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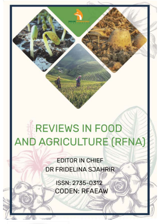

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RESEARCH ARTICLE

INFLUENCE OF WEEDING REGIME AND INTEGRATED NUTRIENT MANAGEMENT ON THE YIELD PERFORMANCE OF TRANSPLANT *AMAN* RICE (cv. BRRI dhan49)

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ABSTRACT

The purpose of this experiment is to study the combined effect of frequency of weeding and integrated nutrient management on the growth and yield of transplant *aman* rice (cv. BRRI dhan49). The experiment consisted of five weeding regimes and four integrated nutrient managements. The experiment was laid out in a randomized complete block design with three replications. The highest grain yield (5.80 t ha^{-1}) was obtained from the interaction between weed free and 25% BRRI RD + 75% N from CD which was followed by the applications of pre-emergence herbicide + one hand weeding at 35 DAT and 25% BRRI RD + 75% N from CD treatment. The lowest grain (3.65 t ha^{-1}) was found from the interaction between no weeding and BRRI recommended chemical fertilizers.The degree of statistical relationship between grain yield and number of effective tillers/hill, grain yield and straw yield of BRRI dhan49 exhibited positive relationship. From the results of the study it can be concluded that the application of 25% BRRI RD + 75% N from CD in weed free condition might be used for obtaining the best performance of BRRI dhan49.

KEYWORDS

weeding regime, integrated nutrient managements, yield performance, BRRI dhan49.

1. INTRODUCTION

Rice is the most important principal food in Asian countries, providing on average 32% of total calorie intake. About 75% of the global rice volume is grown in the irrigated lowlands (MacLean et al., 2002). Where there are cultivable lands, there are weeds. Among the various factors accountable for yield loss, weeds are the most important one. Weed are as old as agriculture, and from the very beginning farmers realized the interference of weed with crop productivity which led to the co-evolution of agro-ecosystems and weed management (Ghersa et al., 2000; Ghersa et al., 1994). Weeds are the greatest yield-limiting constraint to rice. Globally, actual yield losses due to pests have been estimated approximately 40%, of which weeds caused the highest loss (32%) (Rao et al., 2007). The rice crops are severely infested with weeds which can reduce the grain yields up to 16-48% for *Aman r*ice (IRRI, 1998). As a result, subsistence farmers of the tropics are used to spend more time, energy and money on weed control than any other aspects of crop production (Kasasian, 1971).

In Bangladesh, weeds are usually controlled by hand weeding which is very much laborious, time consuming, inefficient and costly. Moreover, in Bangladesh during *aman* season, uprooting of weeds at the critical periods is difficult due to unfavorable weather and peak labor demand. In such situation, herbicides are promising alternatives for controlling weeds. Now-a-days, the chemical methods of weed control are gaining popularity all over the world including Bangladesh because of its astounding results in crop production. The application of pre- and post-emergence herbicides could effectively control weeds in low cost in rice fields but intensive and recurrent use of herbicide can cause environmental pollution and development of resilient weed biotypes, because the weed-rice ecological connection is very complex and dynamic (Karim et al., 2004).

Weed distribution and successions are always affected by management and environmental factors. Weed spectrum and degree of infestation in rice field are often determined by rice ecosystems and establishment methods. Due to high weed pressure, weed management in rice has been a huge challenge for the researchers and farmers as well. Appropriate weed control practice can suppress the weed growth and consequently render better performance to improve the quality and quantity of rice. Thus, integration of manual and chemical weed management would be helpful to control weeds at lower cost and with minimal environmental concern. A group researcher from his experiment originated that weeding regime had significant effect on weed density and dry weight (Haque et al., 2011). Bari got Butachlor herbicide was effective in weed control and obtained highest grain yield of 4.08 t ha^{-1} in transplanted wetland rice during *aman* growing season (Bari, 2010).

A group researcher attained the highest grain yield (5.22 t ha^{-1}) was obtained under good water management in weed free treatment followed by Butachlor 5G @ 2 kg ha^{-1} and one hand weeding (4.96 t ha^{-1}) under same water management (Kabir et al., 2008). Mukherjee *et al.* (2007) detected that the weed control treatments with herbicides were effective in increasing grain yield. In other study, they found that, two hand weedings at 26 and 40 DATs in transplanted rice showed the highest weed control efficiency and proved as par with the herbicide combination of

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Ethoxysulfuron + Anilophos. Rangaraju (2002) in India observed that application of either butachlor or Thiobencarb @ 1.5 kg ha^{-1} successfully controlled the weeds in dry seeded rainfed rice (Bhowmick et al., 2002). On the other hand, the soil fertility status of Bangladesh is low which contains less than 1.5% organic matter and in many cases, it is even less than 1%. Improper soil management practices and long times intensive use of chemical fertilizers create some fertility problems through soil exhaustion. Therefore, the importance of inorganic fertilizers in modern agriculture for increasing crop productivity needs no elaboration. But available reports indicate that repeated use of inorganic fertilizer alone fails to sustain desired yield, impairs the physical condition and reduce the organic matter content of soils. To achieve sustainability, the quantity of nutrient inputs and outputs should be near equal. So, integrated use of organic and inorganic fertilizer has been found to be promising in obtaining sustainable crop productivity on a long-term basis under modern intensive cropping systems.

In this aspect cowdung may play a vital role in soil fertility management as well as supplying primary, secondary and micronutrients for crop production. Cowdung contains 0.5-1.5%N, 0.4-0.8%P, 0.5-1.9%K and other nutrients in small quantity while the poultry manure contains high amount of secondary and micronutrients in addition to 1.6%N, 1.5%P and 0.85%K. It may supply sufficient amount of S, Zn and B for growth of rice plants. Application of cowdung may play an important role in rice cultivation when used alone or in combination with chemical fertilizers. In addition, organic matter improves the physical, chemical and biological properties of soil and thus helps to increase and conserves the soil productivity. Moreover, global environmental pollution can be controlled considerably by reducing the use of fertilizer and increasing the use of cowdung.

Mondal and Swamy found that application of N (120 kg ha^{-1}) as urea in equal splits during transplanting, tillering, panicle initiation and flowering resulted in the highest harvest index (Mondal and Swamy, 2003). A group researcher observed that the application of N (120 kg N ha^{-1}) as urea in equal splits during transplanting, tillering, panicle initiation and 50% of flowering resulted in the highest 1000 grain weight (22.57 g) (Subhendu et al., 2003). Duhan and Singh stated that the rice yield and uptake of nutrients increased significantly with increasing N levels (Duhan and Singh, 2002). A group researcher concluded that the use of Zinc fertilizers increased the yield of rice in wetland soils (Singh et al., 2002). A group researcher originated that the rice yield in the cropping system was meaningfully correlated with zinc removal (Prasad et al., 2002). Amanullah and Hidayatullah stated that the main reason for low rice yield in pakistan is imbalanced nutrient application (Amanullah and Hidayatullah, 2016). So, the use of organic manure has been widely recommended for sustainable agricultural production in Northwest of Pakistan.

