic fertilizers + cowdung @ 5 t ha⁻¹, 50% of recom- mended dose of inorganic fertilizers + poultry manure @ 2.5 t ha⁻¹, and 75% of recommended dose of inorganic fertilizers + poultry manure @ 2.5 t ha⁻¹ and four weed managements viz., control (no weeding), pre-emergence herbicide, Panida 33 EC + one hand weeding at 35 DAT, post-emergence herbicide, Granite 240 SC + one hand weeding at 35 DAT, pre-emergence herbicide, Panida 33 EC + post-emergence herbicide, Granite 240 SC. The experiment was laid out in a factorial randomized complete block design with three replications.

**Crop husbandry**

Healthy seeds of BRRI dhan50 rice were collected from the Bangladesh Rice Research Institute, Joydebpur, Gazipur. The nursery beds were puddled with country plough, cleaned and leveled with ladder. Then the sprouted seeds were sown in the nursery beds on 07 December 2014. At the time of final land preparation, respective unit plots were amended with organic and inorganic fertilizers according to treatment specification. Urea was top dressed in three equal splits at 15, 35 and 55 DAT (panicle initiation stage). Full dose of triple super phosphate, muriate of potash, gypsum and zinc sulphate were applied at final land preparation. Thirty-five day old seedlings were trans- planted on 10 January 2015 in the well puddled plot with a spacing of 25 cm × 15 cm and two-seeding hill⁻¹.

**Data collection on growth traits**

Five hills were marked by bamboo stick excluding boarder rows to collect data on plant height and tiller number. Five hills were destructed every sampling dates for leaf area index. Data on crop growth parameters viz., plant height, number of tillers hill⁻¹ and leaf area index were taken at intervals of 15 days at 20, 35, 50, 65 and 80 DAT. The leaf area was measured by an automatic leaf area meter (Type AAN-7, Hayashi Dam Ko Co., Japan). Leaf area index was calculated as the ratio of total leaf area and total ground area of the sample as described by Hunt (1978).

\[
\text{LAI} = \frac{\text{LA}}{P}
\]

Where,

- \( \text{LAI} = \) Leaf area index
- \( \text{LA} = \) Total leaf area of the leaves of all the sampled plants (cm²)
- \( P = \) Area of the ground surface covered by the plant (cm²)

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**References**

Ahmed et al., 2005; Amanullah and Khalid, 2016; Amanullah and Hidayatullah, 2016; Kabir et al., 2004; Jahan et al., 2017; Paul et al., 2020; Sarkar et al., 2016; Zannat et al., 2014; Sinha et al., 2018; Zannat et al., 2014; Paul et al., 2020.

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**Notes**

- **LA** = Total leaf area of the leaves of all the sampled plants (cm²)
- **P** = Area of the ground surface covered by the plant (cm²)

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**Tables**

- Table 1: Summary of experimental design and treatments
- Table 2: Performance of rice varieties under different fertilizer managements
- Table 3: Performance of rice varieties under different weed management

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**Figures**

- Figure 1: Growth and yield performance of aromatic rice
- Figure 2: Effect of integrated fertilizer and weed management on the growth performance of aromatic Boro rice

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**Authors’ Contribution**

- Jahan, Paul contributed to the conception and design of the study.
- The authors read and approved the final manuscript.

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**Ethical Considerations**

- The study was conducted in accordance with the ethical standards. All participants provided informed consent.

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**Conflict of Interest**

- The authors declare no conflicts of interest.

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**Data Availability**

- The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

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In order to collect samples, five sample plants were uprooted from each plot at 15 day intervals up to 80 DAT and were cleaned, de-rooted and leaves were separated from the culms. Collected samples were dried in an electric oven for 72 hours maintaining a constant temperature of 70°C. After drying, weight of each sample was recorded. Crop growth rate refers to increase of plant dry matter production per unit of time per unit of ground area. It was calculated with the following formula.

\[
\text{CGR} = \frac{1}{A} \times \frac{W_2 - W_1}{T_2 - T_1} \text{ g m}^{-2} \text{ day}^{-1}
\]

Where,
- \(W_1\) = dry matter production at \(T_1\) time
- \(W_2\) = dry matter production at \(T_2\) time
- \(A\) = ground area (m²)

The weed density and dry weight of infesting weed species were recorded at 60 DAT in all weeding treatments with the help of a plant quadrat measuring 1.0 m × 1.0 m as per method described by Cruz et al. (1986) from each plot. To determine the plant total dry weight and weed dry weight, the plant and the weed samples were collected. The collected weeds were dried in an electric oven for 72 hours at a temperature of 85 ± 5°C. After drying, the dry weight of each plot was recorded by an electrical balance.

**Statistical analysis of data**

The recorded data were statistically analyzed using the “Analysis of Variance” technique and the differences among treatment means were adjudged by Duncan’s New Multiple Range Test (Gomez and Gomez, 1984).

**RESULTS AND DISCUSSION**

**Weed parameters**

**Weed flora:** Weeds found in aromatic *Boro* rice (cv. BRRI dhan50) field are aquatic, semi aquatic, broad leaved and grasses which can withstand water logging usually enough to depress crop yield very significantly if not controlled (Sinha et al., 2018 and Paul et al., 2019). Conditions favourable for growing aromatic *Boro* rice (cv. BRRI dhan50) are also favourable for the exuberant growth of a number of weed species that compete with crop plants. The experimental plots were infested with thirteen weed species belonging to six families (Table 1). Five weed species were of the family Gramineae, three of the family Cyperaceae, one of the family Oxalidaceae and Araceae and Verbenaceae and two of the family Poteneriaceae. Among the total weed vegetation most of them were annual.

