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Comparison of Tegra and Conventional Rice Cultivation in Bangladesh

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ABSTRACT

Tegra practice (healthy seedling, mechanical transplanting, herbicide application and advisory services), as a new concept in commercial rice cultivation, needs to be evaluated with farmer's practices in our country. This study was conducted in the farmers' field during Aman 2013 and Boro 2013-14 seasons in Bogra district. In each season, six farmers within one kilometer radius were selected to conduct this study. Randomized complete block design (RCBD) with two treatments namely farmer's practices (FP) and Tegra practices (TP) were used in the experiment. Self-propelled four rows walking-type rice transplanter was used to transplant seedling in TP. Seedlings were raised in plastic tray to use in mechanical transplanter. The mat seedlings were ready to transplant when attained 3-4 leaves and 10-12 cm height. Mechanical transplanting found faster than manual transplanting. Missing/floating hill observed insignificant in mechanically transplanted field. Fuel consumption of mechanical transplanter obtained 4.5 L/ha. Tender aged seedling was used in TP and seedling age was higher in FP than TP. Plant height followed the similar trend in both the practices. Tillering ability obtained the highest in TP than FP. TP produced significantly higher (14-23%) grain yield in both seasons. The total cost of production, gross return, gross margin and BCR obtained the highest in TP. BCR showed 5-13% higher in TP than FP in both the seasons due to higher grain and straw yield. The economic analysis clearly revealed the profitability of TP over FP in both the seasons.

Key words: Fuel, missing hill, spacing, hill density, input cost, yield, benefit-cost ratio

INTRODUCTION

In Bangladesh, rice is grown in the three distinct seasons namely Aus, Aman and Boro. Aus rice is grown in March to August. Transplanted Aman (T. Aman) is grown from July to December, while Boro rice is grown mainly under irrigated conditions and planted in December-January and harvested in April-May. There are many ways to transplant seedling-manual, mechanical, throwing. Transplanting of seedlings into heavy puddled soils is the common practice of rice cultivation in Bangladesh. Farmers typically prepare land by two passes of dry tillage followed by exposure to sun for a few days and then inundation of the field, ploughing and harrowing with standing water. Manual paddy transplanting appeared as tedious, laborious and time consuming operations requiring about 123-150 man-h ha^{-1} which is 19-22% of total labour requirement of rice production (Islam *et al.*, 2015). It was reported that a delay in transplanting by one month reduces the yield by 25% and a delay of two months reduced the yield by 70% (Rao and Pradhan, 1973). Further, due to rapid industrialization and migration to urban areas, the availability of labour became very scarce and with hike in the wages of labour, manual transplanting found costly leading to reduced profits to farmers. Under such circumstances a less expensive and labour saving method of rice transplanting without yield loss is the urgent need of the hour (Tripathi *et al.,* 2004). Mufti and Khan (1995) found 30% increase in yield and a reduction of about 70% in labour requirements in

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transplanting with machine compared to the manual transplanting. Manjunatha *et al.* (2009) reported the breakeven area of Chinese made 8-row self-propelled rice transplanter (Model: 2 ZT-238-8) was at least 28 hectares per year. Their results indicated that the cost of mechanical transplanting per hectare was about 51% lower than that of manual transplanting. The mechanical transplanting of rice has been considered the most promising option, as it saves labour, ensures timely transplanting and attains optimum plant density that contributes to high productivity. Rice transplanters are considerably expensive for almost all Asian small-hold farmers. It is popular in industrialized countries where labour cost is high, for example in South Korea. According to above and necessity of time saving and crop yield, in recent years new models of rice transplanting machine have been introduced in the country and farmers were encouraged to adopt mechanized methods of rice transplanting.

Syngenta, a joint venture company of Syngenta AG Switzerland and BCIC, Bangladesh came forward to start business on mechanized transplanting in the name of Tegra, which is called rice solution in other words. It is a brand name developed by Syngenta. Tegra package consisting of planting high quality seeds coated with seed treatment, raised seedlings, mechanical rice transplanting, labour for logistics while transplanting, and application of herbicides at the time of transplanting, besides advisory on agronomic practices. Rice seedlings are established by the company in a special media comprising rice husk, soil, ash, press mud, nutrients and chemicals. Tegra starts in our country during Aman 2012. Mechanical transplanting is a crucial part to success of Tegra business. It is hypothesized that Tegra practice is cost effective in commercial rice cultivation and produce more grain yield than farmer's practice. Hence, the present study was undertaken to evaluate the Tegra package in the farmers' field.