Singh and Singh reported that the highest grain yield and harvest index was obtained in bacteriocompost (Singh and Singh, 2005). A significant improvement in grain yield was also observed in NPK + cellulocompost, NPK + cellulocompost and NPK only during the second year. A group researcher perceived that poultry manure and sewage study produced better-growth components, viz. plant height, number of tillers $hill^{-1}$, total dry matter $plant^{-1}$ and yield components like number of panicles $hill^{-1}$ and panicle weight (Reddy et al., 2004). When nitrogen fertilizer is provided in tillering, paddy yield increased (Bacon, 1989). The grain yields were 4.1–5.0 t ha^{-1} with 0 kg N ha^{-1} and 6.8–9.2 t ha^{-1} with 180 kg N ha^{-1} (Belder et al., 2004). The rice grain yield was recorded highest in case the N application ranged between 90-250 kg per ha (Bali et al., 1995). A group researcher witnessed that the grain yield increased when nitrogen fertilizer increased from zero to 300 kg ha-1 (Michiel et al., 2010). A group scientist examined that nitrogen harvest index decreased when the consumption of nitrogen fertilizer increased from zero to 300 kg ha^{-1} (Quanbao et al., 2007).

About half of the world's population and all the people in Bangladesh depend on rice *(Oryza sativa)* as staple food. Bangladesh is one of the most important rice growing countries of the world. The crop production in Bangladesh is dominated by intensive rice cropping covering about 80% of arable land and most dominated cropping pattern is *Boro* - T. *aman* - Fallow. There are three distinct growing seasons of rice according to changes in seasonal conditions such as *Aus, Aman* and *Boro*. For 2016/17 (May-April), total rice area and production levels are projected to increase slightly to 11.8 million hectares (ha) and 34.55 million metric tons (MMT). Among them, *aman* covers more than half of the rice area accounting 5.9 million hectares (ha) with a production of 13.35 million tons (BBS, 2017). Therefore, transplant *aman* rice is the most important that contributes a lot in total rice production. So, emphasis should be given to increase the T. *aman* rice yield through the adoption of proper management especially weed control and nutrient management. The present study was, therefore, undertaken to find out the interaction effect of weeding regime and integrated nutrient management on the growth and yield of transplant *aman* rice cv. (BRRI dhan49).

2. MATERIALS AND METHODS

The experiment was directed at the Agronomy Field Laboratory of Bangladesh Agricultural University, Mymensingh during the period from August to November 2015.

2.1 Description of experimental site

The experimental field was situated at 24' 75°N latitude and 90' 50°E longitude at an altitude of 18 m above the mean of sea level. The experimental site belongs to the Old Brahmaputra floodplain Agro ecological Zone (AEZ-9) of Bangladesh. The land was medium high with silts loam texture having pH 6.7 and low in organic matter content. The experimental area was characterized by high temperature, high humidity and heavy precipitation

2.2 Experimental treatments

The experiment contained of the following treatments:

Factor A: Weeding regime

i. No weeding (W_0)
ii. Two hand weeding at 15 and 35 days after transplanting (DATs) (W_1)
iii. Application of pre-emergence herbicide commit (pretilachlor @ 2L ha^{-1}) (W_2)
iv. Application of pre-emergence herbicide commit (pretilachlor @ 2L ha^{-1}) + One hand weeding at 35 days (W_3)
v. Weed free (W_4)

Factor B: Integrated nutrient management

i. BRRI suggested dose of chemical fertilizers (BRRI RD) (F_1)
ii. 75% BRRI RD +25% N from cowdung (CD) (F_2)
iii. 50% BRRI RD + 50% N from CD (F_3)
iv. 25% BRRI RD +75% N from CD (F_4)

2.3 Experimental design and layout

Each block was divided into twenty-unit plots of size 2.5 m × 2.0 m each. Thus, the total numbers of unit plot were 60 (20× 3). The distance preserved between two-unit plots was 0.75 m and between blocks was 1 m.

2.4 Description of variety

BRRI dhan 49, a transplanted *aman* rice variety with 135 days growth duration. Stem of the variety is strong enough to keep the rice plant upright during stormy weather. The variety gives an average yield of 5.0-5.5 t ha^{-1}.

2.5 Sources of seed and seedling

Seeds were collected from the Bangladesh Rice Research Institute, Joydebpur, Gazipur and the seedlings were raised at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh.

2.6 Transplanting of seedling

Seedlings were uprooted carefully from the nursery bed after twenty-eight days of sowing. Uprooted seedlings were transplanted in the unit plots at the rate of three seedlings $hill^{-1}$ maintaining spacing of 25 cm × 15 cm. Gap filling was done at 7 DAT where necessary.

2.7 Harvesting and processing

When 90% of the grains became golden yellow, the crop was considered to be matured. Five hills (excluding border hills and central 1 m × 1 m) were selected randomly from each experimental plot to record data on crop characters and yield contributing characters.

An area of 1 m^2 was selected in the middle portion of each plot to record the yields of grain and straw. Grains were then sun dried at 14% moisture level and cleaned. Straws were also sun dried properly. Finally, straw and grain yields $plot^{-1}$ were recorded and converted to t ha^{-1}.

2.8 Data collection procedure

2.8.1 Plant height

Plant height was measured from the ground level to the tip of the longest panicle. The average of five hills was deliberated as the height of the plant for each plot.

2.8.2 Number of total tillers hill^{-1}

Tillers that had at least one leaf visible were counted. It included both effective tillers and non-effective tillers.

2.8.3 Number of effective tillers hill^{-1}

The tillers having a panicle with at least one grain was considered as effective tiller.

$$\text{Effectively percentage of tiller (\%)} = \frac{\text{Number of effective tiller hill}^{-1}}{\text{Total number of tiller hill}^{-1}} \times 100\%$$

The tillers which had no grain in the panicle and the tillers having no panicles were regarded as non-effective tillers.

2.8.4 Number of grains panicle^{-1}

Presence of any food material in the spikelet was considered as filled grain and total number of grains present on each panicle was counted.

2.8.5 Panicle length

Panicle length was measured from the basal node of the rachis to the apex of each panicle. Each observation was an average of five hills.

2.8.6 Number of sterile spikelets panicle^{-1}

Spikelets lacking any food material inside were considered as sterile spikelets and such spikelets present on each panicle were counted.