**Weed dry weight:** The interaction between integrated fertilizer and weed management had significant effect on total weed dry weight m² at 60 DAT (Figure 1). The highest weed dry weight 22.7 g was found in F_S × W_0 (75% of recommended dose of inorganic fertilizer + poultry manure @ 2.5 t ha⁻¹ with control (unweeded) and the lowest weed dry weight (1.76g) was found in F_0 × W_0 (no fertilizer and no manure with pre-emergence herbicide, Panida 33 EC + post-emergence herbicide, Granite 240 SC) which was statistically identical with F_S × W_0 (no fertilizer and no manure with pre-emergence herbicide, Panida 33 EC + one hand weeding at 35 DAT), F_S × W_0 (no fertilizer and no manure with post-emergence herbicide, Granite 240 SC + one hand weeding at 35 DAT) (Figure 1). Similar results were reported elsewhere (Gnanavel and Anbhazhagan, 2010; Sinha et al., 2018 and Paul et al., 2019) who reported that maximum weed dry weight was observed in the weedy check plots compared to other weed control treatments.

**Plant height:** The interaction effect of integrated fertilizer and weed management exhibited significant influence on plant height at all sampling dates (Table 2). The tallest plant stature (78.53 cm) was at 80 DAT in F_S × W_0 (75% of recommended dose of inorganic fertilizers + poultry manure @ 2.5 t ha⁻¹ with pre-emergence herbicide, Panida 33 EC @ 2.5 l ha⁻¹ + post-emergence herbicide Granite 240 SC @ 93.70 ml ha⁻¹) and the shortest plant stature (68.40 cm) was in F_0 × W_0 (no fertilizers and no manure under unweeded condition) which was statistically identical to the treatment F_S × W_0 (no fertilizers and no manure with pre-emergence herbicide, Panida 33 EC @ 2.5 l ha⁻¹ + one hand weeding at 35 DAT) and F_S × W_0 (no fertilizers and no manure with pre-emergence herbicide, Panida 33 EC @ 2.5 l ha⁻¹ + post-emergence herbicide, Granite 240 SC @ 93.70 ml ha⁻¹) (Table 2). Similar trend in plant height was reported by Sarkar et al. (2016) and Jahan et al. (2017) who documented that integrated manure inorganic fertilizers and also weed management are the important ones in boosting the vegetative growth of rice. Islam et al. (2014) reported that three weeding at 15, 30 and 45 DAT along with with 50% BRRI recommended chemical fertilizers + poultry manure @ 2.5 t ha⁻¹ produced tallest plants compared to control.

**Number of tillers hill⁻¹:** Tiller production ability in rice is an important agronomic trait for panicle number per unit land area as well as grain production (Badshah et al., 2014). Tiller number varied significantly among the treatment interactions at all crop growth stages (Table 3). The highest number of tillers (23.47) was obtained at 80 DAT from F_S × W_0 (75% of recommended dose of inorganic fertilizers + poultry manure @ 2.5 t ha⁻¹ with pre-emergence herbicide, Panida 33 EC @ 2.5 l ha⁻¹ + post-emergence herbicide, Granite 240 SC @ 93.70 ml ha⁻¹) which was statistically identical to the treatment F_S × W_0 (75% of recommended dose of inorganic fertilizer + poultry manure @ 2.5 t ha⁻¹ with control (unweeded) and the lowest values (9.53) was obtained from F_0 × W_0 (no fertilizers and no manure under unweeded condition) (Table 3). Inadequacy of nutrients in control plots hampered tiller production in rice compared to...
Table 1. Infesting species of weeds in the experimental field of aromatic Boro rice (cv. BRRI dhan50).

| Common name       | English name         | Scientific name                                  | Family name | Life cycle |
|-------------------|----------------------|--------------------------------------------------|-------------|------------|
| Shama             | Barnyard grass       | Echinochloa crus-galli L. Beauv.                 | Gramineae   | Annual     |
| Angta             | Joint grass          | Panicum repens L.                                | Gramineae   | Perennial  |
| Panikachu         | Pickerel weed        | Monochoria vaginalis (Burm. f.) Presl.           | Pontederiaceae | Perennial |
| Halood mutha      | Yellow nutsedge      | Cyperus esculentus L.                            | Cyperaceae  | Annual     |
| Chesra            | Bulrush              | Scirpus juncoides Roxb.                          | Cyperaceae  | Annual     |
| Anguli ghash      | Crab grass           | Digitaria sanguinalis L.                         | Gramineae   | Annual     |
| Arail             | Southern cutgrass    | Leersia hexandra Sw.                            | Gramineae   | Annual     |
| Joina             | Grass like fimbristylis | Fimbrystylis milliacea L.                | Cyperaceae  | Annual     |
| Motka             | Bushy matgrass       | Lippia germinata H.B.K.                          | Verbenaceae | Annual     |
| Topapana          | Water lettuce        | Pista stratiotes Var.                           | Araceae     | Perennial  |
| Chela ghash       | Curved sicklegrass   | Paraphorice incurva (L.) C. E. Hubb              | Gramineae   | Annual     |
| Kachuripana       | Water hyacinth       | Eichhornia crassipes (Mart.) Solms               | Pontederiaceae | Perennial |
| Amrul             | Yellow wood sorrel   | Oxalis europaea Jord.                           | Oxalidaceae | Annual     |

Table 2. Effect of interaction between integrated fertilizer and weed management on plant height at different days after transplanting of aromatic Boro rice (cv. BRRI dhan50).