MATERIALS AND METHODS

This study was conducted in the farmers' field under Bogra district in Kodma, Omorpur, Nandigram during Aman 2013 season and Amin Nagar, Nandigram during Boro 2013-14 season. The soil type was clay loam (Sand 0%, Silt 3% and Clay 97%), AEZ 25 level Barind tract. Figure 1 shows the weather condition during the experimental period. This experiment was carried out in randomized complete block design (RCBD) with two treatments, viz 'farmers' practices (FP) and Tegra practices (TP). In each season, six farmers within one kilometer radius were selected to conduct this study. The field was prepared using common tillage practice, which is first ploughing (primary tillage) once, followed by puddling (secondary tillage) twice and leveling using two-wheel tractor under the flooding conditions. After first rotatilling, the field was flooded with water and kept as such for seven days and then second rotatilling was done on 8th day and the field was leveled by a plank. The plastic trays were used to raise mat-type seedlings. Dry soil was filled in tray in such a

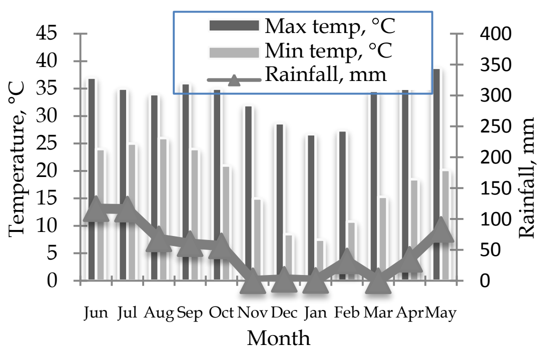

Fig. 1. Temperature and rainfall distribution during experimental period (2013-14).

way that the soil was free from any stone, stubble and grass. Syngenta developed recipe was used to fill tray for seedling establishment. Sprouted seeds were spread uniformly over the tray by using mechanical sowing line. To protect the seeds from the birds, the mats were covered with black net. Water was sprinkled normally twice a day by rose cane until there was complete emergence of seedlings. The mat seedlings were ready to transplant when they had 3-4 leaves and 10-12 cm height. Seedbed preparation often involves secondary tillage by using spade and puddling was done after inundating the field. Drainage canals were constructed for proper water removal. Puddled soil was leveled and raised to 5-10 cm height. Organic manure (decomposed) and a small amount of inorganic fertilizer was applied as basal dressing to increase seed vigour and allows easier uprooting for transplanting. Sprouted seeds were broadcast in the seedbed.

Tables 1 and 2 show the rice variety, seed rate, seedling characteristics in Aman and Boro seasons. Self-propelled four rows walking-type rice transplanter (Asia Transplanter) was used to transplant seedling. It has a fixed row spacing of 30 cm and has provisions for adjustments of planting depth, number of seedlings per hill and hill spacing. Before starting the transplanter, all the required adjustments as hill spacing, number of plant per hill and planting depth were done based on the machine operator's manual and other agronomical aspects. Tables 3 and 4 show comparative input in two practices in Aman and Boro seasons. Seedling age was higher in FP than TP. Rice variety, fertilizer rate, cultural practices, disease infestation depended on rice season. Proper care was taken and agronomic services were provided regularly in TP. Data on fuel consumption, planting depth, number of seedlings per hill, hill spacing, number of missing hill, floating hills, effective tiller and plant population were collected in both the seasons. Grain yield were recorded from pre-selected 10 m^2 land area and adjusted moisture content at the 14% moisture level. For computing yield contributing characters, four hills were collected from outside the selected area. Panicle number of each hill was counted to determine the panicle number m^{-2}. Plant samples were separated into straw and panicles. Panicles were hand-threshed and the filled spikelets were separated from unfilled spikelets. Spikelets per panicle, grain-filling percentage and harvest index were calculated.

Table 1. Seedling characteristics during Aman 2013 season.

Parameter	TP	FP
Variety	BRRI dhan49	BRRI dhan49
Date of seeding	6 Jul 2013	6 Jul 2013
Seed rate	150 gm dry seed $tray^{-1}$	37.5 kg ha^{-1}
Seedling raising technique	Plastic tray method	Traditional seedbed
Seedling raising media	Syngenta developed media	Farmers' nursery bed
Date of transplanting	26 Jul 2013	31 Jul 2013
Age of seedling	16 days	20 days

Table 2. Seedling characteristics during Boro 2013-14 season.

