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Growth and Yield of Transplant Aman Rice (BRRI dhan38) as Affected by Weeding and Zinc Level

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Abstract: The study was conducted at the Agronomy Field Laboratory Department of Agronomy and Agricultural Extension, University of Rajshahi, during the period of July 2019 - December 2019 to study the effect of zinc and weeding on the yield of transplant Aman rice (BRRI dhan38). The experiment consisted of two factors i.e., i) four weeding treatment viz. (control), 1, 2 and 3 hands weeding (at 20, 40 and 60 DAT) and ii) four levels of Zinc treatments (0, 5, 10, 15 kg Zn ha^{-1}). The study was conducted in a Randomized Completely Block Design (RCBD) with three replications. The area of each unit was $10m^2$. Results revealed that the effect of weeding was significant on plant height, number of tiller $hill^{-1}$, number of effective and non-effective tiller $hill^{-1}$, panicle length, number of grain $panicle^{-1}$, number of effective grain $panicle^{-1}$, number of non-effective grain $panicle^{-1}$, weight of 1000 grain, grain yield and straw yield. Among the different weeding regimes the highest result obtaind from the three weedings (completely weed-free condition). The lowest grain yield and yield characters that contributed were produced from no weeding condition. On the other hand, zinc treatment had a significant effect on yield parameters expect the number of non-effective grain $panicle^{-1}$. Among the different zinc treatment, the maximum grain yield was gained from the fourth level of zinc (15 kg Zn ha^{-1}) and the minimum grain yield was produced from control treatment (0 kg Zn ha^{-1}) From the results, it may be said that four weedings with 15 kg Zn ha^{-1} is better for transplanted aman rice yield (BRRI dhan38).

Keywords: Growth, Yield, Transplant Aman Rice, Weeding And Zinc

1. Introduction

Bangladesh is a nation that agrarian. The most of her financial exercises primarily depending on farming. Farming may be a critical segment of the economy of Bangladesh it plays a critical part almost 13.35% of the GDP of Bangladesh and more than 40% individuals included in this segment. Natural and geological condition of this locale are reasonable for rice generation. Rice supply food almost 2 billion individuals in AsiaAfrica and Latin America [10]. Rice may be a primary food of Bangladesh where rice create as it were twice a year amid the final 3 decades and come to very 25 million tons in 2001-2002 [1]. The demography of Bangladesh will expand to 173 million in 2020 that's 31% over this condition [6]. NAC said that to nourish the expand individuals in 2020 47 million of rice is reaching to be required to supply inside the country. For give sufficent nourishment of this locale rice development is required to be increase from 3 tons per hacter to 5 tons per hacter within the afterward 20 a long time [12].

The North-Western locale of this nation are more reasonable to delivered scent variety of rice. Concurring to DAE the generation of scent rice has expand than the past time so has the gathering much obliged to HYV. The individuals of Bangladesh favor fragrant rice. It is required more in several celebrations. It is exceptionally tasty. Supplement lack in soil is the vital cause for the less generation of rice in Bangladesh. Fertilizers are irreplaceable for the trim generation framework of later farming. Nowadays inorganic fertilizers hold the key to victory for expanded trim generation being obligated for approximately

50% of the complete development [3]. Lack of zinc causes misfortune of grain surrender and rice grain with moo Zinc substance contributes to human dietary zinc lacks [11]. Zinc lacks are broadly spread all through the planet particularly inside the rice lands of Asia and lacks happen in unbiased and calcareous soils [16]. Lack of micronutrients with stretch to zinc particularly has been detailed in wetland rice soils of Bangladesh and fabulous reaction by application of 5 kg Zn h^{-1} are recorded [15], it had been detailed that around 2.0 M hectares of Agrarian arrive are zinc lacking beneath distinctive AEZ of this region. Zinc is vital for changed chemical frameworks and is competent of shaping numerous steady bonds with N and S ligands.

The production of T-Aman rice approximately 48.67% of the full rice range and it gives approximately 42.78 percent of the full ricedevelopment [2]. But this crop yield is exceptionally less than that of other nations. The most important calculate of moo abdicate is weed pervasion [13]. The climatic condition is reasonable for different weed development that restriction with rice trim. [14] detailed that weed development declined the production approximately 64-100% for direct-seeded Aus rice 18-48% for T- aman rice and 22-38% for modern boro rice. Agriculturists spend more capital for weed control in this case. Ordinary weeding is ordinarily tired the numerous region of Bangladesh. Advanced weeding and chemical control are utilized are the options routine weeding. Numerous mechanical gadget are utilized in a few region. BRRI has produced a modern and simple innovation for weed control.