Sterility percentage of grain = 100%

$$\text{Total number of spikelets panicle} = \frac{\text{Number of sterile spikelets panicle}^{-1}}{\text{Total number of spikelets panicle}^{-1}} \times 100\%$$

2.8.7 1000-grain weight

Thousand grains were taken from each plot randomly and weighed in an electrical balance after sun drying.

2.8.8 Grain yield

Grains obtained from one square meter central area of each plot were sun dried at 14% moisture and weighed carefully to record the grain yield plot^{-1}, which was then converted to kg plot^{-1} and finally t ha^{-1}.

2.8.9 Straw yield

Straws obtained from the harvested area for each unit plot were sun dried and weighed. Straw yield was then converted to t ha^{-1}.

2.8.10 Biological yield

Grain yield and straw yields altogether were regarded as biological yield. The biological yield was calculated with the following formula:

Biological yield = Grain yield + straw yield.

2.8.11 Harvest index

Harvest index is the ratio of economic yield (grain yield) to biological yield expressed as percentage and was calculated with the following formula:

$$\text{Harvest index (\%)} = \frac{\text{Grain yield}}{\text{Biological yield}} \times 100\%$$

2.9 Statistical analysis

The collected data were compiled and tabulated in proper form and analyzed statistically. Analysis of variance was done following ANOVA technique with the help of computer package MSTAT and the mean differences among the treatments were adjudged by Duncan's Multiple Range Test (Gomez and Gomez, 1984).

3. Results

3.1 Interaction effect of weeding regime and integrated nutrient management on Plant height

Plant height was not meaningfully subjective to the interaction between weeding regime and integrated nutrient management.

Numerically the tallest plant (107.33 cm) was observed in the interaction of $W_4 \times F_4$ (weed free with 25% BRRI RD + 75% N from CD) and the shortest plant (94.78cm) was observed in $W_0 \times F_1$ (no weeding with BRRI recommended chemical fertilizers (RD) (Figure 1).

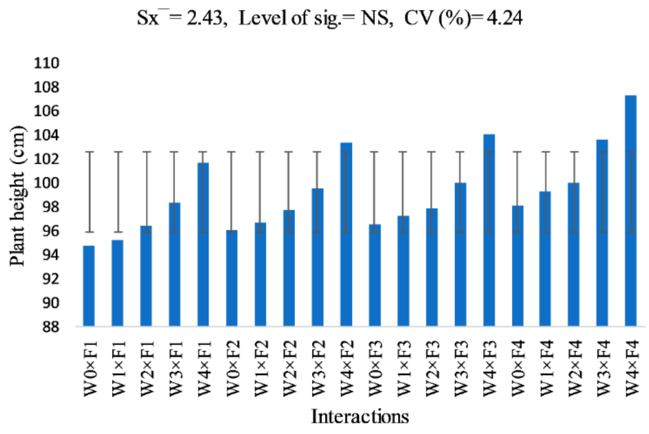

Figure 1: Combined effect of Nutrient management and weed management on plant height. The vertical bar shows standard deviations

3.2 Interaction effect of weeding regime and integrated nutrient management on Number of total tillers hill^{-1}

Number of total tillers hill^{-1} was not significantly influenced by the interaction between weeding regime and integrated nutrient management. The highest number of total tillers hill^{-1} (12.70) was found in $W_4 \times F_4$ (Weed free with 25% BRRI RD +75% N from CD) and the lowest number of total tillers hill^{-1} (9.35) was found in $W_0 \times F_1$ (no weeding with BRRI recommended chemical fertilizer) (Table 1).

3.3 Interaction effect of weeding regime and integrated nutrient management on Number of effective tillers hill^{-1}

It was found that number of effective tillers hill^{-1} was not significantly influenced by the interaction between weeding regime and integrated nutrient management.

Numerically the highest number of effective tillers hill^{-1} (12.37) was observed in $W_4 \times F_4$ (weed free with 25% BRRI RD + 75% N from CD) and the lowest one (8.27) was observed in $W_0 \times F_1$ (no weeding with BRRI recommended chemical fertilizers RD) treatment (Table 1).

3.4 Interaction effect of weeding regime and integrated nutrient management on Number of grains panicle^{-1}

Number of grains panicle^{-1} was not significantly influenced by the interaction between weeding regime and integrated nutrient management.

Numerically the highest number of grains panicle^{-1} (196.20) was observed in $W_4 \times F_4$ (weed free with 25% BRRI RD + 75% N from CD) and the lowest number of grains panicle^{-1} (155.80) was found in $W_0 \times F_1$ (no weeding with BRRI suggested chemical fertilizer) (Table 1).

3.5 Effect of interaction between weeding regime and integrated nutrient management on Panicle length

Panicle length was not significantly influenced by the interaction of weeding regime and integrated nutrient management.

Numerically the longest panicle (24.17 cm) was found in the interaction of $W_4 \times F_4$ (weed free with 25% BRRI RD + 75% N from CD) and the shortest one (20.87 cm) in $W_0 \times F_1$ (no weeding with BRRI recommended chemical fertilizer) interaction (Figure 2).

Table 1: Combined effect of Nutrient management and weed management on Total tillers hill^{-1}, Effective tillers hill^{-1}, Grains panicle^{-1}

Interactions	Total tillers hill^{-1} (no.)	Effective tillers hill^{-1} (no.)	Grains panicle^{-1} (no.)
$W_0 \times F_1$	9.35	8.27	155.80
$W_1 \times F_1$	9.93	8.98	162.53
$W_2 \times F_1$	10.10	9.20	169.20
$W_3 \times F_1$	10.48	9.62	177.13
$W_4 \times F_1$	10.87	10.02	181.40
$W_0 \times F_2$	9.93	8.93	166.93
$W_1 \times F_2$	10.22	9.20	173.20
$W_2 \times F_2$	10.67	9.70	179.13
$W_3 \times F_2$	11.27	10.40	181.13
$W_4 \times F_2$	11.73	10.90	183.80
$W_0 \times F_3$	10.23	9.30	171.93
$W_1 \times F_3$	10.73	9.90	178.20
$W_2 \times F_3$	11.33	10.59	181.93
$W_3 \times F_3$	11.80	11.13	183.33
$W_4 \times F_3$	12.00	11.43	185.73
$W_0 \times F_4$	10.67	9.93	175.80
$W_1 \times F_4$	11.20	10.50	181.40
$W_2 \times F_4$	11.87	11.23	184.27
$W_3 \times F_4$	12.33	11.83	190.73
$W_4 \times F_4$	12.70	12.37	196.20
Sx	0.389	0.204	3.99
Level of sig.	0.06NS	0.09NS	18.73NS
CV (%)	6.14	3.47	3.89