Parameter	TP	FP
Variety	BRRI dhan28	BRRI dhan28
Date of seeding	20 Dec 2013	20 Dec 2013
Seed rate	150 gm dry $seedtray^{-1}$	37.5 kg ha^{-1}
Seedling raising technique	Plastic tray method	Traditional seedbed
Seedling raising media	Syngenta developed media	Farmers' nursery bed
Date of transplanting	18 Jan 2014	1 Feb 2014
Age of seedling	28 days	42 days

Table 3. Comparative inputs during Aman 2013 season.

Parameter	TP	FP	Remarks
Basal Fertilizer	TSP- 105 kg ha^{-1} MOP-75 kg ha^{-1} Gypsum- 60 kg ha^{-1}	TSP- 105 kg ha^{-1} MOP-75 kg ha^{-1} Gypsum- 60 kg ha^{-1}	
Micro Nutrient	Grozin-7.5 kg ha^{-1} Bingo-2.5 kg ha^{-1} Megma-15 kg ha^{-1}	Grozin- 7.5 kgha^{-1}	
Weedicide	Rifit + Laser (1 litre + 130gm ha^{-1})	Rifit (1 Litre ha^{-1})	
Time of application	30 Jul 13	3 Aug 13	
Weeding	No manual weeding	No manual weeding	
Top dressing	Urea-187 kg ha^{-1} MOP-37kg ha^{-1}	Urea-150 kg ha^{-1} MOP- 56kg ha^{-1} DAP-56kg ha^{-1}	
1st top dress	Urea- 75 kg ha^{-1} at 15 DAT	Urea-75 kg ha^{-1}at 21 DAT	
2nd top dress	Urea-75 kgha^{-1}at 30 DAT		
3rd top dress	Urea-37 kg ha^{-1} MOP-37 kg ha^{-1}at 41 DAT	Urea-75 kg ha^{-1} MOP-56 kg ha^{-1} DAP-56 kg ha^{-1}at 55 DAT	Late application of more urea and DAP in FP, tiller and vegetative growth enhance at 60 to 80 DAT in FP.
Thiovit (sulfur)	Thiovit-1 kg at 15 DAT	Thiovit-1 kg at 21 DAT	
Insecticide	Virtako- 75gm ha^{-1} Plenum- 300gm ha^{-1}	Virtako- 75gm ha^{-1} Plenum- 300 gm ha^{-1}	BPH was 10% in Tegra and 20% was in FP than immediately take action.
Fungicide	Amister Top- 500 ml ha^{-1}, Filia- 1 litre ha^{-1} Score- 500 ml ha^{-1}	Amister Top- 400ml ha^{-1}, Filia- 1 L ha^{-1} Score- 400 ml ha^{-1}	False smut was 5% in Tegra and 15% was in FP.
Date of maturity	14 Nov 13	20 Nov 13	Tegra can be harvested 7 days earlier than FP

Table 4. Comparative inputs during Boro 2013-14 season.

Parameter	TP	FP	Remarks
Basal fertilizer	TSP@99 kg ha^{-1} MOP@70 kg ha^{-1} Gypsum@60 kg ha^{-1}	TSP@104 kg ha^{-1} MOP@110 kg ha^{-1} Gypsum@75 kg ha^{-1}	Farmer used more basal fertilizer than Tegra
Micro nutrient	Zn@7.5kg ha^{-1} B@2.5 kg ha^{-1} Mg@15 kg ha^{-1}	-	
Weedicide	Rifit+Laser@1L+185 g ha^{-1}	Rifit@750 ml ha^{-1}	
Time of application	23 Jan 2014	6 Feb 2014	
Weeding	One time harrowing only	3 times	
Top dressing	Urea 185 kg ha^{-1}	Urea 280 kg ha^{-1}, DAP 50 kg ha^{-1}	Farmers applied more fertilizer
1st top dress	Urea 74 kg ha^{-1}	Urea 120 kgha^{-1}	
2nd top dress	Urea 74 kg ha^{-1}	Urea 120 kg ha^{-1}	
3rd top dress	Urea 37 kg ha^{-1}	Urea 40 kg ha^{-1} DAP 50 kg ha^{-1}	
Cow dung	-	170 kg ha^{-1}	Used as top dressed
Thiovit (sulfur)	7.5 kg ha^{-1}	4.75 kgha^{-1}	
Insecticide	Virtako 2 times@ 75 g ha^{-1} Plenum 2 times@300g ha^{-1}	Virtako 1 times@75 g ha^{-1} Plenum 2 times@300 g ha^{-1}	
Fungicide	Score 1 time@500 ml ha^{-1} Amister Top 2 times@500ml ha^{-1}	Score 2 time@500ml ha^{-1} Amister Top 2 times@500ml ha^{-1}	
Date of maturity	25 Apr 2014	28 Apr 2014	