Bangladesh is mostly an agricultural nation. Agriculture is the primary economic activity in her country. Over 40% of Bangladesh's workforce is employed in the agriculture sector, which contributes significantly to the country's economy—roughly 13.35% of GDP. This region's physical and environmental conditions are favorable for rice cultivation. About 2 billion people in Asia, Africa, and Latin America depend on rice for their food [10]. Bangladesh's staple grain is rice, which is produced there twice a year and reached a peak of around 25 million tons in 2001–2002 [1]. Bangladesh's population is expected to increase to 173 million in 2020, which is 31% more than what it is now [6]. NAC stated that in order to feed the more people.

Due to increased output, farmers are becoming more interested in high-yielding rice growing these days. They are BR5 (Dulabhog), BRRI dhan34, BRRI dhan 37, BRRI dhan 38, BRRI dhan 70, BRRI dhan 75, BRRI dhan 80 and BRRI dhan 50. The DAE claims that Bangladesh's soil and climate are ideal for growing HYV rice.

The North-Western region of this country are more suitable to produced fragrance variety of rice. According to DAE, the production of fragrance rice has augment than the past time, so has the assembly thanks to HYV. The people of Bangladesh prefer aromatic rice. It is needed more in different festivals. It is very delicious. Nutrient deficiency in soil is the important cause for the less production of rice in Bangladesh. Fertilizers are indispensable for the crop production system of recent agriculture. Today inorganic fertilizers, hold the key to success for increased crop production, being liable for about 50% of the entire cultivation [7]. Deficiency of zinc causes loss of grain yield and rice grain with low Zinc content contributes to human nutritional zinc deficiencies [11]. Zinc deficiencies are widely spread throughout the planet, especially within the rice lands of Asia and deficiencies occur in neutral and calcareous soils [16]. Deficiency of micronutrients with stress to zinc especially has been reported in wetland rice soils of Bangladesh and spectacular response by application of 5 kg Zn h^{-1} are recorded [15], it had been reported that about 2.0 M hectares of Agricultural land are zinc deficient under different AEZ of this region. Zinc is important for varied enzyme systems and is capable of forming many stable bonds with N and S ligands.

The production of T-Aman rice about 48.67% of the total rice area and it provides about 42.78 percent of the total rice cultivation [2]. But this crop yield is very less than that of other countries. The most important factor of low yield is weed infestation [14]. The climatic condition is suitable for various weed growth that opposition with rice crop. Mamun [13] reported that weed growth declined the production about 64-100% for direct-seeded Aus rice, 18-48% for T- aman rice, and 22-38% for contemporary boro rice. Farmers spend more capital for weed control in this case. Conventional weeding is usually done in the many area of Bangladesh. Modern weeding and chemical control are used are the alternatives conventional weeding. Many mechanical device are used in some region. BRRI has generated a new and easy technology for weed control.

This research trial deals with the effect of zinc and weed control on the growth and yield of T-Aman rice this are given below some objectives:

1. To determine the effect of weeding on yield of T-aman rice.
2. To determine the effect of zinc on yield of T-aman rice.
3. To evaluate the combined effect of weeding and zinc on yield of T-aman rice.

2. Material and Methods

The experiment was conducted at the University of Rajshahi's Agronomy Field Laboratory, which is part of the Department of Agronomy and Agricultural Extension. To investigate the impact of zinc and weeding on the production of transplant Aman rice (BRRI dhan38), research will be conducted from July 2019 to December 2019.

2.1. Experimental Period

The experiment was carried out between July and December of 2019.

2.1.1. Location and Site

Situated on the western side of the University of Rajshahi's Department of Agronomy and Agricultural Extension lies the experimental farm. Geographically, the experimental field is located at a height of 71 feet above sea level at 24° 22′ 36″ N latitude and 88° 38′ 27″ E longitude. According to [6] the experimental area is located in the sub-tropical climatic zone "AEZ-11," which is located in the central-southern portion of the High Ganges Floodplain. The terrain was level, well-drained, medium-high, and above flood level.