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 5% level of probability, NS = Not significant
F_1 = BRRI recommended fertilizers (RD), F_2 = 75% BRRI RD + 25% N from CD,
F_3 = 50% BRRI RD + 50% N from CD, F_4 = 25% BRRI RD + 75% N from CD
W_0 = No weeding,
W_1 = 2 hand weeding at 15 & 35 DAT, W_2 = Pre-emergence herb
W_3 = Pre-emergence herbicide + one hand weeding at 35 DAT,
W_4 = Weed free

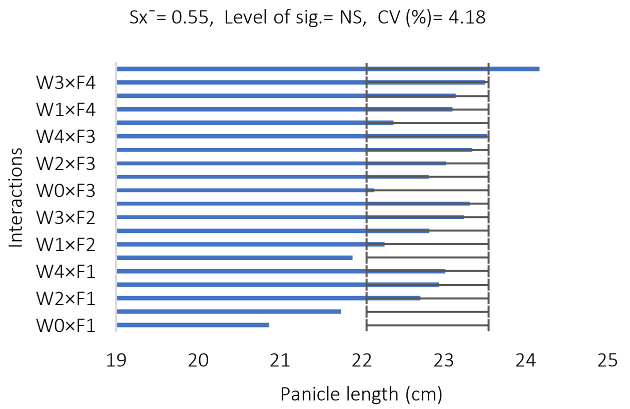

Figure 2: Combined effect of Nutrient management and weed management on Panicle length. The horizontal bar shows standard deviation

3.6 Interaction effect of weeding regime and integrated nutrient management on Number of sterile spikelets panicle^{-1}

Number of sterile spikelets panicle^{-1} was not significantly influenced by the interaction between weeding regime and integrated nutrient management. Numerically the highest number of sterile spikelets (22.73) was found in $W_0 \times F_1$ (no weeding with BRRI recommended chemical fertilizers) (Table 2).

3.7 Interaction effect of weeding regime and integrated nutrient management on 1000-grain weight

Weight of 1000 grain was not significantly influenced by the interaction of weeding regime and integrated nutrient management. However, numerically the highest 1000-grain weight (24.05 g) was noted in the interaction of $W_4 \times F_4$ (weed free with 25% BRRI RD + 75% N from CD) and the lowest one (20.38 g) was found in the interaction of $W_0 \times F_1$ (no weeding with BRRI recommended chemical fertilizers) (Table 2).

3.8 Interaction effect of weeding regime and integrated nutrient management on Grain yield

A remarkable alteration was observed due to the interaction of weeding regime and integrated nutrient management. The highest grain yield (5.80 t ha^{-1}) was obtained from $W_4 \times F_4$ (weed free with 75% BRRI RD + 25% N from CD) and the lowest grain yield (3.65t ha^{-1}) was obtained from $W_0 \times F_1$ (no weeding with BRRI recommended chemical fertilizers) (Table 2).

Table 2: Combined effect of Nutrient management and weed management on sterile spikelets panicle^{-1}, 1000 grain weight, Grain yield

Interactions	Sterile spikelets panicle^{-1} (no.)	1000 grain weight (g)	Grain yield (t ha^{-1})
$W_0 \times F_1$	22.73	20.38	3.65k
$W_1 \times F_1$	22.27	21.13	4.23j
$W_2 \times F_1$	22.07	21.22	4.55hi
$W_3 \times F_1$	21.93	21.37	4.84efg
$W_4 \times F_1$	22.20	21.55	5.08d
$W_0 \times F_2$	22.53	20.97	4.12j
$W_1 \times F_2$	22.13	21.30	4.64gh
$W_2 \times F_2$	21.67	21.67	4.80fg
$W_3 \times F_2$	20.93	21.54	5.11d
$W_4 \times F_2$	20.33	22.27	5.33c
$W_0 \times F_3$	22.33	21.12	4.42i
$W_1 \times F_3$	21.47	21.37	4.94def
$W_2 \times F_3$	21.27	22.00	5.01de
$W_3 \times F_3$	20.60	22.27	5.42bc
$W_4 \times F_3$	20.13	23.07	5.55b
$W_0 \times F_4$	22.13	21.37	4.80fg
$W_1 \times F_4$	21.40	21.85	5.36bc
$W_2 \times F_4$	20.93	22.22	5.40bc
$W_3 \times F_4$	20.60	23.00	5.55b
$W_4 \times F_4$	19.73	24.05	5.80a
Sx	0.78	0.53	0.06
Level of sig.	0.39NS	0.35NS	0.03*
CV (%)	6.37	4.24	2.28

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 5% level of probability, NS = Not significant
F_1 = BRRI recommended fertilizers (RD), F_2 = 75% BRRI RD + 25% N from CD,
F_3 = 50% BRRI RD + 50% N from CD, F_4 = 25% BRRI RD + 75% N from CD
W_0 = No weeding,
W_1 = 2 hand weeding at 15 & 35 DAT, W_2 = Pre-emergence herbicide,
W_3 = Pre-emergence herbicide + one hand weeding at 35 DAT,
W_4 = Weed free

3.9 Interaction effect of weeding regime and integrated nutrient management on Straw yield

Straw yield was significantly influenced by the interaction between weeding regime and integrated nutrient management. The highest straw yield (6.96t ha^{-1}) was obtained from the interaction from $W_4 \times F_4$ (weed free with 25% BRRI RD + 75% N from CD). The lowest one was (4.30 t ha^{-1}) in $W_0 \times F_1$ (no weeding with BRRI recommended chemical fertilizers) (Table 3).

3.10 Interaction effect of weeding regime and integrated nutrient management on Biological yield

Biological yield was not significantly influenced by the interaction of weeding regime and integrated nutrient managing. Numerically the highest biological yield (12.77 t ha^{-1}) was obtained from the interaction from $W_4 \times F_4$ (weed free with 25% BRRI RD + 75% N from CD) which was the result of highest value of grain yield and straw yield and the lowest one (7.9 5 t ha^{-1}) was obtained from $W_0 \times F_1$ (no weeding with BRRI recommended chemical fertilizers) (Table 3).

3.11 Interaction effect of weeding regime and integrated nutrient management on Harvest index

Harvest index was not significantly influenced by the interaction between weeding regime and integrated nutrient management. However, numerically the highest harvest index (47.80%) was recorded from the interaction of $W_1 \times F_1$ (Two hand weeding at 15 and 35 DATs with BRRI recommended chemical fertilizers) and the lowest one (45.04%) from $W_2 \times F_3$ (Two hand weeding at 15 and 35 DATs with 25% BRRI RD + 75% N from CD) interaction (Table 3).