Border areas of all sides of the plot were excluded to avoid border competition effects. In order to estimate transplanting cost, the data on working speed, total time and labour inputs by the transplanter were recorded. Land value and interest on investment was considered to calculate the total input cost. Price of the produce was collected from the local markets to compute total production cost, gross return, gross margin and benefit-cost ratio. Statistical analysis was done by following Gomez and Gomez (1984). Data were analyzed using the ANOVA and the means comparison was determined using Duncan's multiple range tests (DMRT) with the help of the computer package MSTAT-C.

RESULTS AND DISCUSSION

Fuel consumption

Fuel consumption in walk behind type mechanical transplanter in both seasons ranged from 4.4-4.6 L ha^{-1} and varied depending on the soil condition. Fuel consumption depended on soil type and operational speed.

Plant spacing and hill density

In mechanical transplanter, line to line spacing was fixed at 30 cm whereas, plant to plant spacing can be varied and set at 15 and 17 cm. Figure 2 shows the distribution of plant to plant spacing in actual field condition. In mechanically transplanted plot, hill density ranged from 20.5-21.7 and 18.9-20.8 in Aman and Boro season respectively. Inconsistent hill density was observed in both the seasons. Exact plant spacing could not be maintained in mechanically transplanted plot due to slippage and skidding of the machine caused by water height, puddled depth and land leveling. In manually transplanted plot, hill density no. m^{-2} ranged from 14.8-18.3 and 17.46-21.2 in Aman and Boro season, respectively. It might be due to labourers transplanted seedling by eye estimation and unable to maintain proper plant spacing.

Missing hill

In mechanically transplanted plot, missing hill was observed 1-2%, which might be treated as acceptable range in crop production. Missing hill largely depended on the seed rate, seed germination, uniformity of seeding and seedling emergence in tray. Seeds having germination of more than 95% is recommended for seeding in tray to get the uniformity of seedling emergence (Islam and Rahman, 2015).

Number of seedlings dispensed per hill

Figure 3 presents the number of seedlings dispensed per hill in mechanically transplanted fields. Number of seedling dispensed per hill dependent on the seedling density in tray and seedling density setting. Seedling tray requirement in each plot largely depended on the seedling dispensed per stroke. More number of seedling dispensed per hill increased the tray requirement. In practical situation, number of seedlings in each hill varied in different plots. In most of the cases, 1-8 numbers of seedlings dispensed per hill. Single vigour seedling is enough to satisfy agronomic requirement. Calibration should be done on seedling density setting before operation in each plot to get optimum seedling density. To avoid missing hill, number of seedling dispensed should be more than one.