2.1.2. Soil

The soil of the experimental area belonged to the Ganges Floodplain under the Agro-ecological Zone "AEZ-11" The soils of the experimental plots were sandy loam. The PH value of the soil is 8.6 total Nitrogen was 0.04%, organic matter 0.46%, phosphorus 11.33ppm, potassium 0.19 Milli equivalent\100gm soil, zinc 0.78 ppm, and Sulpher 3.10 ppm. the physical and chemical characteristics of the soil of the experimental field.

2.1.3. Climate

The subtropical climate of the experimental region is marked by heat and moderate rainfall from April to September during the Kharif season, and sparse rainfall along with moderate cold temperatures from October to March during the Rabi season.

2.2. Materials of the Experiment

2.2.1. Planting Material

BRRI dhan38 was used as planting material. It is a Transplant aromatic Aman Rice variety.

2.2.2. Description of the Used Variety

BRRI dhan38 was selected for the study. Bangladesh Rice Research Institute (BRRI) has developed BRRI dhan38. the variety was released in 1998, originated from Bangladesh. This variety is photo insensitive. Its life cycle is about 145 days. The plant height is 125 cm, clean rice, medium slender and aromatic. The yield is about 3.5 ton/ha.

2.3. Treatments

The study consists of the following 2 (two) factors-

Factor A: Weeding Regime

The weeding regime was used for the study as follows:

I. W_0 = weeding (Weeds are allowed to grow in this treatment with crop till harvest)
II. W_1= 1 Hand weeding (i.e. 1st hand weeding was done at 20 DAT)
III. W_2= 2 Hand weeding (i.e. 1st hand weeding was done at 20 DAT and 2nd at 40 DAT)
IV. W_3= 3 Hand weeding (i.e. 1st hand weeding was done at 20 DAT, 2nd at 40 DAT and 3rd at 60 DAT)

Factor B: Four levels of Zn as

i. Zn_0: 0 kg Zn ha^{-1}
ii. Zn_1: 5 kg Zn ha^{-1}
iii. Zn_2: 10 kg Zn ha^{-1}
iv. Zn_3: 15 kg Zn ha^{-1}

2.4. Experimental Design and Layout

With three replications, the experiment was set up using a Randomized Complete Block Design. The three blocks that made up the experimental area each represented a replication. Once more, each block was split into sixteen unit plots, each of which received a randomly assigned treatment combination. 48 made up the whole unit plot. The unit plot measured 10 m^2 (5 m x 2 m).

2.4.1. Seed Collection and Sprouting

Only 20 days prior to the seeds being sown in a seedbed, fragrant rice variety seeds were gathered from the Bangladesh Rice Research Institute (BRRI), Regional Station, Shyampur, Rajshahi. Clean, healthy seeds were immersed in water for 24 hours to produce seedlings, which were then visible in the seedbed after 72 hours. A well-prepared seedbed was used to plant the sprouting seeds evenly. When appropriate, precautions were made to safeguard the seeds within the seedbed.

2.4.2. Raising of Seedlings

Puddling with plowing and then laddering was the method used to prepare the crib. On June 21, 2019, the seeds that had germinated were spread out as evenly as possible among beds. When needed, water was gently brought to the bed.

2.4.3. Land Preparation

On July 18, 2019, an influence tiller tractor inaugurated the experimental field. After that, the soil was thoroughly tilled, almost preparing it for planting. After the removal of stubble and weeds, laddering was used to level the area. To achieve the desired puddle state, it was plowed and cross-ploughed three times using a country plough pulled by a bullock and then laddered. The fields' corners were well-spaded. After that, the experimental field was split up into unit plots, each of which had been spaded at some time prior to transplantation in order to include the base fertilizers. Ultimately, before to transplanting, a private plot was planned.

2.4.4. Fertilizers and Manure Application

N, K, P, S, Zn, and B fertilizers in the forms of urea, TSP, MoP, gypsum, zinc sulfate, and borax, in that order. Specifically, 180, 100, 70, 60, and 10 kg ha^{-1} of urea, TSP, MoP, gypsum, and borax were administered. At 76.8 kg h^{-1}, vermicompost was administered. As part of the therapy, zinc was administered. When finalizing land preparation, the full amount of vermicompost, TSP, MoP, gypsum, zinc sulphate, and borax were applied. At 25, 45, and 65 days after treatment, urea was given in stages as a basal and top dressing.