Table 3: Combined effect of Nutrient management and weed management on Straw yield, Biological yield, Harvest index (%)

Interactions	Straw yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest index (%)
$W_0 \times F_1$	4.30o	7.95	45.77
$W_1 \times F_1$	4.60n	8.83	47.80
$W_2 \times F_1$	5.33jk	9.88	46.07
$W_3 \times F_1$	5.47ijk	10.31	46.88
$W_4 \times F_1$	6.00fg	11.08	45.87
$W_0 \times F_2$	4.87m	8.99	45.78
$W_1 \times F_2$	5.25kl	9.89	46.88
$W_2 \times F_2$	5.68hi	10.48	45.79
$W_3 \times F_2$	5.87gh	10.99	46.33
$W_4 \times F_2$	6.22def	11.55	46.01
$W_0 \times F_3$	5.09l	9.51	46.42
$W_1 \times F_3$	5.61i	10.55	46.34
$W_2 \times F_3$	6.10ef	11.11	45.04
$W_3 \times F_3$	6.31cde	11.73	46.14
$W_4 \times F_3$	6.50c	12.05	46.00
$W_0 \times F_4$	5.50ij	10.30	46.57
$W_1 \times F_4$	6.12ef	11.48	46.67
$W_2 \times F_4$	6.37cd	11.77	45.86
$W_3 \times F_4$	6.75b	12.30	45.13
$W_4 \times F_4$	6.96a	12.77	45.41
Sx	0.07	0.29	0.64
Level of sig.	0.03*	0.09NS	0.78NS
CV (%)	2.25	4.71	2.40

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 5% level of probability, NS = Not significant
F_1 = BRRI recommended fertilizers (RD), F_2 = 75% BRRI RD + 25% N from CD,
F_3 = 50% BRRI RD + 50% N from CD, F_4 = 25% BRRI RD + 75% N from CD
W_0 = No weeding,
W_1 = 2 hand weeding at 15 & 35 DAT, W_2 = Pre-emergence herbicide,
W_3 = Pre-emergence herbicide + one hand weeding at 35 DAT,
W_4 = Weed free

3.12 Correlation and regression studies

The degree of arithmetical relationship between grain yield and number of effective tillers/hill, grain yield and straw yield of BRRI dhan49 has been found out significant relationship at 1% level of probability. The positive slopes exhibited positive relationship.

3.12.1 Grain yield and number of effective tillers/plant

The degree of relationship between grain yield and number of effective tillers/hill of BRRI dhan49 was studied (Figure 3). The result revealed that grain yield and number of effective tillers/hill have a direct significant positive relationship at 1% level of significance which has been confirmed with correlation co-efficient r = 0.95366 (Figure 3). The relationship was more evident by the equation Y= and sowing gradual Y = 0.486x -0.0134 increase in grain yield with the increase of number of effective tiller/hill.

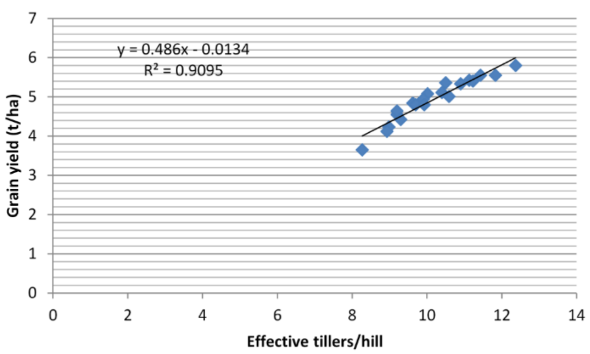

Figure 3: Relation between grain yield and no. of effective tillers/hill of BRRI dhan49

3.12.2 Grain yield and straw yield

From the results of experiment, it is observed that grain yield showed significantly positive correlation with its straw yield (r = 0.9798). The regression equation of Y (grain yield) vs (straw yield) was found to be Y = 0.7592x + 0.5687 (Figure 4). It means that an increase in straw yield will lead to an increase in grain yield.

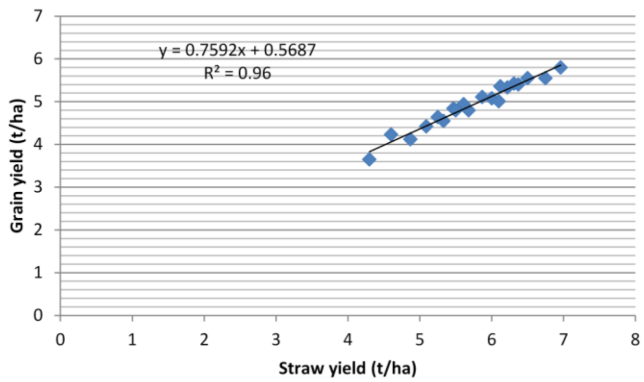

Figure 4: Relation between grain yield and straw yield of BRRI dhan49

4. Discussion

4.1 Plant height (cm)

A group researcher who designated that the tallest plant (111.00 cm) was produced due to weed free condition and the shortest one (87.83 cm) was in no weeding plot (Chowdhury et al., 1994). Azim carried out an experiment with rice and found significant increase of plant height due to combined application of cow dung and inorganic fertilizers (Azim, 1999). But in the present study it is observed that plant height was not significantly influenced by the interaction between weeding regime and integrated nutrient management. Interaction effect of nitrogen fertilizer and weed management did not illustrate significant effect on final plant height (Adhikari et al., 2018).

4.2 Number of total tillers hill^{-1}

Weeding treatments reduced weed population and thereby decreased weed-crop competition during entire growth stage and increased nutrient supply. Thus, increases the productive tillers and other yield attributes. Similar result was reported (Amarjit et al., 2005). Ahmed and Rahman originated that organic and chemical fertilizers increased the number of tillers hill^{-1} (Ahmed and Rahman, 1991). Tillering is an important trait for grain production e.g. rice yield (Hasanuzzaman et al., 2010).

4.3 Number of effective tillers hill^{-1}

Results revealed that effective weed management enhanced tiller production hill^{-1}. Number of effective tillers hill^{-1} exhibited similar behavior as that of number of total tillers hill^{-1} due to different weeding treatments. Similar result was also reported (Ahmed et al., 1986). This might be due to availability of higher amount of nutrient from organic and inorganic sources that enhanced productive tillering and thereby reduced the number of non-effective tillers hill^{-1}. De Datta found that effective weed management increased number of effective tillers hill^{-1} due to more availability of nutrients, water and light (Datta, 1990). Similar results were originated (Singh et al., 1999).