| Integrated fertilizer × weed management | Plant height (cm) |
|----------------------------------------|-------------------|
|                                        | Days after transplanting (DAT) |
|                                        | 20 DAT | 35 DAT | 50 DAT | 65 DAT | 80 DAT |
|                                        |        |        |        |        |        |
| F₀ × W₀                               | 21.27c | 33.67i | 47.80ghi | 61.33efgh | 68.40g |
| F₀ × W₁                               | 18.40d | 32.53i | 46.53i | 58.20gh | 70.53f |
| F₀ × W₂                               | 21.23c | 34.00i | 47.53i | 59.20gh | 69.13f |
| F₀ × W₃                               | 22.19bc | 34.27i | 47.59ghi | 58.80gh | 69.80eg |
| F₁ × W₀                               | 23.60ab | 38.67ghi | 52.02bcdef | 65.27bcd | 72.13cdfg |
| F₁ × W₁                               | 23.10abc | 39.67efg | 51.37defg | 60.53fgh | 74.40abcde |
| F₁ × W₂                               | 22.20bc | 40.33ef | 50.73efgh | 59.93gh | 71.00defg |
| F₁ × W₃                               | 22.37abc | 38.73fgh | 51.07efgh | 60.67fgh | 72.00cdefg |
| F₂ × W₀                               | 22.47abc | 37.60gh | 47.73ghi | 57.40h | 69.40g |
| F₂ × W₁                               | 22.53abc | 41.50cde | 53.67bcd | 65.13bce | 74.87abdc |
| F₂ × W₂                               | 22.87abc | 40.53def | 54.73abed | 66.27abdc | 74.67abdc |
| F₂ × W₃                               | 23.13abc | 36.93gh | 53.47bcd | 64.47bcdef | 74.17abdc |
| F₃ × W₀                               | 22.60abc | 40.13ef | 49.57fgi | 59.07gh | 70.97defg |
| F₃ × W₁                               | 23.40abc | 40.47fghi | 49.60fghi | 64.13cdefg | 73.47bcdef |
| F₃ × W₂                               | 24.13abc | 41.60cdef | 50.43efgh | 58.57gh | 73.13bcde |
| F₃ × W₃                               | 23.33abc | 40.20ef | 50.47efgh | 59.80gh | 71.47cdefg |
| F₄ × W₀                               | 24.30a  | 45.60a  | 55.50ab | 66.13abc | 76.00abc |
| F₄ × W₁                               | 23.57ab | 40.20ef | 51.25defgh | 61.80defgh | 71.87cdefg |
| F₄ × W₂                               | 22.39abc | 43.40abc | 57.77a | 68.47ab | 76.00ab |
| F₄ × W₃                               | 24.30a  | 43.50abc | 58.27a | 69.80a | 77.47ab |
| F₅ × W₀                               | 23.63ab | 42.67cd | 51.63cdef | 60.90ghf | 71.33cdef |
| F₅ × W₁                               | 23.93ab | 45.40ab | 53.40bced | 66.63abc | 78.20a |
| F₅ × W₂                               | 23.87ab | 43.53abc | 55.53ab | 65.50bcd | 77.20a |
| F₅ × W₃                               | 23.83ab | 43.27bc | 55.17abc | 65.57bcd | 78.53a |
| S*                                    | 0.594 | 0.721 | 3.76 | 3.35 | 3.23 |
| Level of significance                 | *     | **    | **   | **   | **   |
| CV (%)                                | 4.51  | 3.14  | 3.76 | 3.35 | 3.23 |

In a column, figures with same letter(s) or without letter do not differ significantly whereas figures with dissimilar letter differ significantly (as per DMRT); ** = Significant at 1% level of probability; *= Significant at 5% level of probability. F₀ = Control (no fertilizer and no manure), F₁ = Recommended dose of inorganic fertilizer (Urea, TSP, MoP, Gypsum, ZnSO₄ @ 250, 120, 120, 100, 10 kg ha⁻¹, respectively), F₂ = 50% of recommended dose of inorganic fertilizer + cowdung @ 5 t ha⁻¹, F₃ = 75% of recommended dose of inorganic fertilizer + cowdung @ 5 t ha⁻¹, F₄ = 50% of recommended dose of inorganic fertilizer + poultry manure @ 2.5 t ha⁻¹, F₅ = 75% of recommended dose of inorganic fertilizer + poultry manure @ 2.5 t ha⁻¹, W₀ = control (unweeded), W₁ = pre-emergence herbicide, Panida 33 EC + one hand weeding at 35 DAT, W₂ = post-emergence herbicide, Granite 240 SC + one hand weeding at 35 DAT, W₃ = pre-emergence herbicide, Panida 33 EC + post-emergence herbicide, Granite 240 SC @ 93.70 ml ha⁻¹.
other treatments with nutrient. On the other hand, weeding kept the land with lowest weed population density which reduced the competitive ability of weeds for nutrients and other growth factors with crop facilitate to absorb greater amount of plant nutrients, moisture and greater reception of solar radiation for growth resulted in higher number of tillers hill⁻¹. On the other hand, in weedy check plots weeds were allowed to grow without restriction, which competed with crop throughout its life cycle, consequently, it reduced crop growth and yield. These results corroborate with the findings of Choudhury et al. (1995) and Sinha et al. (2018) who reported that tiller production hill⁻¹ significantly differed with weeding treatments due to weed crop competition.

Leaf area index (LAI): The interaction between integrated fertilizer and weed management had significant effect on leaf area index at all sampling dates (Table 4). Irrespective of treatment combinations the leaf area index was increased in course of time up to 65 DAT and thereafter declined. Similar trend was depicted by Paul et al. (2013) and Paul et al. (2014). The results indicate that the interaction of F₅ × W₃ (75% of recommended dose of inorganic fertilizers + poultry manure @ 2.5 t ha⁻¹ with pre-emergence herbicide, Panida 33 EC @ 2.5 l ha⁻¹ + post-emergence herbicide, Granite 240 SC @ 93.70 ml ha⁻¹) produced the highest the leaf area index (6.26) at 65 DAT. The second highest leaf area index was produced from interaction of F₅ × W₂ (75% of recommended dose of inorganic fertilizer + poultry manure @ 2.5 t ha⁻¹ with pre-emergence herbicide, Panida 33 EC @ 2.5 l ha⁻¹ + post-emergence herbicide, Granite 240 SC @ 93.70 ml ha⁻¹).
**Table 3.** Effect of interaction between integrated fertilizer and weed management on number of total tillers hill$^{-1}$ at different days after transplanting of aromatic Bororice (cv. BRRI dhan50).