2.4.5. Transplanting of Seedling

Before being uprooted, the seedbeds were moistened by applying water in the morning and evening of the preceding day. After being gently removed to prevent mechanical damage to the roots, the seedlings were placed in a shaded area on soft mud until July 30, 2019, when they were transferred onto a suitable puddle plot at a 20-by-15-cm spacing. Each hill received the transplantation of two seedlings.

2.5. Data Collection and Recording

Data was collected two times such as before harvest and after harvest.

2.5.1. Procedure of Recording Data

Below is a quick summary of the information recording process:

1. Plant height

In five randomly selected hills of each plot, the height of the plants was measured from the soil to the tip of the leaf or panicle.

2. Number of tiller hill^{-1}

The tillers with at least one leaf showing were tallied. It contained tillers that were both efficient and inefficient.

3. Number of effective tiller hill^{-1}

Because of the quantity of panicle-bearing tillers during harvesting, the total effective tiller hill-1 was counted. Five hills were chosen for data collection on effective tillers hill^{-1}, and the average value was then collected.

4. Number of non-effective tiller hill^{-1}

Because there were more non-panicle bearing tillers during harvesting, the total number of ineffective tillers hill-1 was tallied. Five hills were chosen for data collection on non-effective tillers hill^{-1}, and the average value was subsequently collected.

5. Panicle length

Five panicles were chosen, and each panicle's length was measured using a meter scale. The average length of each panicle was then recorded in centimeters.

6. Number of effective grain panicle^{-1}

The average number of effective grain panicle-1 was obtained after the total number of effective grain was randomly taken from five panicles of a plot supported on grain within the spikelet.

7. Number of non-effective grain panicle^{-1}

After determining that there were no grains in the spikelets of five randomly chosen plants in a plot, the total number of ineffective grains was counted, and the average number of ineffective grains panicle^{-1} was noted.

8. Number of total grain panicle^{-1}

The average number of grain panicles-1 was recorded, and the total quantity of grain was computed by summing the effective and non-effective grain from five chosen plants in a plot.

9. Grain yield

After being sun-dried, the grains from every unit plot were meticulously weighed. Each plot's dry grain weight was measured and translated to tons per hectare.

10. Straw yield

Every unit plot's share of straw was sun-dried and meticulously weighed. Each plot's dry straw weight was measured and translated to tons per hectare.

2.5.2. Statistical Analysis

The collected data were statistically analyzed. With the aid of the MSTAT-C application, the Duncan's New Multiple Range Test (DMRT) was used to determine mean differences using the analysis of variance approach.

3. Results and Discussion

3.1. Effect of Weeding

3.1.1. Plant Height

Result presented in Table exhibits that weeding had a 5% level of significant effect on plant height. (Table 1) shows that the highest plant height (123.273 cm) was recorded in W_3 and the lowest plant height (89.528 cm) was recorded in W_0 (no weeding) treatment (Table 1). Weed conflict was strike with no weeding state and those plant height of rice were waned. On the other in weed-free treatment through the crop growth period, the competition of weed with the plant was less and the height was increased. [8, 17] also reported that heavy weed infestation in rice significantly reduced plant height.

3.1.2. Number of Tillers Hill^{-1}

It was a 1% level of Significant difference observed in respect of a number of total tillers hill^{-1}. The results dedicated in (Table 1) manifested that the highest number of total tillers hill^{-1} (16.201) was recorded in W_3 and the lowest number of total tillers hill^{-1} (11.511) was recorded in W_0 treatment. (Table 1). [8] also found that unrestricted weed growth reduced the no. of total tillers hill^{-1}.

3.1.3. Number of Effective Tillers Hill^{-1}

There was 1% level of Significant variation observed in respect of a number of effective tillers hill^{-1}. The results dedicated in (Table 1) manifested that the highest number of effective tillers hill^{-1} (14.804) was recorded in W_3 (weed-free) and the lowest number of effective tillers hill^{-1} (8.183) was recorded in W_0 (no weeding) treatment. (Table 1). The result conform with that of [5];. Tillers plant $^{-1}$ increased discovering were also indicated [8, 9, 17].

