Efficacy of mechanical seedling transplanter and deep placement of mixed fertilizer on rice yield

Abstract

A field experiment was conducted at the West Byde of BRRI farm, Gazipur during T. Aman and Boro, 2021-22 season to evaluate the efficacy of newly developed mechanical rice transplanter cum fertilizer applicator. Five treatments in Randomized Complete Block Design with three replications. Individual plot size was 8m×5m with 30 cm buffer zone. The treatments were T_1 = Mechanical transplanting along with 100% fertilizer (Urea, TSP, MoP and Gypsum) deep placement, T_2 = Mechanical transplanting along with 80% fertilizer (80% Urea and 100% TSP, MoP and Gypsum) deep placement, T_3 = Mechanical transplanting along with 70% fertilizer (70% urea and 100% TSP, MoP and Gypsum) deep placement, T_4 = Mechanical transplanting along with 100% fertilizer hand broadcasting (TSP, MoP and Gypsum fertilizer as basal dose and urea fertilizer in three split) and T_5 = Hand transplanting of same seedling of rice transplanter along with 100% fertilizer hand broadcasting (TSP, MoP and Gypsum in basal dose and urea fertilizer in three split) and T6 = BRRI recommended practice. In this experiment, BRRI dhan89 and BRRI dhan92 was used in T. Aman and Boro seasons, respectively. No significant differences among the treatments was found in growth parameters. Significant variations were recorded in case of yield. BRRI recommended practice and mechanical transplanting with 80% urea with other fertilizers were produced very similar grain yield. From these results, it might be said that mechanical transplanting with 80% urea fertilizer is recommended with BRRI recommended hand transplanting practice. Urea saving is additional benefit with time savings and low transplanting cost when transplanted with rice transplanter cum fertilizer applicator.

Keywords: Mechanical transplanting, Rice Transplanter, Mixed fertilizer, Fertilizer deep placement

1. Introduction

Rice is the dominant and staple food crop, plays an important role in food security of about 160 million people in Bangladesh. It provides nearly 48% of rural employment, about two-third of total calorie supply and one- half of the total protein consumption of the country's people depend on rice [2]. Rice production in Bangladesh is a crucial part of the national economy. Bangladesh has ranked third globally in rice production for the fourth consecutive year with a projected output of 38.4 million tonnes. ('Food Outlook-June 2022'.) Cultivation area of rice, per unit yield, overall production and cropping intensity expanded appreciably over the last 45 years. Employed labor in the agricultural sector decreased remarkably due to increasing rural to urban migration with the growth of non-farm employment opportunities, inflicting rural labour

shortages [13]. Half of agricultural GDP and one-sixth of rural household income depends on rice [9]. Modernization of rice production is the utmost need to feed the growing population of the country from gradually decreasing land. It mostly depends on the agricultural mechanization that helps to enhance the agricultural and food production of the country [3]. Due to labor scarcity, there is a need to explore establishment methods for rice that require less labor but still allow the crop to be transplanted on time. The use of a mechanical transplanter is one alternative to address this issue. Mechanical transplanting of rice is the process of transplanting young rice seedlings, which have been grown in a mat nursery, using a self-propelled rice transplanter. In conventional manual transplanting practice, 8-12 laborers are required to transplant one acre. However, if a self-propelled rice transplanter is used, three people can transplant up to four acres in a day. Manual transplanting is tedious and time consuming which frequently causes delayed rice transplanting. One month delayed of transplanting reduces yield about 25% while two months delayed reduces yield about 70% [10]. A total of 156.2 man-days is required for rice production in one hectare of land from which 44.5 man-days (28.24% of total labor requirement) are consumed by seedling raising and transplanting [8]. Thus, mechanized rice transplanting is seen as an answer to the present labor crisis. However, rice seedling transplanting using mechanical rice transplanter ensures uniform plant spacing as well as fast and efficient planting also. With this point of view, mixed fertilizer (Urea, TSP, MoP and Gypsum) deep placement mechanisms incorporate with the existing walking type rice transplanter. Deep placement of either urea fertilizer or NPK fertilizer significantly increased grain yields and net economic return across all the rice-growing seasons and years compared to traditional practices [5]. because only 30 to 50% N used effectively by the plant from top dressing of urea fertilizer [12]. Top dressing prilled urea fertilizer produced higher amounts of ammonium N in floodwater compared to deep placement of urea [4]. The higher amount of ammonium N in floodwater leads to a higher amount of ammonia volatilization loss [11]. However, broadcast application of N, P, and K fertilizers increases nutrients concentration in floodwater [4]. that leads to significant losses with surface runoff. Urea fertilizer deep placement (UDP) or fertilizer (Urea, TSP, MoP and Gypsum) deep placement (FDP) is an effective management practice for wetland transplanted rice by increasing its productivity and reducing fertilizer losses [6 &1]. By using UDP technology, yield also increased significantly with less use of urea about 10-20 as compared to prilled urea [7]. Hence, an endeavor has been undertaken to attach the fertilizer deep placement technology (suitable for either urea alone or combination of urea, TSP, MoP and Gypsum together) to the prevailing mechanical rice transplanter (both the walking and riding) without sacrificing the merit of transplanting to confirm both the mechanized rice transplanting and mixed fertilizer deep placement simultaneously. For the above discussion based on cost efficiency this type of research was under taken with the following objectives:

- To evaluate the efficacy of mechanical rice transplanter with deep placement of mixed fertilizer and
- To observe the yield and yield contributing parameters.

2. Materials and Methods

This experiment was conducted at the West Byde of BRRI farm, Gazipur during T. Aman and Boro, 2021-22 seasons to evaluate the efficacy of newly developed BRRI mechanical rice transplanter cum fertilizer applicator. Urea fertilizer along with TSP, MoP and Gypsum fertilizer can be placed and covered in 6-8 cm soil depth during mechanical transplanting using the developed rice transplanter. Randomized Complete Block (RCB) design was followed with three replications. Individual plot size was 8m × 5m along with 30 cm buffer spacing. Treatments of the studies were T_1 = Mechanical transplanting along with 100% fertilizer (Urea, TSP, MoP and Gypsum) deep placement, T_2 = Mechanical transplanting along with 80% fertilizer (80% Urea and 100% TSP, MoP and Gypsum) deep placement, T_3 = Mechanical transplanting along with 70% fertilizer (70% urea and 100% TSP, MoP and Gypsum) deep placement, T_4 = Mechanical transplanting along with 100% fertilizer hand broadcasting (TSP, MoP and Gypsum fertilizer as basal dose and urea fertilizer in three split) and T_5 = Hand transplanting (soil depth ?)of same seedling of rice transplanter along with 100% fertilizer hand broadcasting (TSP, MoP and Gypsum in basal dose and urea fertilizer in three split) and T6 = BRRI recommended practice. In this experiment, BRRI dhan87 and BRRI dhan92 was used in T. Aman and Boro seasons, respectively. Twenty days old mat type seedlings were used in mechanical transplanting at 30 cm × 15 cm spacing whereas spacing of manual transplanting was 20 cm × 20 cm. All intercultural operations were done according to BRRI recommendation and were same for all treatments. Yield and yield components data were taken at harvesting time. Growth data (plant height and tiller) were collected. Collected data were statistically analyzed using standard statistical procedure (Statistix 10).

3. Results and Discussion

Growth and yield contributing parameters such as tiller number, panicle number, filled grain, unfilled grain, and 1000 grain weight were not significantly affected by mechanical transplanting along with fertilizer deep placement and hand transplanting along with hand broadcasting of fertilizer. Mechanical transplanting with 80% urea fertilizer along with 100% TSP, MoP, and Gypsum fertilizer deep placement gave the highest yield in T. Aman season where as this treatment gave same yield compared to BRRI recommended practice during Boro season.

3.1. Plant height

Plant height was not significantly affected by mechanical seedling transplanting and deep placement of fertilizer in both T. Aman and Boro seasons (Table 1). Plant height of BRRI recommended practice plot were found taller due to higher seedling age (15 days older than mechanical transplanted seedlings) which was finally similar when compared at maturity stage (Fig. 1).