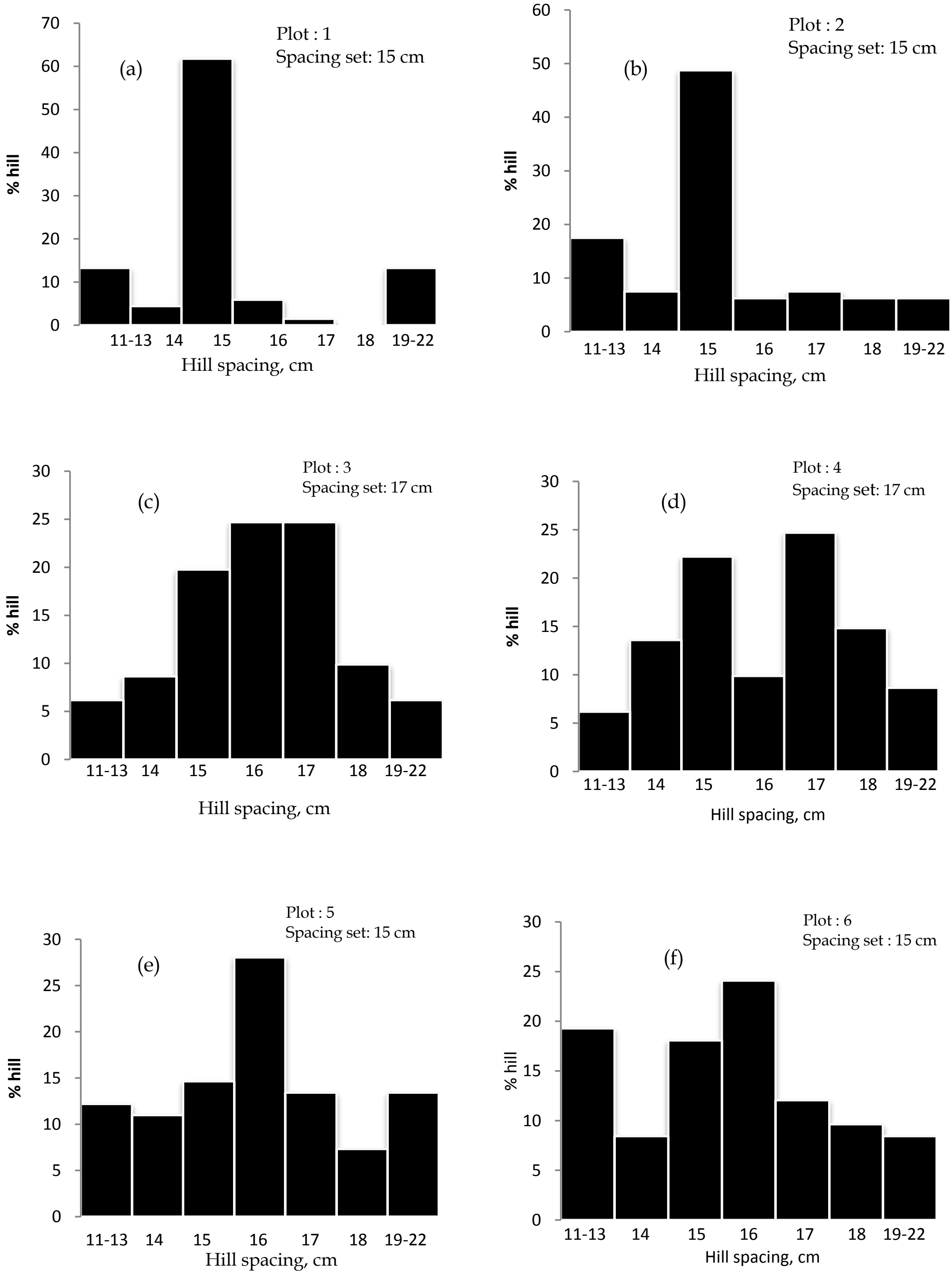

Fig. 2. Hill spacing under different space settings in mechanically transplanted plot.