3.1.4. Number of Non-Effective Tiller Hill^{-1}

There was a 1% level of Significant variation observed in respect of a number of non-effective tillers hill^{-1}. The results dedicated in (Table 1) manifested that the maximum number of non-effective tillers hill^{-1} (1.397) was recorded in W_3 (weed-free) and the lowest number of non-effective tillers hill^{-1} (3.328) was recorded in W_0 (no weeding) treatment. (Table 1).

3.1.5. Panicle Length

There was a 1% level of Significant variation investigated in respect of panicle length. The results presented in (Table 1) exhibited that the highest number of panicle length (23.817) was recorded in W_3 (weed-free) and the minimum number of panicle length (10.482) was recorded in W_0 (no weeding) treatment (Table 1). The result is in conformity with that of [5, 17].

3.1.6. Number of Effective Grain Per Panicle

There was a 1% level of Significant variation observed in respect of a number of effective grain per panicle. The results dedicated in (Table 1) exhibited that the highest number of effective grain per panicle (142.411) was recorded in W_3 (weed-free) and the lowest number of effective grain per panicle (99.162) was recorded in W_0 (no weeding) treatment (Table 1).

3.1.7. Number of Non-Effective Grain Per Panicle

There was a 1% level of Significant variation observed in respect of a number of non-effective grain per panicle. The results presented in (Table 1) exhibited that the maximum number of non-effective grain per panicle (29.219) was filed in W_0 (no weeding) and the lowest number of non-effective grain per panicle (17.195) was recorded in W_3 (weed-free) treatment (Table 1).

Table 1. Impact of weeding on yield and yield contibuting characters of rice.

Treatment	Plant height (cm)	No. of tiller hill^{-1}	No. of effective tiller hill^{-1}	No. of non effective tiller hill^{-1}	Panicle length (cm)	No. of effective grain/panicle	No. of non effective grain/panicle
W_0	89.52 d	11.51 d	8.18 d	3.33 a	10.48 d	99.16 d	29.22 a
W_1	96.35 c	14.60 c	12.02 c	2.58 b	13.43 c	111.34 c	25.59 b
W_2	108.71 b	15.06 b	12.80 b	2.26 b	17.93 b	126.48 b	23.18 b
W_3	123.27 a	16.20 a	14.80 a	1.39 c	23.81 a	142.41 a	17.19 c
CV (%)	4.37	5.10	4.25	13.68	4.78	4.48	12.69

W0= No weeding, W1=1 hand weeding, W2= 2 hand weeding and W3= 3 hand weeding

3.1.8. Number of Total Grain Per Panicle

There was a 1% level of Significant variation seen in respect of a number of total grain per panicle. The results dedicated in (Table 2) manifested that the highest number of total grain per panicle (175.250) was recorded in W_3 (weed-free) and the lowest number of total grain per panicle (116.078) was recorded in W_0 (no weeding) treatment (Table 2).

3.1.9. Grain Yield

There was a 1% level of Significant variation seen in respect to grain yield. The results presented in (Table 2) exhibited that the maximum grain yield (3.80 t ha^{-1}) was recorded in W_3 (weed-free) and the lowest number of grain yields (2.899 t ha^{-1}) was recorded in W_0 (no weeding) treatment (Table 2).

3.1.10. Straw Yield

It was 1% level of Significant variation observed in respect of straw yield. The results dedicated in (Table 2) manifested that the maximum straw yield (4.657 t ha^{-1}) was recorded in W_3 (weed-free) and the lowest number of grain yield (3.984 t ha^{-1}) was recorded in W_0 (no weeding) treatment (Table 2).

Table 2. Impact of weeding on yield and yield contibuting characters of rice.

Treatment	No. of total grain/panicle	Grain yield t ha^{-1}	Straw yield t ha^{-1}
W_0	75.25 a	2.89 d	3.98 bc
W_1	136.26 c	2.98 c	3.97 c
W_2	156.59 b	3.30 b	4.18 b
W_3	116.07 d	3.80 a	4.65 a
CV (%)	4.22	4.56	4.29

W_0= No weeding, W_1=1 hand weeding, W_2= 2 hand weeding and W_3= 3 hand weeding

3.2. Effect of Zinc

3.2.1. Plant Height

Plant height various significantly depending on zinc. In Table 3 the highest plant height (108.417 cm) was seen in treatment Zn_3 and the lowest height (100.250 cm) was observed from treatment Zn_0.