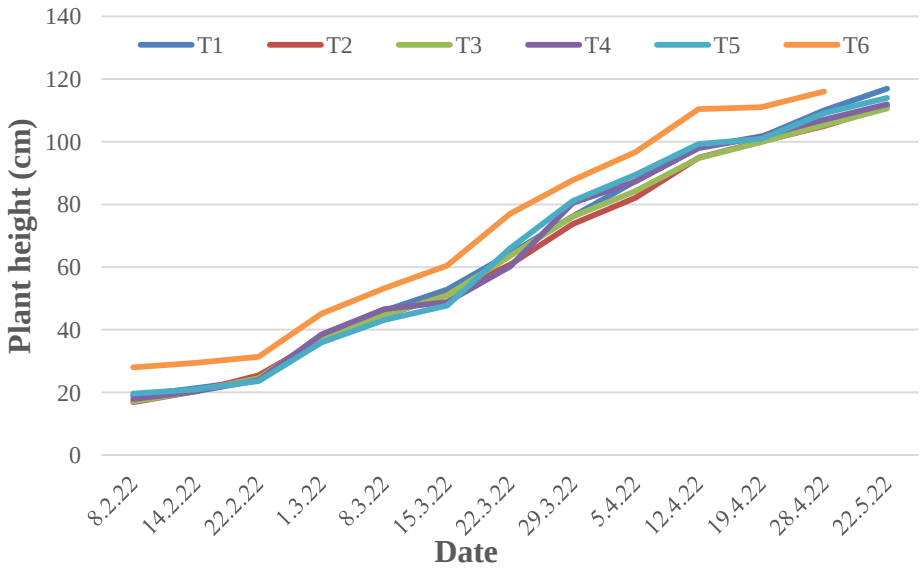

Fig.1. Plant height in cm at days after transplanting as affected by mechanical seedling transplanting with deep placement of mixed fertilizer and hand transplanting with hand broadcasting in T. Aman and Boro, 2021-22 seasons

3.2. Tiller production

There were significant variations recorded in tiller production at different days after transplanting (Fig.2) among the mechanical transplanting along with deep placement of fertilizer application and hand transplanting along with hand broadcasting of fertilizer during both T. Aman and Boro seasons (Fig.1 and Fig.2).

3.3. Panicle number

Number of panicle m^{-2} was not varied significantly with the mechanical transplanting along with deep placement of fertilizers and hand transplanting along with hand broadcasting of fertilizer. (Table 1).

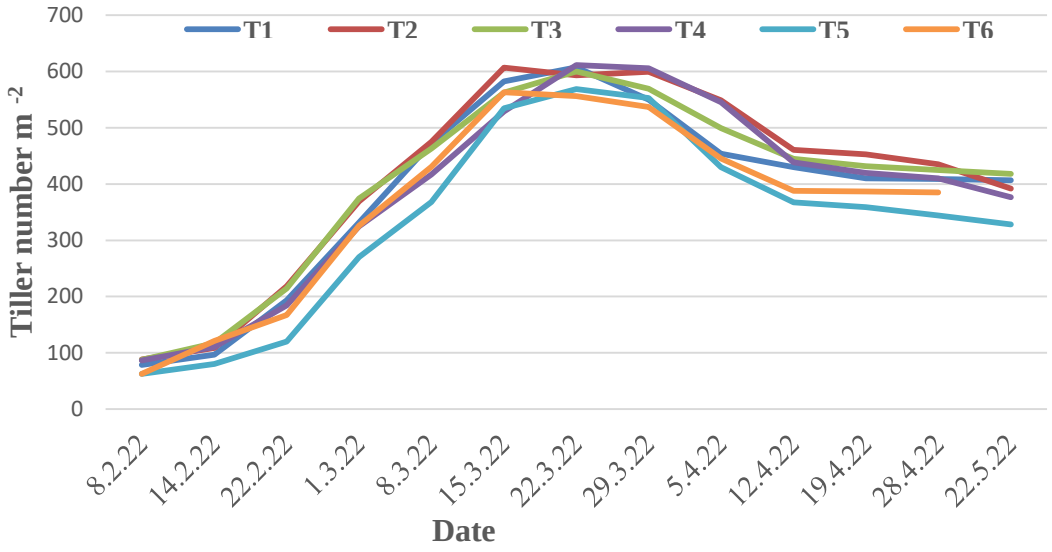

Fig.2. Number of tillers per square meter at days after transplanting as affected by mechanical seedling transplanting with deep placement of mixed fertilizer and hand transplanting with hand broadcasting in T. Aman and Boro, 2021-22 seasons