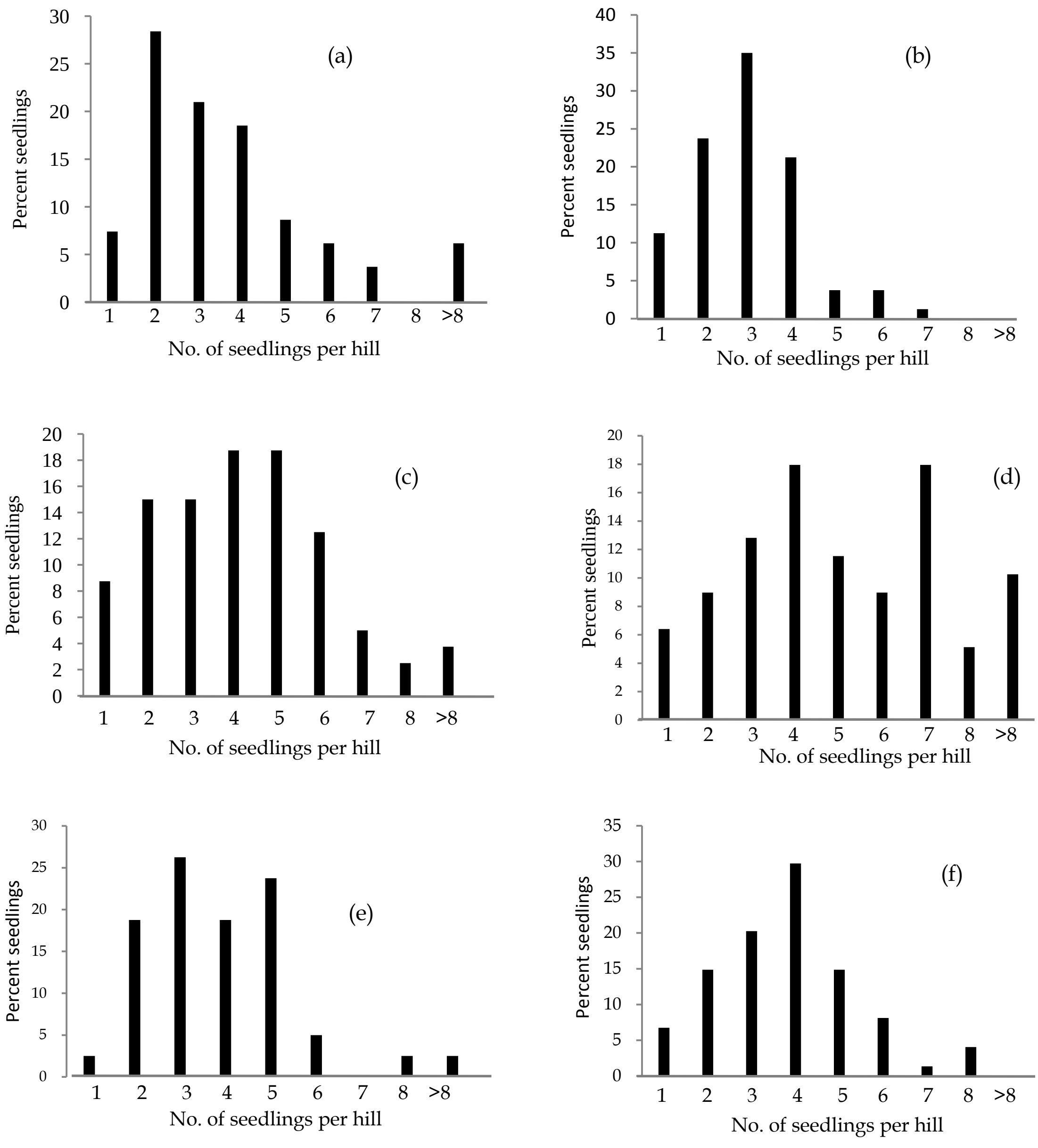

Fig. 3. Seedling density in mechanically transplanted field.

Plant height

The effects of management practices at different days after transplanting produced significant effect on plant height. Plant height observed similar in both the practices (Fig. 4). Plant height increased progressively overtime attaining the highest at 85 and 100 DAT in Aman and Boro season respectively and there after decreased at the maturity stage. It was due to leaf senescence. Plant height followed rapid growth from 20 to 55 DAT.

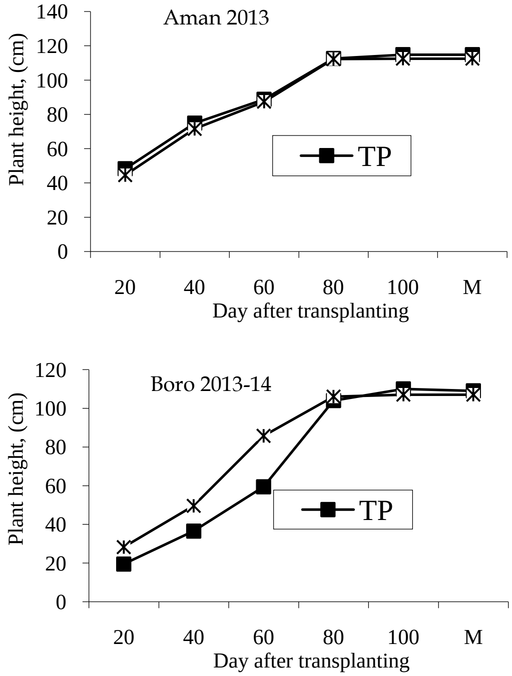

Fig. 4. Plant height in different management practices.

Tillering pattern

Figure 5 shows the effect of management practices on tillering pattern of Aman and Boro rice. Tillering pattern behaved similarly throughout the production period. Irrespective of management practice, tillering pattern followed increasing trend upto 40 DAT. In both the practices, the tiller production sharply increased from 20 DAT and the maximum tillering stage reached in 40 DAT in Aman and 60 DAT in Boro season and then decreased gradually due to tiller mortality. Tegra practices produced remarkably higher tillers than farmer practices upto maturity stage.

Stage-wise plant population

Figure 6 shows the stage-wise tiller production under different management practices. Tegra practices produced the highest tillers at all the studied stages and it was more pronounced at maximum tiller and panicle initiation stages. Figure 6 also shows that the highest tiller was produced in TP at the maximum tillering stage. Irrespective of management practices, tiller number was reduced at flowering and maturity stages.