3.2.2. Number of Tiller Hill^{-1}

Zinc has a significant influence on the no. of tillers hil^{-1}. The highest numbers of total tillers hill^{-1} (15.287) were obtained at treatment Zn_3 and the lowest number of tillers hill^{-1} (12.963) was obtained at treatment Zn_0 (Table 3).

3.2.3. Number of Effective Tiller Hill^{-1}

Zinc hasa great impact on the number of effective tillers hil^{-1}. The highest numbers of effective tillers hill^{-1} (13.405) were gained at treatment Zn_3 and the lowest number of effective tillers hill^{-1} (9.791) was obtained at treatment Zn_0 (Table 3).

3.2.4. Number of Non-Effective Tiller Hill^{-1}

Zinc has a great effect on the number of non-effective tiller hil^{-1}. The maximum numbers of non-effective tillers hill^{-1} (3.173) were gained at treatment Zn_0 and the minimum number of non-effective tillers hill^{-1} (1.883) was obtained at treatment Zn_3 (Table 3).

3.2.5. Panicle Length

Panicle length varied significantly depending on zinc. From Table 3 the maximum panicle length (18.078 cm) was seen in the treatment Zn_3 and the lowest (14.971 cm) was observed in treatment Zn_0.

3.2.6. Number of Effective Grain/Panicle

Zinc showed flag variation in terms of a number of effective grain panicle^{-1}. However, numerically the large number of effective grain panicle^{-1} (124.922) was recorded from the treatment Zn_3 and the lowest (114.648) was recorded from Zn_0. (Table 3).

3.2.7. Number of Non-Effective Grain/Panicle

Zinc showed non-significant variation in terms of a number of non-effective grain panicle^{-1}. However, numerically the large number of non-effective grain panicle^{-1} (25.397) was recorded from the treatment Zn_0 and the minimum (22.299) was recorded from Zn_3. (Table 3).

Table 3. *Impact of Zinc on yield and yield contibuting characters of rice.*

Treatment	Plant height (cm)	No. of tiller hill^{-1}	No. of effective tiller hill^{-1}	No. of non effective tiller hill^{-1}	Panicle length (cm)	No. of effective grain/panicle	No. of non effective grain/panicle
Zn_0	100.25 d	12.96 d	9.79 d	3.17 a	14.97 d	114.65 d	25.39
Zn_1	103.37 c	14.22 c	11.88 c	2.41 b	15.77 c	118.02 c	23.86
Zn_2	105.82 b	14.91 b	12.81 b	2.09bc	16.84 b	121.81 b	23.63
Zn_3	108.41 a	15.28 a	13.40 a	1.88 c	18.07 a	124.92 a	22.29
CV (%)	4.37	5.10	4.25	13.68	4.78	4.48	12.69

Zn_0= 0 kg Zn ha^{-1}, Zn_1= 5 kg Zn ha^{-1}, Zn_2= 10 kg Zn ha^{-1} and Zn_3= 15 kg Zn ha^{-1}

3.2.8. Number of Total Grain Panicle^{-1}

Zinc showed great variation in terms of a number of total grain panicle^{-1}. However, numerically the highest total number of grain panicle^{-1} (151.617) was recorded from the treatment Zn_3 and the lowest (138.704) was recorded from Zn_0. (Table 4).

3.2.9. Grain Yield

There was a great variation in respect to grain yield due to zinc. Results presented in Table 4 showed that the maximum grain yield (3.404 t ha^{-1}) was obtained from the treatment Zn_3 and the lowest grain yield (3.058 t ha^{-1}) was obtained from treatment Zn_0.

3.2.10. Straw Yield

The straw yield of rice vary significantly for zinc gave significantly different straw yields (Table 4). The maximum straw yield (4.435 t ha^{-1}) was recorded from the treatment Zn_3 and the minimum straw yield (3.948 t ha^{-1}) was recorded at Zn_0.