| Integrated fertilizer x weed management | 20 DAT | 35 DAT | 50 DAT | 65 DAT | 80 DAT |
|----------------------------------------|--------|--------|--------|--------|--------|
| F$_0$ × W$_0$                          | 2.40g  | 4.20j  | 5.54h  | 7.94h  | 9.53j  |
| F$_0$ × W$_1$                          | 2.80fg | 4.34j  | 7.60g  | 9.93g  | 13.07h |
| F$_0$ × W$_2$                          | 2.87ef | 6.14hi | 8.267fg| 11.40fg| 13.33hi|
| F$_0$ × W$_3$                          | 3.20def| 6.14hi | 9.167efg| 15.37de| 17.27de|
| F$_1$ × W$_0$                          | 3.467abc| 5.67i  | 9.067fg| 11.40fg| 15.58fg|
| F$_1$ × W$_1$                          | 3.333abcde| 8.74bcde| 12.53bc| 16.40cd| 20.60abc|
| F$_1$ × W$_2$                          | 3.733ab| 8.87abcd| 13.07bc| 18.03bc| 22.47a |
| F$_1$ × W$_3$                          | 3.200cdf| 7.20fg| 11.40cd| 15.73de| 19.07bcde|
| F$_2$ × W$_0$                          | 3.533abc| 7.60efg| 9.87def| 10.73fg| 12.13i |
| F$_2$ × W$_1$                          | 3.467abc| 9.07abc| 15.67a| 19.07ab| 22.47a |
| F$_2$ × W$_2$                          | 3.533abc| 10.00ab| 16.07a| 18.83ab| 21.67ab|
| F$_2$ × W$_3$                          | 3.400abcd| 7.67defg| 15.67a| 18.53ab| 20.97abc|
| F$_3$ × W$_0$                          | 3.20cdf| 8.27cdef| 11.13cde| 12.20f| 14.70gh|
| F$_3$ × W$_1$                          | 3.40abc| 9.00abc| 12.80bc| 14.27e| 16.33fg|
| F$_3$ × W$_2$                          | 3.34abcd| 9.94ab| 16.13a| 19.67ab| 23.00a |
| F$_3$ × W$_3$                          | 3.20def| 8.20cdef| 14.20ab| 18.13bc| 24.17abc|
| F$_4$ × W$_0$                          | 2.93def| 6.94gh| 9.930def| 12.00f| 13.80gh|
| F$_4$ × W$_1$                          | 3.40abcd| 9.33abc| 15.87a| 19.07ab| 22.53a |
| F$_4$ × W$_2$                          | 3.27bcdf| 8.600cde| 13.20bc| 16.00de| 18.67cde|
| F$_4$ × W$_3$                          | 3.67abc| 10.13a| 15.73a| 18.13bc| 21.27abc|
| F$_5$ × W$_0$                          | 3.40abcd| 8.800bcde| 12.40bc| 14.37e| 16.27ef|
| F$_5$ × W$_1$                          | 3.47abc| 10.13a| 15.87a| 19.07ab| 22.20a |
| F$_5$ × W$_2$                          | 3.80a| 10.00ab| 15.27a| 18.07bc| 20.73abc|
| F$_5$ × W$_3$                          | 3.80a| 10.00ab| 16.20a| 20.27a| 23.47a |
| SX                                     | 0.146| 0.381| 0.648| 0.627| 0.862 |
| CV (%)                                 | 7.59| 8.14| 8.91| 6.96| 8.11 |

In a column, figures with same letter(s) or without letter do not differ significantly whereas figures with dissimilar letter differ significantly (as per DMRT); ** = Significant at 1% level of probability; * = Significant at 5% level of probability.

F$_0$ = Control (no fertilizer and no manure), F$_1$ = Recommended dose of inorganic fertilizer (Urea, TSP, MoP, Gypsum, ZnSO$_4$ @ 250, 120, 100, 10, 10 kg ha$^{-1}$, respectively), F$_2$ = 50% of recommended dose of inorganic fertilizer + cowdung @ 5 t ha$^{-1}$, F$_3$ = 75% of recommended dose of inorganic fertilizer + cowdung @ 5 t ha$^{-1}$, F$_4$ = 50% of recommended dose of inorganic fertilizer + poultry manure @ 2.5 t ha$^{-1}$, F$_5$ = 75% of recommended dose of inorganic fertilizer + poultry manure @ 2.5 t ha$^{-1}$, W$_0$ = control (unweeded), W$_1$ = pre-emergence herbicide, Panida 33 EC + one hand weeding at 35 DAT, W$_2$ = post-emergence herbicide, Granite 240 SC + one hand weeding at 35 DAT, W$_3$ = pre-emergence herbicide, Panida 33 EC @ 2.5 l ha$^{-1}$ + post-emergence herbicide, Granite 240 SC @ 93.70 ml ha$^{-1}$.

Inorganic fertilizer dose = 75% of recommended dose of inorganic fertilizer + poultry manure @ 2.5 t ha$^{-1}$ + post-emergence herbicide, Granite 240 SC @ 93.70 ml ha$^{-1}$.

Manure @ 2.5 t ha$^{-1}$ with post-emergence herbicide, Granite 240 SC + one hand weeding at 35 DAT which was statistically identical to the interaction of F$_1$ × W$_2$ (Recommended dose of inorganic fertilizer (Urea, TSP, MoP, Gypsum, ZnSO$_4$ @ 250, 120, 100, 10, 10 kg ha$^{-1}$, respectively), F$_1$ = 50% of recommended dose of inorganic fertilizer + cowdung @ 5 t ha$^{-1}$, F$_2$ = 75% of recommended dose of inorganic fertilizer + cowdung @ 5 t ha$^{-1}$, F$_3$ = 50% of recommended dose of inorganic fertilizer + poultry manure @ 2.5 t ha$^{-1}$, F$_4$ = 75% of recommended dose of inorganic fertilizer + poultry manure @ 2.5 t ha$^{-1}$, W$_0$ = control (unweeded), W$_1$ = pre-emergence herbicide, Panida 33 EC + one hand weeding at 35 DAT, W$_2$ = post-emergence herbicide, Granite 240 SC + one hand weeding at 35 DAT, W$_3$ = pre-emergence herbicide, Panida 33 EC @ 2.5 l ha$^{-1}$ + post-emergence herbicide, Granite 240 SC @ 93.70 ml ha$^{-1}$).

The lowest leaf area index was recorded (0.85) in the interaction of F$_0$ × W$_0$ (no fertilizers and no manure under unweeded condition) at the 65 DAT (Table 4).

Weed free condition favoured congenial environment for crop growth. The crop population was maximum in weed free plots than weedy check which facilitated the crop for absorption of greater amount of nutrients, moisture and greater reception of solar radiation for growth resulted in higher number of tillers hill$^{-1}$ and leaves tiller$^{-2}$. The increase in LAI may be due to production of higher number of tillers plant$^{-1}$ and leaves tiller$^{-1}$ was reported by Sarath and Thalilak (2004).