3.4. Filled grain per panicle and 1000 grain-wt.

There were no significant differences among the treatments in case of number of filled grain panicle^{-1} and 1000 grain weight. All the treatments produced statistically similar number filled grain panicle^{-1} and 1000 grain weight (Table 1).

Table 1: Yield and yield contributing parameters of rice as affected by mechanical seedling transplanting with deep placement of mixed fertilizer and hand transplanting with hand broadcasting in T. Aman and Boro, 2021-22 seasons

Treatments	Plant height (Cm)	Panicle m^{-2} (no.)	Filled grain panicle^{-1} (no.)	1000 grain wt. (gm)	Grain yield (t ha^{-1})
T. Aman season (BRRI dhan87)					
T_1	127	225	152	23.38	3.31
T_2	130	218	153	22.33	4.66
T_3	133	234	157	23.35	4.38
T_4	131	218	167	23.33	4.48
lsd (0.05)	NS	NS	NS	NS	0.90
CV%	5.6	3	9	3.14	10.80
Boro season (BRRI dhan92)					
T_1	116	406	113	22.49	7.26
T_2	111	391	110	22.63	7.32
T_3	110	417	102	22.39	6.52
T_4	111	376	108	22.79	6.79

T_5	113	328	103	21.62	6.14
T_6	115	384	110	22.54	7.47
lsd (0.05)	NS	NS	NS	NS	0.59
CV%	2.36	7.75	2.57	4.23	4.77

T_1 = Mechanical transplanting along with 100% fertilizer (Urea, TSP, MoP and Gypsum) deep placement, T_2 = Mechanical transplanting along with 80% fertilizer (80% Urea and 100% TSP, MoP and Gypsum) deep placement, T_3 = Mechanical transplanting along with 70% fertilizer (70% urea and 100% TSP, MoP and Gypsum) deep placement, T_4 = Mechanical transplanting along with 100% fertilizer hand broadcasting (TSP, MoP and Gypsum fertilizer as basal dose and urea fertilizer in three split) and T_5 = Hand transplanting along with 100% fertilizer hand broadcasting (TSP, MoP and Gypsum in basal dose and urea fertilizer in three split). T_6 = BRRI recommended practice.

3.5. Grain yield

Among different variables, only grain yield were significantly varied among the treatments (Table 1). In T. Aman season, T_2 (Mechanical transplanting along with 80% fertilizer deep placement) gave the highest grain yield (4.66 t ha^{-1}) followed by T_4, T_3 & T_1 (4.48, 4.38 and 3.31 t ha^{-1}, respectively). However, grain yield of treatment T_1 gave statistically lower yield compared to others. This might be due to the severe attack of criseck just after transplanting. Due to high amount of urea application at transplanting time in treatment T_1 foster the severity of creseck and ultimately yield was hampered.

On the other hand, during Boro season T_6 (BRRI recommended practice), T2 (mechanical transplanting with 80% urea) and T_1 (mechanical transplanting with 100% urea) produced similar grain yield which was higher than the other treatments (Table 1).

4. Conclusions

It may be concluded that no significant differences among the treatmets was found in growth parameters. Significant variations were recorded in case of yield and BRRI recommended practice and mechanical transplanting with 80% urea with other fertilizers were produced very similar grain yield. From these results, it might be said that mechanical transplanting with 80% urea fertilizer is recommended with BRRI recommended hand transplanting practice. Urea saving is additional benefit with time saving and low transplanting cost (labour cost) when transplanted with rice transplanter cum fertilizer applicator.

6. References

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