Table 4. *Impact of Zinc on yield and yield contibuting characters of rice.*

Treatment	No. of total grain/ panicle	Grain yield t ha^{-1}	Straw yield t ha^{-1}
Zn_0	138.70 b	3.05 d	3.94 b
Zn_1	145.30 ab	3.23 c	4.10 b
Zn_2	148.56 a	3.29 b	4.31 a
Zn_3	151.61 a	3.40 a	4.43 a
CV (%)	4.22	4.56	4.29

Zn_0= 0 kg Zn ha^{-1}, Zn_1= 5 kg Zn ha^{-1}, Zn_2= 10 kg Zn ha^{-1} and Zn_3= 15 kg Zn ha^{-1}

3.3. Interaction Effect of Weeding and Zinc

3.3.1. Plant Height

The plant height had a significant impact due to the interaction of weeding and zinc. Apparently, the highest plant height (125.903cm) was observed in the interaction W_3Zn_3 Whereas the lowest plant height (86.840 cm) was get from the interaction W_0Zn_0.

3.3.2. Number of Tiller Hill^{-1}

The interaction impact between weeding and zinc was found significant (Table 5). However the highest number of total tillers hill^{-1} (17.290) was gained from the interaction W_3Zn_3 and the lowest number of tillers hill^{-1} (10.470) was gained from the interaction W_0Zn_0.

3.3.3. Number of Effective Tiller Hill^{-1}

The interaction impact between weeding and zinc was found non-significant (Table 5). However the highest number of effective tillers hill^{-1} (16.327) was obtained from the interaction W_3Zn_3 and the lowest number of effective tillers hill^{-1} (6.570) was obtained from the interaction W_0Zn_0.

3.3.4. Number of Non-Effective Tiller Hill^{-1}

The interaction effect between weeding and zinc was found non-significant (Table 5). However the highest number of non-effective tillers hill^{-1} (3.900) was obtained from the interaction W_0Zn_0 and the lowest number of non-effective tillers hill^{-1} (0.963) was obtained from the interaction W_3Zn_3.

3.3.5. Panicle Length

The interaction was significant between weeding and zinc (Table 5). it was numerically highest (24.083cm) in the interaction W_3Zn_3 and the lowest (9.407cm) was obtained from the interaction W_0Zn_0 in Table 5.

3.3.6. Number of Effective Grain Panicle^{-1}

The interaction effect of weeding and zinc on the number of effective grain panicle^{-1} was significant (Table 5). Table 5 showed that the highest number of effective grain panicle^{-1} (145.897) was obtained from the treatment combination W_3Zn_3 The lowest number of grain panicle^{-1} (95.560) was obtained from the treatment Combination W_0Zn_0.

3.3.7. Number of Non-Effective Grain Panicle^{-1}

The interaction effect of weeding and zinc on the number of non-effective grain panicle^{-1} was non-significant (Table 5). Table 5 showed that the highest number of non-effective grain panicle^{-1} (31.360) was obtained from the treatment combination W_0Zn_0 The lowest number of non-effective grain panicle^{-1} (15.593) was obtained from the treatment Combination W_3Zn_3.

Table 5. Interaction effect of weeding and zinc on yield and yield contibuting characters of rice.

Treatment	Plant height (cm)	No. of tiller hill^{-1}	No. of effective tiller hill^{-1}	No. of non effective tiller hill^{-1}	Panicle length (cm)	No. of effective grain/panicle	No. of non effective grain/panicle
W_0Zn_0	86.84 k	10.47 k	6.57 k	3.90	9.40 j	95.56 o	31.36
W_0 Zn_1	88.80 jk	11.37 j	7.910 j	3.46	10.03 j	96.88 n	29.96
W_0 Zn_2	90.22 ijk	12.13 i	8.993 i	3.14	10.92 i	100.60 m	28.66
W_0 Zn_3	92.24 hij	12.06 i	9.260 hi	2.80	11.56 hi	103.60 l	26.89
W_1Zn_0	93.66 ghi	13.46 h	9.997 gh	3.46	12.05 h	106.07 k	25.83
W_1 Zn_1	95.32 gh	14.19 fg	11.50 f	2.68	13.16 g	109.07 j	23.78
W_1 Zn_2	97.06 fg	15.09 de	12.85 d	2.24	13.95 f	113.12 i	26.97
W_1 Zn_3	99.36 ef	15.68 cd	13.74 c	1.94	14.56 ef	117.12 h	25.83
W_2Zn_0	101.04 e	13.68 gh	10.17 g	3.07	14.97 e	119.70 g	25.16
W_2Zn_1	106.03 d	14.62 ef	12.49 de	2.13	16.14 d	124.70 f	23.98
W_2Zn_2	111.61 c	15.83 c	13.81 c	2.02	18.49 c	128.47 e	22.73
W_2Zn_3	116.16 b	16.11 bc	14.290 c	1.82	22.10 b	133.06 d	20.87
W_3Zn_0	119.45 b	14.23 fg	11.98 ef	2.25	23.45 a	137.26 c	19.29
W_3Zn_1	123.32 a	16.70 ab	15.32 b	1.38	23.74 a	141.43 b	17.72
W_3Zn_2	124.40 a	16.58 b	15.59 ab	0.99	23.99 a	145.05 a	16.17
W_3Zn_3	125.90 a	17.29 a	16.32 b	0.96	24.08 a	145.89 a	15.59
CV (%)	4.37	5.10	4.25	13.68	4.78	4.48	12.69