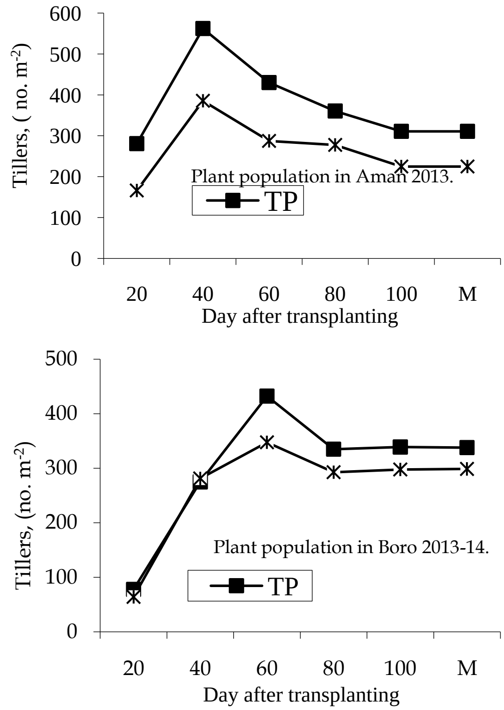

Fig. 5. Effect of management practices on tillering pattern of Aman and Boro rice.

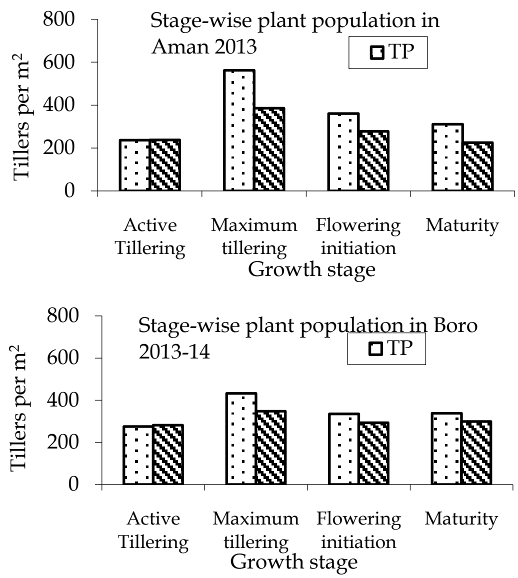

Fig. 6. Growth stage-wise tiller production in different management practices.

Panicle intensity

Figure 7 shows the panicle intensity as influenced by TP and FP. The data demonstrated that management practices showed statistically significant effect on panicle intensity in both the seasons.

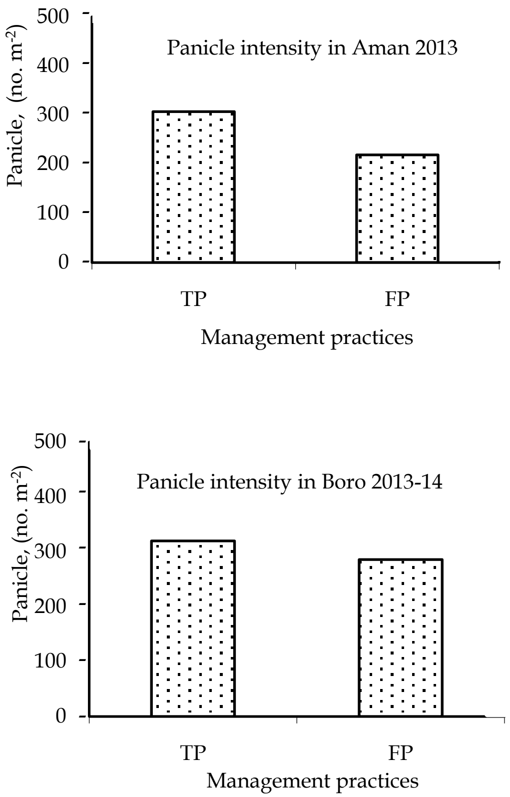

Fig. 7. Panicle intensity as influenced by TP and FP.

Yield and yield contributing character

Crop matured 3-6 days earlier in TP than FP. Management practices had significant effect on panicle length. TP produced the longest panicle than FP in both the seasons. TP produced the highest grain per panicle than FP. Sterile spikelet production was not significantly affected by management practices. TP produced the highest 1000-grain mass than FP (Tables 5 and 6). Grain yield is a function of interplay of various yield components such as number of productive tillers, spikelets per panicle and 1000-grain weight (Hassan *et. al*., 2003). TP produced significantly highest grain yield in both the seasons due to use of tender age seedling and good management practices. Grain yield obtained 14-23% higher in TP than FP in both the seasons.