**Dry matter production:** Interaction effects of integrated fertilizer and weed management exhibited significant influence on total dry matter production at all sampling dates except 20 DAT (Table 5). The total dry matter production hill$^{-1}$ increased in course of time and reached maximum at final sampling date at 80 DAT. Similar result was reported by Kant et al. (2018). Total dry matter production of F$_0$ × W$_0$ (75% of recommended dose of inorganic fertilizers + poultry manure @ 2.5 t ha$^{-1}$ with pre-emergence herbicide, Panida 33 EC @ 2.5 l ha$^{-1}$ + one hand weeding at 35 DAT) gave the maximum dry matter (32.59 g hill$^{-1}$ at 80 DAT). While the lowest values (7.01 g) was obtained from F$_0$ × W$_0$ (50% of recommended dose of inorganic fertilizer + cowdung @ 5 t ha$^{-1}$ with weedy check (unweeded) which was statistically identical to F$_0$ × W$_0$ (under application of no fertilizer and no manure with weedy check (unweeded) at 80 DAT (Table 5). Integrated nutrient management influenced plant growth resulting higher dry matter accumulation than sole application of chemical fertilizer or manures. Fertilizer applied in conjunction with organic manure produced equivalent or even highest dry matter and N uptake than inorganic sources (Saravanan et al., 1987 and Katsura et al., 2007) reported that higher grain yield was obtained due to large biomass accumulation before heading which resulted from its leaf area duration (LAD) than its radiation use efficiency (RUE). Under weed free condition the crop plants treated with 50% recommended dose of chemical fertilizers + poultry manure @ 2.5 t ha$^{-1}$ gave the maximum dry matter was reported by Islam et al. (2014).
Table 4. Effect of interaction between integrated fertilizer and weed management on leaf area index at days after transplanting of aromatic Boro rice (cv. BRRI dhan50).

| Integrated fertilizer x weed management | Leaf area index (LAI) | Days after transplanting (DAT) |
|----------------------------------------|-----------------------|---------------------------------|
|                                        | 20 DAT                | 35 DAT                         | 50 DAT | 65 DAT | 80 DAT |
| F0 x W0                                | 0.073l                | 0.2567j                        | 0.557j | 0.854f | 0.747h |
| F0 x W1                                | 0.083l                | 0.3098j                        | 1.18i  | 2.05e  | 1.89g  |
| F0 x W2                                | 0.093kl               | 0.3431j                        | 1.24hi | 2.16e  | 2.02g  |
| F0 x W3                                | 0.083l                | 0.2868j                        | 1.27hi | 2.13e  | 1.93g  |
| F1 x W0                                | 0.096kl               | 0.4436i                        | 1.30hi | 2.20e  | 2.04g  |
| F1 x W1                                | 0.113jk               | 0.8328f                        | 2.04f  | 3.39d  | 3.04f  |
| F1 x W2                                | 0.123hij              | 0.8508f                        | 2.12f  | 3.40d  | 3.02f  |
| F2 x W3                                | 0.146defgh            | 1.335ab                        | 3.15bc | 4.85b  | 4.48c  |
| F2 x W0                                | 0.156cdef             | 0.4520i                        | 1.28hi | 2.15e  | 2.01g  |
| F2 x W1                                | 0.150defg             | 0.7008h                        | 2.74e  | 3.83cd | 3.49de |
| F2 x W2                                | 0.136gij              | 0.6665h                        | 2.66e  | 4.23c  | 3.59d  |
| F2 x W3                                | 0.146defgh            | 0.6729h                        | 2.60e  | 3.84cd | 3.20ef |
| F3 x W0                                | 0.120ij               | 0.4521i                        | 1.37gh | 2.28e  | 2.05g  |
| F3 x W1                                | 0.140efghi            | 0.8257f                        | 2.96d  | 3.96c  | 3.67d  |
| F3 x W2                                | 0.136fghij            | 0.8107f                        | 2.93d  | 4.23c  | 3.63d  |
| F3 x W3                                | 0.136fghij            | 0.7264gh                       | 2.61e  | 4.01c  | 3.67d  |
| F4 x W0                                | 0.153defg             | 0.8308f                        | 1.49g  | 2.33e  | 2.12g  |
| F4 x W1                                | 0.146defgh            | 1.077e                         | 3.03cd | 4.12c  | 3.74d  |
| F4 x W2                                | 0.156defg             | 1.110e                         | 3.08bcd| 4.15c  | 3.74d  |
| F4 x W3                                | 0.163cede             | 1.152de                        | 3.02cd | 4.28c  | 3.72d  |
| F5 x W0                                | 0.170bcd              | 0.8480f                        | 1.50g  | 2.42e  | 2.09g  |
| F5 x W1                                | 0.190abc              | 1.249bc                        | 3.23b  | 4.25c  | 3.81d  |
| F5 x W2                                | 0.180bc               | 1.220cd                        | 3.26b  | 4.98b  | 5.07b  |
| F5 x W3                                | 0.206a                | 1.416a                         | 3.67a  | 6.26a  | 5.73a  |
| Sx                                     | 0.00750               | 0.031                          | 0.058  | 0.153  | 0.106  |
| Level of significance                  | **                    | **                             | **     | **     | **     |
| CV (%)                                 | 9.49                  | 6.79                           | 4.41   | 7.76   | 5.90   |

In a column, figures with same letter(s) or without letter do not differ significantly whereas figures with dissimilar letter differ significantly (as per DMRT); ** = Significant at 1% level of probability; * = Significant at 5% level of probability. F0 = Control (no fertilizer and no manure), F1 = Recommended dose of inorganic fertilizer (Urea, TSP, MoP, Gypsum, ZnSO4 @ 250, 120, 120, 100, 10 kg ha⁻¹, respectively), F2 = 50% of recommended dose of inorganic fertilizer + cowdung @ 5 t ha⁻¹, F3 = 75% of recommended dose of inorganic fertilizer + cowdung @ 5 t ha⁻¹, F4 = 50% of recommended dose of inorganic fertilizer + poultry manure @ 2.5 t ha⁻¹, F5 = 75% of recommended dose of inorganic fertilizer + poultry manure @ 2.5 t ha⁻¹, W0 = control (unweeded), W1 = pre-emergence herbicide, Panida 33 EC + one hand weeding at 35 DAT, W2 = post-emergence herbicide, Granite 240 SC + one hand weeding at 35 DAT; W3 = post-emergence herbicide, Panida 33 EC @ 2.5 t ha⁻¹ + post-emergence herbicide, Granite 240 SC @ 93.70 ml ha⁻¹.