4.4 Number of grains panicle^{-1}

The grains panicle^{-1} was increased over no weeding regime to weed free regime. Reduced grains panicle^{-1} under no weeding condition might be due to competition for assimilate between weeds and crop plants that is not capable to supply available assimilates to the grains. This result was in agreement with the results of Bari who reported that un-weeded plot had the lowest number of grains panicle^{-1} compared to weeded plot in rice (Bari, 2004). A remarkable change was observed due to integrated nutrient management for number of grains panicle^{-1}. Kant and Kumar found that number of grains panicle^{-1} increased with combined application of FYM and inorganic fertilizers namely urea and TSP (Kant and Kumar, 1994). Interaction effect of nitrogen fertilizer and weed management did not show significant effect on number of grains panicle^{-1} (Adhikari et al., 2018).

4.5 Panicle length (cm)

Panicle length happened the shortest in no weeding treatment. Significant difference was found for panicle length among different varieties due to the variation of plant height in SRI system (Tohiduzzaman, 2011). The longest panicle length (23.80 cm) was observed in weed free treatment and the smallest one (21.52 cm) was observed in no weeding treatment (Azme et al., 2016). It is alike to the present experiment. The longest panicle (24.36 cm) was observed by application early post-emergence herbicide Manage treatment which was statistically identical with that of two hand weedings (at 15 & 35 DATs) and the shortest one (20.55 cm) was observed in No weeding treatment (Ferdous et al., 2016). Panicle length was significantly influenced by integrated nutrient management. Among the different fertilizer treatments, 50% RDCF + 4-ton poultry manure/ha significantly enhanced the number of effective tillers/hill, plant height, panicle length, number of filled grain/panicle, straw yield and grain yield over control (Islam et al., 2013). Interaction effect of nitrogen fertilizer and weed management did not show significant consequence on panicle length, (Adhikari et al., 2018).

4.6 Number of sterile spikelets panicle^{-1}

The highest number of sterile spikelet's panicle^{-1} (22.55) was produced by no weeding treatment, while the lowest one (15.16) was produced by weed free treatment. Similar result was gotten in the present experiment (Ferdous et al., 2016). The highest number of unfilled spikelets (23.40) panicle^{-1} was found in no weeding and the lowest number of unfilled spikelets (7.85) panicle^{-1} was found in weed free condition (Mondal et al., 2013). On the other hand, Number of sterile spikelets panicle^{-1} was not significantly affected by the interaction between weeding regime and integrated nutrient management.

4.7 1000-grain weight (g)

Interaction effect of nitrogen fertilizer and weed management did not show significant effect on 1000-grain weight (Adhikari et al., 2018). Weight of 1000 grain was not significantly influenced by the interaction of weeding regime and integrated nutrient management in the present study. A group researcher found that 1000-grain weight was increased by the application of chemical fertilizer along with organic manure (Yang et al., 2004).

4.8 Grain yield

The highest grain (4.50 t ha^{-1}) and straw yield (6.10 t ha^{-1}) was obtained from 80 kg N ha−1 × weeding at 20, 35 and 50 DAT combination and the lowest one was obtained from no nitrogen fertilizer control × unweeded control combination (Adhikari et al., 2018). A similarity is found in the present study. Lin *et al*. (2011) reported that irrigation with organic material application increased yield of rice.

4.9 Straw yield (t ha^{-1})

The highest straw yield (5.56 t ha-1) was observed in Weed free treatment and the lowest one (4.11 t ha-1) was observed in application of pre-emergence herbicide (Rifit) treatment which was statistically identical with No weeding (Ferdous et al., 2016). The highest straw yield of rice (7.12 t/ha) was recorded with the treatment combination of (Alternate wetting and drying, 50% RDCF + 4 ton poultry manure/ha) and the lowest straw yield (5.07 t/ha) was found in (Continuous flooding + control) treatment combination (Islam et al., 2013).

4.10 Biological yield (t ha^{-1})

The highest biological yield (9.94 t ha-1) was obtained in weed free condition and the lowest biological yield (6.71 t ha-1) was obtained in no weeding treatment (Azme et al., 2016). It is similar to the present study. Biological yield as well as straw yield was highest with the treatment 100% of the recommended NPK (e.g. $N_{80}P_{12}K_{72}S_{10}$) and this treatment provided maximum requirement of primary essential elements which were needed for plant's vegetative growth and hence the highest straw yield was obtained (Hasanuzzaman et al., 2010). Biological yield is the total sum of grain yield (economic yield) and straw yield and thus it was also followed the trend like straw yield. This result was supported (Channabasavanna and Biradar, 2001).

4.11 Harvest index (%)

According to a study, Treatment with (Poultry manure @ 4 t ha^{-1} + $N_{40}P_6K_{36}S_{10}$ i.e. 50% NPK) produced the highest harvest index (41.43%) (Hasanuzzaman et al., 2010). Interaction effect of nitrogen fertilizer and weed management did not show significant effect on harvest index (Adhikari et al., 2018). It is similar with the present study. Rice should be kept weed free as much as possible through the life cycle to obtain good yield (Adhikari et al., 2018). Yield variations in rice due to weeding were also noticed by many researchers (Chowdhury et al., 1994; Ahmed et al., 1998; Hossain et al., 2002; Islam et al., 2003, Liu et al., 2016). Application of nitrogenous fertilizer encouraged vegetative growth of rice in terms of plant height and number of total tillers hill^{-1}, which ultimately resulted in the increase of straw yield (Mishra et al., 2003). The biological yield and harvest index also affected significantly due to application of nitrogenous fertilizer (Adhikari et al., 2018). Farmers can use the combination of organic fertilizer and reduced rate of inorganic fertilizers to boost the yield of rice (Siavoshi et al., 2011).

5. Conclusion

The highest plant height (107.33 cm), number of effective tillers hill^{-1} (12.37), straw yield (12.37 t ha^{-1}), grain yield (5.80 t ha^{-1}) were found in $W_4 \times F_4$ (weed free with 25% BRRI RD + 75% N from CD). The highest number of sterile spikelets panicle^{-1} (22.75) was found in $W_0 \times F_1$ (no weeding with BRRI RD). The lowest plant height (94.78 cm), number of lowest effective tillers hill^{-1} (8.27) and grain yield (3.65 t ha^{-1}) were found in $W_0 \times F_1$ (no weeding with BRRI RD). The lowest number of sterile spikelets (19.73) was found in $W_4 \times F_4$ (weed free with 25% BRRI RD + 75% N from CD). From the present study it can be concluded that 25% BRRI RD +75% N from CD and weed free condition may be used to obtain the highest yield of transplant *aman* rice cv. BRRI dhan49.

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Conflict of interest

The authors have no clash of concentration to report.

References

Adhikari, J., Sarkar, M.A.R., Uddin, M.R., Sarker, U.K., Hossen, K., Rosemila, U., 2018. Effect of nitrogen fertilizer and weed management on the yield of transplant aman rice. J Bangladesh Agril Univ., 16 (1), Pp. 12–16. https://doi.org/10.3329/jbau.v16i1.36473

Ahmed, M., Rahman, S., 1991. Influence of organic matter on the yield and mineral nutrition of modern rice and soil properties. Bangladesh Rice. J., 2 (1-2), Pp. 107-119.