W_0= No weeding, W_1=1 hand weeding, W_2= 2 hand weeding and W_3= 3 hand weeding
Zn_0= 0 kg Zn ha^{-1}, Zn_1= 5 kg Zn ha^{-1}, Zn_2= 10 kg Zn ha^{-1} and Zn_3= 15 kg Zn ha^{-1}

3.3.8. Number of Total Grain Panicle^{-1}

The interaction effect of weeding and zinc on the number of total grain panicle^{-1} was non-significant (Table 6). Table 6 showed that the large number of total grain panicle^{-1} (171.313) was obtained from the treatment combination W_3Zn_3 The lowest number of grain panicle^{-1} (110.550) was gained from the treatment Combination W_0Zn_0.

3.3.9. Grain Yield

Grain yield was significantly affected by the interaction between weeding and zinc (Table 6). From Table 6, it was evident that the highest grain yield (3.913 t ha^{-1}) was given by the interaction $W_3Zn_3$and lowest grain yield (2.793 t ha^{-1}) was obtained from the interaction W_0Zn_0.

3.3.10. Straw Yield

The straw yield was significantly influenced by the interaction between weeding and zinc (Table 6). From Table 6, it was evident that the highest straw yield (4.773 t ha^{-1}) was given by the interaction W_3Zn_3 and lowest straw yield (3.720 t ha^{-1}) was obtained from the interaction W_0Zn_0.

Table 6. Interaction effect of weeding and zinc on yield and yield contibuting characters of rice.

Treatment	No. of total grain/ panicle	Grain yield t ha^{-1}	Straw yield t ha^{-1}
W_0Zn_0	110.55	2.79 h	3.72 gh
W_0 Zn_1	114.56	2.84 gh	3.91 efgh
W_0 Zn_2	114.45	2.95 fg	4.28 bc
W_0 Zn_3	124.74	3.01 f	4.02 cdef
W_1Zn_0	124.67	2.85 gh	3.69 h
W_1 Zn_1	135.44	2.92 fg	3.96 defgh
W_1 Zn_2	140.06	2.99 f	4.01 cdefg
W_1 Zn_3	144.89	3.16 e	4.23 bcd
W_2Zn_0	148.18	2.93 fg	3.85 fgh
W_2Zn_1	154.08	3.33 d	4.00 cdefg
W_2Zn_2	158.58	3.42 cd	4.15 cde
W_2Zn_3	165.51	3.53 bc	4.71 a
W_3Zn_0	171.41	3.65 b	4.52 ab
W_3Zn_1	177.12	3.82 a	4.52 ab
W_3Zn_2	181.15	3.81 a	4.80 a
W_3Zn_3	171.31	3.91 a	4.77 a
CV (%)	4.22	4.56	4.29

W_0= No weeding, W_1=1 hand weeding, W_2= 2 hand weeding and W_3= 3 hand weeding
Zn_0= 0 kg Zn ha^{-1}, Zn_1= 5 kg Zn ha^{-1}, Zn_2= 10 kg Zn ha^{-1} and Zn_3= 15 kg Zn ha^{-1}

4. Conclusion

The overall result of the research work indicate that the treatment combination of W_3Zn_3 (Three-hand weeding with 15 kg zinc ha^{-1}) may be the best combination for higher yield of transplanted Aman rice (BRRI Dhan 38).

Conflicts of Interest

The authors declare no conflicts of interest.

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