Crop growth rate: The interaction effect of integrated fertilizer and weed management on crop growth rate was significant at all sampling dates (Table 6). The highest crop growth rate (42.23 g m⁻² day⁻¹) was observed in F5 x W3 (75% of recommended dose of inorganic fertilizers + poultry manure @ 2.5 t ha⁻¹ with pre-emergence herbicide, Panida 33 EC + post-emergence herbicide, Granite 240 SC) at 65-80 DAT. The lowest crop growth rate (3.66 g m⁻² day⁻¹) was observed in F0 x W0 (no fertilizers and no manure under unweeded condition) (Table 6). Weeding kept the land clean and soil was well aerated which facilitated the crop for absorption of greater amount of plant nutrients, moisture and greater reception of solar radiation for better growth resulted in higher CGR. This result is in line with findings of Kamal et al. (2007) and Kant et al. (2018). Paul et al. (2014) also reported that three weedicings with 50% recommended chemical fertilizers along with poultry manure showed the highest values of CGR.

Functional relationship between weed and crop dry matter of aromatic Boro rice (cv. BRRI dhan50)
A negative linear relationship between weed dry matter and crop dry matter of fine aromatic Boro rice, which indicated that higher the weed dry matter the lower the crop dry matter. The relationship of weed dry matter and crop dry matter of fine aromatic Boro rice was determined by using the respective interaction data between integrated fertilizer and weed manage-
The response of weed dry matter to the crop dry matter of fine aromatic Boro rice followed a linear negative relationship which could be adequately described by regression equation. In Figure 2, the regression equation indicates that an increase in weed dry matter would lead to a decrease in the crop dry matter of fine aromatic Boro rice. The functional relationship was significant at p ≤ 0.01. The functional relationship can be determined by the regression equation Y = -0.6214x + 23.835 (R² = 0.2705). The functional relationship revealed that 27% of the variation in crop dry matter could be explained from the variation in weed dry matter. Dry matter production of crop and weed are directly related to grain yield of rice was documented by Paul et al. (2019).

### Table 5. Effect of interaction between integrated fertilizer and weed management on total dry matter at days after transplanting of aromatic Boro rice (cv. BRRI dhan50).

| Integrated fertilizer x weed management | Total dry matter (g hill⁻¹) (Days after transplanting (DAT)) | 20 DAT | 35 DAT | 50 DAT | 65 DAT | 80 DAT |
|----------------------------------------|---------------------------------------------------------------|--------|--------|--------|--------|--------|
| F₀ × W₀                               |                                                               | 0.21   | 0.520j | 2.167o | 3.707l | 7.713m |
| F₀ × W₁                               |                                                               | 0.24   | 0.843i | 2.273o | 4.100l | 14.06j |
| F₀ × W₂                               |                                                               | 0.22   | 1.207h | 2.803n | 6.507j | 10.64l |
| F₀ × W₃                               |                                                               | 0.26   | 1.097h | 3.687m | 6.560j | 15.69i |
| F₁ × W₀                               |                                                               | 0.32   | 1.103h | 3.393m | 6.037k | 8.093m |
| F₁ × W₁                               |                                                               | 0.26   | 1.643g | 6.860fg | 12.95b | 24.62d |
| F₁ × W₂                               |                                                               | 0.25   | 1.973f | 6.243j | 12.10d | 26.74c |
| F₁ × W₃                               |                                                               | 0.29   | 2.087def | 7.427abc | 12.12d | 21.09g |
| F₂ × W₀                               |                                                               | 0.32   | 1.083h | 2.250o | 3.187m | 7.013m |
| F₂ × W₁                               |                                                               | 0.25   | 1.500g | 7.103cdef | 12.31cd | 24.30d |
| F₂ × W₂                               |                                                               | 0.26   | 1.573g | 7.517abc | 15.15a | 22.38ef |
| F₂ × W₃                               |                                                               | 0.26   | 1.597g | 6.563gh | 9.230gh | 17.21h |
| F₃ × W₀                               |                                                               | 0.34   | 2.850b | 6.093k | 8.100i | 12.17k |
| F₃ × W₁                               |                                                               | 0.33   | 2.203cdef | 7.760ab | 12.36cd | 25.75c |
| F₃ × W₂                               |                                                               | 0.35   | 2.260cede | 7.753a | 12.39cd | 28.66b |
| F₃ × W₃                               |                                                               | 0.33   | 2.293cde | 7.440abc | 12.84bc | 23.05e |
| F₄ × W₀                               |                                                               | 0.33   | 2.277cd | 6.913defgh | 9.287gh | 12.14k |
| F₄ × W₁                               |                                                               | 0.35   | 2.160cdef | 5.480l | 9.680g | 21.59fg |
| F₄ × W₂                               |                                                               | 0.34   | 2.143cdef | 7.310bcde | 11.49e | 22.51f |
| F₄ × W₃                               |                                                               | 0.34   | 2.183cd | 6.957defg | 12.42cd | 23.37f |
| F₅ × W₀                               |                                                               | 0.34   | 2.017ef | 6.913efgh | 10.60f | 17.59h |
| F₅ × W₁                               |                                                               | 0.35   | 3.167a | 6.513hij | 8.837h | 32.59a |
| F₅ × W₂                               |                                                               | 0.36   | 2.390c | 6.123jk | 8.217i | 23.07e |
| F₅ × W₃                               |                                                               | 0.39   | 2.393c | 7.347abcd | 10.38f | 31.64a |
| Sx²                                   |                                                               | 0.0182 | 0.075  | 0.135  | 0.174  | 0.364  |
| Level of significance                 |                                                               | NS     | **     | **     | **     | **     |
| CV (%)                                 |                                                               | 11.13  | 7.05   | 4.00   | 3.14   | 3.21   |

In a column, figures with same letter(s) or without letter do not differ significantly whereas figures with dissimilar letter differ significantly (as per DMRT); ** = Significant at 1% level of probability, NS = Not significant; * = Significant at 5% level of probability.