Ahmed, S., Mamun, A.A., Islam, M.A., Hossain S.M.A., 1986. Critical period of weed competition on transplanted Aus rice. Bangladesh J. Agril., 11, Pp. 1-7.

Ahmed, Z., Khan, D.R., Alim, S.D., Tahir, M., Marwat, K.B., 1998. Effect of economics of time and weed removal on the yield and yield components of rice. Sarhad J. Agril., 14 (4), Pp. 335-338.

Amanullah, Hidayatullah, 2016. Influence of Organic and Inorganic Nitrogen on Grain Yield and Yield Components of Hybrid Rice in Northwestern Pakistan. Science Direct Rice Science, 23 (6), Pp. 326–333. https://doi.org/10.1016/j.rsci.2016.02.007

Amarjit, S.B., Bali, A.S., Singh, M., Kachrod, D., Sharma, B.C., Shivram, D.R., 2005. Efficacy of herbicide in transplanted medium duration of rice under sub- tropical condition of Jammu. Indian J. Agron., 51 (2), Pp. 128-130.

Azim, S.M.A., 1999. Effect of sulphur, zinc and boron supplied from manures and fertilizer on BRRI Dhan29. M. S. Thesis, Dept. Soil Sci., Bangladesh Agril. Univ., Mymensingh., pp. 57-59.

Azme, N.A., Hossain, M.D., Salam, M.A., 2016. Effect of planting method and weeding regime on the performance of transplant Aman rice. Progressive Agriculture, 27 (3), Pp. 249-255. https://doi.org/10.3329/pa.v27i3.30804

Bacon, P., 1989. Response of Inga rice to application of nitrogen fertilizer at varying growth stages. Australian journal of experimental agriculture and animal husbandry (Australia). 24 (125), Pp. 250 – 254. https://doi.org/10.1071/ea9840250

Bali, A.S., Siddique, M., Ganai, B.A., Khan, H.V., Singh, K.N., 1995. Response of rice (Oryza sativa) genotypes to nitrogen levels under transplanted conditions in Kashmir valley. Indian J. Agron, 40 (1), Pp. 35-37.

Bari, M.N., 2010. Effect of herbicides on weed suppression and rice yield in transplanted wetland rice. Pakistan J. Weed Sci. Res., 16 (4), Pp. 349-361.

Bari, S.M.W., 2004. Effect of method of planting and weeding on the yield and yield contributing characters of Aman rice. M. S. Thesis, Dept. Agron., Bangladesh Agril. Univ., Mymensingh. Pp. 38.

BBS (Bangladesh Bureau of Statistics). 2017. Yearbook of Agricultural Statistics of Bangladesh. Bangladesh Stat. Div., Minis. of Plan. Govt. People's Repub. Bangladesh, Dhaka. Pp. 45.

Belder, P., Bouman, B.A.M., Cabangon, R., Lu, G., EJP. 2004. Quilang, Y. Li, J.H.J. Spiertz and T.P. Tuong. Effect of water-saving irrigation on rice yield and water use in typical lowland conditions in Asia. Agric. Water Manage., 65 (3), Pp. 193–210. https://doi.org/10.1016/j.agwat.2003.09.002

Bhowmic, M.K., Nayar, R.L., Ray, D., 2002. Herbicide studies on weed management, crop phytotoxicity, growth and yield of dry season rice. Ann. Agril. Res., 23 (1), Pp. 116-122.

Channabasavanna, A.S., Biradar, D.P., 2001. Response of irrigated rice to the application of poultry manure and inorganic fertilizers N, P and K in Karnataka, India. Intl. Rice res. Notes., 26 (2), Pp. 64-65.

Chowdhury, M.J.U., Sarkar, A.U., Sarkar, M.A.R., Kashem, M.A., 1994. Effect of weed infestation regime on the growth and yield of transplant Aman rice. Bangladesh J. Agril. Sci., 21 (1), Pp. 141-147.

De Datta, S.K. 1990. Weed control in rice in South East Asia. Ext. Bull. No. 146 FFTC. Taiwan. pp. 1-24.

Duhan, B.S., Singh, M., 2002. Effect of green manuring and nitrogen on the yield and uptake of micronutrient by rice. J. Indian Soc. Soil Sci., 50 (2), Pp. 178-180.

Ferdous, J., Islam, N., Salam, M.A., Hossain, M.S., 2016. Effect of weed management practices on the performance of transplanted aman rice varieties. J. Bangladesh Agril. Univ., 14 (1), Pp. 17–22. https://doi.org/10.3329/jbau.v14i1.30591

Ghersa, C.M., Benech-Arnold, R.L., Satorre, E.H., Martinez-Ghersa, M.A., 2000. Advances in weed management strategies. Field Crops Res., 67, Pp. 95-104.

Ghersa, C.M., Roush, M.L., Radosevich, S.R., Cordray, S.M., 1994. Coevolution of agroecosystems and weed management. Bio Sci., 44, Pp. 85-94. https://doi.org/10.2307/1312206

Gogoi, A.K., Rajkhowa, D.J., Kandali, R., 2000. Effect of varieties and weed control practices on rice productivity and weed growth. Indian J. Agron., 45 (3), Pp. 580-585. https://doi.org/10.1016/s0378-4290(00)00086-1

Gomez, K.A., Gomez, A.A., 1984. Statistical Procedures for Agricultural Research. 2nd Ed., Jhon Wiley and Sons. New York. Pp. 97-111.

Hasanuzzaman, M., Ahamed, K.U., Rahmatullah, N.M., Akhter, N., Nahar, K., Rahman, M.L., 2010. Plant growth characters and productivity of wetland rice (Oryza sativa L.) as affected by application of different manures. Emir. J. Food Agric., 22 (1), Pp. 46-58. http://ffa.uaeu.ac.ae/ejfa.shtml.

Hoque, S.M.A., Hossain, M.D., Talukder, K.H., Asaduzzaman, M., Sayed, M.A., Hoque, M.N., 2011. Effect of weeding regime on the weed infestation and crop performance of transplant Aman rice. J. Sci. Foundation, 9 (1&2), Pp. 27-40. https://doi.org/10.3329/jsf.v9i1-2.14645

Hossain, M.M., Haque, M.Z., 2002. Seedling age and weed density effects on basal tillers survival and yield of transplanted deep-water rice. In: Proc. Intl. Deep Water Rice Workshop. Manila. Philippines. Pp. 16–20.

IRRI (International Rice Research Institute).1998. Annual Report for 1990. Intl. Rice Res. Inst., Los Banos, Phillippines. Pp. 246.