Economic analysis

Table 7 shows the price of the product collected from the local market. Table 8 includes all inputs (fuel, labour, irrigation, pesticides, weeding and other expenses) from seedbed preparation to harvesting operations and benefit-cost ratio. Same amount of seed, labour, fertilizer and irrigation water was applied in all the plots of FP. This is not the real farmers' practices.

Farmers always influenced by the Tegra practices and applied more input with a hope to increase yield. The total production cost, gross return, gross margin and BCR were the highest in TP in two seasons. Production cost was 12% higher in TP than FP in Aman season due to applying higher input. Input cost was almost similar in Boro season as the farmers applied same input by following the Tegra practices. Gross return was higher in TP than FP due to higher grain and straw yield. Gross margin was higher in TP than FP in both the seasons. BCR was 8-19% higher in TP than FP in both the seasons due to the higher input cost as well as the higher gross margin compared to FP. TP was more remunerating than FP in both the seasons.

Table 5. Yield and yield contributing character during Aman 2013 season.

Practice	Panicle length(cm)	No. of filled grain panicle^{-1}	No. of unfilled grain panicle^{-1}	1000-grain weight (gm)	Grain yield, (t ha^{-1})
TP	23.01	129.4	26.53	22.4	5.32
FP	22.16	108.8	27.11	21.9	4.66
CV, (%)	2.22	7.63	9.76	0.77	3.78
Level of significance	**	*	NS	*	*

Table 6. Yield and yield contributing character during Boro 2013-14 season.

Practice	Panicle length (cm)	No. of filled grain panicle^{-1}	No. of unfilled grain panicle^{-1}	1000-grain weight (gm)	Grain yield, (t ha^{-1})
TP	23.30	112.60	30.90	23.20	6.40
FP	24.50	122.70	37.00	22.30	5.20
CV (%)	1.97	18.24	42.78	1.34	7.24
Level of significance	*	NS	NS	*	*

Table 7. Product name with price.

Name of product	Quantity	Price (Tk)	Name of product	Quantity	Price (Tk)
TSP	50 kg	1220	Plenum	100 g	480
MOP	50 kg	730	Score	500 ml	1110
Urea	50 kg	820	Amister Top	500 ml	1335
Gypsum	10 kg	220	Rifit	500 ml	380
Zinc	1 kg	200	Laser	25 g	45
Megma	1 kg	105	Thiovit	1 kg	180
Bingo	1 kg	400	DAP	50 kg	900
Paddy price	1 t	20000			

Table 8. Production cost and benefit-cost ratio of TP and FP during Aman 2013 and Boro 2013-14 season.

Item, Tk ha^{-1}	Aman 2013		Boro 2013-14	
	TP	FP	TP	FP
Seed	2805	2319	2618	1309
Seedling raising	13464	3625	6508	3590
Land preparation	4488	4488	6732	6732
Basal fertilizer	8243	6859	8826	6016
Irrigation	2244	2244	7480	7480
Transplanting	1122	5984	2094	3740
Herbicide	1047	748	898	648
Gap filling + weeding			11220	14960
Urea top dressed	3740	4563		
Sulpher + Thiovit	1346	1346	4294	6024
Insecticide	4712	3815	3590	2525
Fungicide	6313	4795	3642	3643
Harvesting +Threshing	9724	9724	11220	11220
Sub total	59249	50510	69121	67887
Land value	20000	20000	20000	20000
Interest on investment (12%)	1982	1764	2229	2198
Total production cost	81231	72274	91351	90086
Gross return	123760	101779	148397	122615
Gross margin	42529	29505	57046	32529
Benefit-cost ratio	1.52	1.41	1.62	1.36

CONCLUSION

Plant spacing of mechanically transplanted plot varied depending on puddled condition, soil type and water height. Plant height followed the similar trend in both the practices. Tillering ability showed the highest in TP. TP showed significantly higher grain yield than FP due to use of tender age seedling and good management practices. Tegra practice was more profitable in Boro than Aman season. It could be promoted extensively in farmer's field to get better yield and economic performance.

RECOMMENDATION

The results should be validated in different Agro-ecological zone.

ACKNOWLEDGEMENT

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