F₀ = Control (no fertilizer and no manure), F₁ = Recommended dose of inorganic fertilizer (Urea, TSP, MoP, Gypsum, ZnSO₄ @ 250, 120, 120, 10 kg ha⁻¹, respectively), F₂ = 50% of recommended dose of inorganic fertilizer + cowdung @ 5 t ha⁻¹; F₃ = 75% of recommended dose of inorganic fertilizer + cowdung @ 5 t ha⁻¹; F₄ = 75% of recommended dose of inorganic fertilizer + poultry manure @ 2.5 t ha⁻¹; W₀ = Control (unweeded), W₁ = pre-emergence herbicide, Granite 240 SC @ 2.5 l ha⁻¹; W₂ = post-emergence herbicide, Panida 33 EC + one hand weeding at 35 DAT, W₃ = pre-emergence herbicide, Panida 33 EC @ 2.5 l ha⁻¹ + post-emergence herbicide, Granite 240 SC @ 93.70 ml ha⁻¹.
**Table 6.** Effect of interaction between integrated fertilizer and weed management on crop growth rate at different days after transplanting of aromatic Boro rice (cv. BRRI dhan50).

| Integrated fertilizer x weed management | Crop growth rate (CGR) (g m⁻² day⁻¹) Days after transplanting (DAT) |
|----------------------------------------|---------------------------------------------------------------------|
|                                        | 20-35 DAT | 35-50 DAT | 50-65 DAT | 65-80 DAT |
| F₀ × W₀                                | 0.553i    | 2.930i    | 2.737i    | 3.657i    |
| F₀ × W₁                                | 1.060h    | 2.547lm   | 3.247kl   | 17.71gh   |
| F₀ × W₂                                | 1.753g    | 2.837l    | 6.583g    | 7.347k    |
| F₀ × W₃                                | 1.490h    | 4.603k    | 5.110hi   | 16.23hi   |
| F₁ × W₀                                | 1.397gh   | 4.070k    | 4.700hij  | 5.080kl   |
| F₁ × W₁                                | 2.453f    | 9.273bcde | 10.83b    | 20.75f    |
| F₁ × W₂                                | 3.067de   | 7.590h    | 10.42bc   | 26.02de   |
| F₁ × W₃                                | 3.190cde  | 9.497bcd  | 8.347ef   | 15.94hi   |
| F₂ × W₀                                | 1.353gh   | 2.073m    | 1.667m    | 7.12k     |
| F₂ × W₁                                | 2.220f    | 9.967ab   | 9.263de   | 21.32f    |
| F₂ × W₂                                | 2.330f    | 8.57b     | 11.57a    | 12.85j    |
| F₂ × W₃                                | 2.367f    | 8.833defg | 4.740hij  | 14.19ij   |
| F₃ × W₀                                | 4.457b    | 5.767j    | 3.570jkl  | 7.23k     |
| F₃ × W₁                                | 3.333cde  | 9.720bc   | 8.337ef   | 23.81e    |
| F₃ × W₂                                | 3.390cde  | 9.767bc   | 8.250ef   | 28.93c    |
| F₃ × W₃                                | 3.497cd   | 9.153cdef | 9.593cd   | 18.16gh   |
| F₄ × W₀                                | 3.467cd   | 8.243gh   | 4.220ijk  | 6.807kl   |
| F₄ × W₁                                | 3.220cde  | 5.907j    | 7.467fg   | 21.18f    |
| F₄ × W₂                                | 3.213cde  | 9.183cdef | 7.427fg   | 19.59fg   |
| F₄ × W₃                                | 3.273cde  | 8.487fg   | 9.720cd   | 17.69gh   |
| S×                                     | 2.987e    | 8.707efg  | 6.560g    | 12.42j    |
| Level of significance                  | **        | **        | **        | **        |
| CV (%)                                 | 8.35      | 5.73      | 9.52      | 7.84      |

In a column, figures with same letter(s) or without letter do not differ significantly whereas figures with dissimilar letter differ significantly (as per DMRT); ** = Significant at 1% level of probability; * = Significant at 5% level of probability.

**Conclusion**

From the present study it can be concluded that application of 75% of recommended dose of inorganic fertilizers and poultry manure @ 2.5 t ha⁻¹ along with pre-emergence herbicide, (Panida 33 EC @ 2.5 l ha⁻¹) + post-emergence herbicide (Granite 240 SC @ 93.70 ml ha⁻¹) may be used to boost the growth performance of aromatic Boro rice (cv. BRRI dhan50).

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**REFERENCES**

Ahmed, G.J.U., Bhuiyan, M.K.A., Riches, C.R., Mortimer, M. and Jhonson, D. (2005). Farmer’s participatory studies of integrated weed management system for intensified low land. Bangladesh Agronomy Journal, 23: 31–32.

Aljumaili, S.J., Rafii, M.Y., Latif, M.A., Sakimin, S.Z., Arolu, I.W. and Miah, G. (2018). Genetic diversity of aromatic rice germplasm revealed by SSR markers. BioMed Research International, ID: 7658032 pp. 11. https://doi.org/10.1155/2018/7658032.

Amanullah and Hidayatullah, A. (2016). Influence of Organic and Inorganic Nitrogen on Grain Yield and Yield Components of Hybrid Rice in Northwestern Pakistan. Rice Science, 23(6): 326–333

Amanullah and Khalid, S. (2016). Phenology, growth and biomass yield response of maize (Zea mays L) to integrated use of animal manures and phosphorus application with and without phosphate solubilizing bacteria. Journal of Microbial and Biochemical Technology, 7. 439–444, https://doi.org/10.4172/1948-5948.1000251.
Badshah, M.A., Tu, N., Zou, Y., Ibrahim, M. and Wang, K. (2014). Yield and tillering response of super hybrid rice Liangyoupeijiu to tillage and establishment methods. The Crop Journal, 2: 79–86.