Islam, M.M.A.F., Khan, M.A., Bari, A.S.M.F., Hosain, M.T., Sabikunnaher, 2013. Effect of Fertilizer and Manure on the Growth, Yield and Grain Nutrient Concentration of Boro Rice (Oryza sativa L.) under Different Water Management Practices. The Agriculturists, 11 (2), Pp. 44-51. https://doi.org/10.3329/agric.v11i2.17486

Islam, M.Z., 2003. Effect of weeding regime on the growth and yield of rice. J. Agric. Environ. Sci., 11 (5), Pp. 640–646.

Kabir, M.H., Bari, M.N., Haque, M.M., Ahmed, G.J.U., Islam, J.M.S., 2008. Effect of water management and weed control treatments on the performance of transplanted Aman rice. Bangladesh J. Agril. Res., 33 (3), Pp. 399-408. https://doi.org/10.3329/bjar.v33i3.1599

Kant, S., Kumar, R., 1994. Comparative study on the effect of four soil amendments on the uptake of Fe, Mn and yield of rice in salt affected soil. Indian J. Agric. Chem., 27 (283), Pp. 59-70.

Karim, S.M.R., Azmi, B.M., Ismail, B.S., 2004. Weed problems and their management in rice fields of Malaysia: An overview. Weed Biol. Mgnt., 4, Pp. 177-186. https://doi.org/10.1111/j.1445-6664.2004.00136.x

Kasasian, L., 1971. Weed control in Tropics, London, England, Leonard Hill, Pp. 124-215.

Lin, X.Z.D., Xinjunlin. 2011. Effects of water management and organic fertilization with SRI crop practices on hybrid rice performance and rhizosphere dynamics. Paddy and Water Environment, 9, Pp. 33-39. https://doi.org/10.1007/s10333-010-0238-y

Liu, X., Wang, H., Zhou, J., Hu, F., Zhu, D., 2016. Effect of N Fertilization Pattern on Rice Yield, N Use Efficiency and Fertilizer–N Fate in the Yangtze River Basin, China. PLOS ONE, 11 (11), Pp. e0166002. https://doi.org/10.1371/journal.pone.0166002

MacLean, J.L., Dawe, C., Hardy, B., Hettel, G.P., 2000. Rice Almanac, third ed.IRRI, Los Banos, Philippines, Pp. 253.

Michiel, E., Rodenburg, J., Bado, B.V., Sow, A., Leffelaar, P.A., Giller, E., 2010. Rice production with less irrigation water is possible in a sahelian environment. Field Crop Research, 116, Pp. 154-164. https://doi.org/10.1016/j.fcr.2009.12.006

Mishra, P.K., Rajput, R.S., Tripathy, R.K., Joshi, B.S., 2003. Effect of integrated nitrogen nourishment and growth regulators on yield attributes and grain yield of hybrid rice. Ann. of Agric. Res., 24 (2), Pp. 411–415.

Mondal, B., Sarkar, M.A.R., Paul, S.K., Zaman, F., 2013. Effect of variety and weeding regime on the yield components and yield of Aus rice. J. Bangladesh Agril. Univ., 11 (1), Pp. 17–21. https://doi.org/10.3329/jbau.v11i1.18198

Mondal, S., Swamy, S.N., 2003. Effect of time on N application yield and yield attributes of rice (Oryza saliva L.) cultivar. Env. Ecol., 21 (2), Pp. 411-413.

Mukherjee, P.K., Malty, S.K., 2007. Weed control in transplanted and wet seeded rainy season rice (Oryza sativa). Indian J. Agric. Sci., 81 (2), Pp. 134-139.

Prasad, B., Sharma, M.M., Sinha, S.K., 2002. Evaluating zinc fertilizer requirement on Typic I-Ialaquent in rice - wheat cropping system. J. sustainable Agric., 19 (3), Pp. 39-49. https://doi.org/10.1300/j064v19n03_05

Quanbao, Y., Hongcheng, H., Haiyan, W., Ying, Z., Benfu, W., Ke, X., Zhongyang, H., Qigen, D., Ke, X., 2007. Effects of nitrogen fertilizer on nitrogen use efficiency and yield of rice under different soil conditions. Agric. China., 1 (1), Pp. 30–36. https://doi.org/10.1007/s11703-007-0005-z

Rangaraju, G., 2002. Weed flora and weed dynamics of pre-monsoon dry seedbed rainfed rice as influenced by herbicide and its time of application. Indian J. Dryland Agril. Res. Dev., 17 (2), Pp. 100-103.

Rao, A.N., Johnson, D.E., Sivaprasad, B., Ladha, J.K., Mortimer, A.M., 2007. Weed management in direct seeded rice. Adv Agron., 93, Pp. 153-255. https://doi.org/10.1016/s0065-2113(06)93004-1

Reddy, M.N., Sitaramayya, M., Swamy, S.N., Sairam, A., Kanth, G.K., 2004. Productivity and soil fertility changes under continuous fertilization changes of rice (Oryza sativa) cropping system.

Siavoshi, M., Nasiri, A., Laware, S.L., 2011. Effect of Organic Fertilizer on Growth and Yield Components in Rice (Oryza sativa L.). Journal of Agricultural Science, 3 (3), https://doi.org/10.5539/jas.v3n3p217

Singh, A.K., Singh, N.P., Nongkynrith, P., 2002. Response of rice to Zn in the soils of meghalaya. Fertilizer News, 47 (8), Pp. 53-54.

Singh, G., Singh, R.K., Singh, V.P., Nayak, R., Singh, R.S., 1999. Weed management in transplant rice (Oryza sativa) under rainfed lowland condition. Indian J. Agron., 44 (4), Pp. 728-732.

Singh, H.P., Sing, T.N., 2005. Enhancement in zinc response of rice by magnesium in alkali soil. Univ. Agric. and Tech., Faizabad, India. 10 (2), Pp. 158-161.

Subhendu, M., Salamy, S.N., Mandal, S., 2003. Effect of time on nitrogen application on yield and yield attributes of rice (Oryza saliva L.) cultivars. Env. Ecol., 21 (2), Pp. 411-413.

Tohiduzzaman. 2011. Screening of rice varieties responsive to system of rice intensification (sri) in boro season. M. Sc. (Ag) Thesis. Dept. of Agronomy. Sher-e-Bangla Agricultural University, Dhaka, Bangladesh.

Yang, C.M., Yang, L., Yang, Y., Ouyang, Z., 2004. Rice root growth and nutrient uptake as influenced by organic manure in continuously and alternately flooded paddy soils. Agricultural Water Management, 70 (1), 67-81. https://doi.org/10.1016/j.agwat.2004.05.003