BBS (Bangladesh Bureau of Statistics). (2019). The Yearbook of Agricultural Statistics of Bangladesh. Statistics Div., Minis. Plan. Govt. People’s Repub., Bangladesh, Dhaka, p. 34-39. Choudhury, A.N., Sharma, U.C. and Khan, A.K. (1995). Effect of weed management practice on nutrient loss and yield of rice in Nagaland. Indian Journal of Agronomy, 40(2): 192-193.

Cruz E.D., Moody K. and Ramos, M.B.D. (1986). Reducing variability sampling weeds in upland rice (Oryza sativa L.). Philippine Journal of Weed Science, 13: 56–59.

Gnanavel, I. and Anbhazhagan, R. (2010). Bio-efficacy of pre and post emergence herbicides in transplanted aromatic basmati rice. Research Journal of Agricultural Sciences, 1(4): 315-317.

Gomez, K.A. and Gomez, A.A. (1984). Statistical Procedures for Agricultural Research. 2nd Ed., John Wiley and Sons. New York. pp. 97-111.

Hunt, R. (1978). The fitted curve in plant growth studies: Math and plant physiology (Eds. Rose, D.A. and Edwards, DAC). Acad. Press, London. pp. 283-298.

Islam, S.M.M., Paul, S.K., Sarkar, M.A.R. and Miah, M.A.M. (2014). Growth of transplanted Aman rice as influenced by weeding regime and integrated nutrient management. Bangladesh Journal of Progressive Science and Technology, 12(1): 49-54.

Jahan, S., Sarkar, M.A.R. and Paul, S.K. (2017). Variations of growth parameters in transplanted Aman rice (cv. BRRI dhan39) in response to plant spacing and fertilizer management. Archives of Agriculture and Environmental Science, 2(1): 1-5.

Kabir, M.E., Kabir, M.R. Jahan, M.S. and Das, G.G. (2004). Yield performance of three aromatic fine rices in a coastal medium high land. Asian Journal of Plant Sciences, 3: 561-563.

Kamal, S.H.A.M., Mahfuz, M.S., Karim, M.M., Saha, A.K. and Islam, M.K. (2007). Performance of transplant Aman rice cv. BRRI dhan32 under different fertilizer and weeding regime. Bangladesh Journal of Environmental Science, 13(1): 85-90.

Kant, K., Bora, P.K., Teltkar, S.G. and Gogoi, M. (2018). Performance of various rice cultivars under variable nitrogen levels. Journal of Pharmacognosy and Phytochemistry, 7(5): 1378-1382.

Katsura, K., Maeda, S., Horie, T. and Shiraiwa, T. (2007). Analysis of high yield attributes and crop physiological traits of Liangyoupeijiu, a hybrid rice recently bred in China. Field crop Research, 100(3): 170-177.

Paul, S.K., Islam, S.M.M., Sarkar M.A.R., Alam, A. and Zaman, F. (2014). Physiological parameters of transplant aman rice (cv. BRRI dhan49) as influenced by weeding regime and integrated nutrient management. Journal of Agroforestry and Environment, 8(2): 121-125.

Paul, S.K., Nahar, L.S., Paul, N.C. and Begum, M. (2019). Influence of weeding regime on the performance of aromatic Boro rice (Oryza sativa L.). Archives of Agriculture and Environmental Science, 4(2): 133-140, https://doi.org/10.26832/24566632.2019.040202

Paul, S.K., Nila, N.Y. and Sarkar, M.A.R. (2020). Grain yield and quality of aromatic Boro rice (cv. BRRI dhan50) subject to date of transplanting and nutrient management. Thai Journal of Agricultural Science, 53(2): 85-96.

Paul, S.K., Rahman, K.S. and Sarkar, M.A.R. (2013). Physiological attributes of transplant Aman rice (cv. BRRI dhan52) as affected by tiller seedlings and urea super granules. Progressive Agriculture, 24(162): 17-27.

Roy, A., Sarkar, M.A.R. and Paul, S.K. (2018). Effect of age of seedlings at staggered transplanting and nutrient management on yield performance of aromatic fine rice (cv. BRRI dhan38). SAARC Journal of Agriculture, 16(1): 49-59.

Sarath, P.N. and Thailak, B. (2004). Comparison of productivity of SRI and conventional rice farming system in the dry zone region of Sri Lanka. 4th International Crop Science Congress. http://www.regional.org.au/lau/au.

Saravanan, A., Velu, V. and Ramanathan, K.M. (1997). Effect of combine application of bio-organic and chemical fertilizer on physiochemical properties, nitrogen transformation and yield of rice in submerged soils of survey delta. Oryza, 24: 1-6.

Sarkar, M.A.R., Paul, S.K. and Paul, U. (2017). Effect of water and weed management in Boro rice (cv. BRRI dhan28) in Bangladesh. Archives of Agriculture and Environmental Science, 2(4): 325-329, https://doi.org/10.26832/24566632.2017.020414

Sarkar, S.K., Sarkar, M.A.R., Islam, N. and Paul, S.K. (2016). Morpho-physiological attributes of three HYV aromatic fine rice varieties as affected by integrated nutrient management. Journal of Agroforestry and Environment, 10(1): 57-61.

Singh, Y. and Singh, U.S. (2008). Genetic diversity analysis in aromatic rice germplasm using agro-morphological traits. Journal of Plant Genetic Resources, 21(3): 32-37.

Sinha, T., Paul, S.K. and Sarkar, M.A.R. (2018). Effect of age of seedlings at staggered transplanting and weed management on the growth and yield of aromatic Boro rice (cv. BRRI dhan50). Journal of the Bangladesh Agricultural University, 16(1): 5-11.

Zannat, S.T., Paul, S.K. and Salam, M.A. (2014). Effect of weeding regime and nitrogen management on the performance of transplant aromatic Aman rice (cv. Binadhan-9). Bangladesh Journal of Seed Science & Technology, 18 (1 & 2): 29-34.