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Performance of wheat varieties under different tillage systems in Bangladesh

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Abstract

Wheat, as a winter cereal crop, occupies an important position in reducing the shortage of food in Bangladesh. It ranks second both in acreage and production. To meet the increasing demand for food cereals in Bangladesh, efforts are being made to develop improved wheat varieties and cultivation practices with high yield potential that lower farmers' production costs. Cultivation of wheat on raised beds is gaining popularity in Bangladesh. In this technique, the raised beds are prepared by a single pass using a bed planter machine that simultaneously seeds and fertilizes two rows of wheat on top of the beds. Irrigation water is applied through the furrows between the beds. Typically, the bed planter is connected to a power tiller that is commonly used in all over Bangladesh. These techniques have been reported to result in higher grain production, as well as reduced costs by 25% as ploughing and seeding are done by one or two passes only in comparison to 3-4 passes under conventional system. By irrigation in furrows rather than by flooding, irrigation water can also be saved. A farmer's involved research trial was conducted in Faridpur district, Bangladesh during the 2012-13 *rabi* season to observe the performance of wheat varieties under two cultivation technique, bed planting and conventional tillage systems. Four wheat cultivars BARI Gom 25, BARI Gom 26, Prodip and Shatabdi were considered. BARI

Gom 26 produced the highest grain yield (4.72 t/ha) among the varieties tested. The spike length (9.79 cm), number of grains per spike (42) and 1000-grain weight (43.24g) were higher in plants cultivated under bed planting system compared to those in conventional tillage (9.43 cm, 39 & 39.67g). As such, bed planting technique gave significantly 14% higher grain yield over the conventional tillage systems (4.05 t/ha). A significant interaction was found when BARI Gom 26 was grown under bed planting. This combination provided the highest grain yield 4.98 t/ha, while the lowest yield was obtained from Shatabdi cultivated under conventional tillage systems (3.62 t/ha). Comparing cost and benefit, bed planting reduced cultivation costs (ploughing, seeding, weeding, irrigation, rat control) by around 30% compared to conventional tillage.
Key word: Bed Planting, Conventional Tillage, Conservation Agriculture

1. Introduction

In Bangladesh, wheat occupies second place in terms of grain production after rice, though its yield is typically lower than other wheat-growing countries (Hossain and Teixeira da Silva, 2012). Wheat, as a winter cereal crop, occupies an important position in reducing the shortage of food in Bangladesh. It ranks second both in acreage and production (Anon., 2001). To meet the increasing demand for food cereals in Bangladesh, efforts are being made to develop improved wheat varieties and cultivation practices with high yield potential that lower farmers' production costs. Hassan *et al.* (1998) reported significant variation in grain yield of wheat genotypes grown under different management practices. Following the 2007 Intergovernmental Panel on Climate Change report, Islam (2009) and Poulton and Rawson (2011) stated that temperature in Bangladesh is increasing and will likely impact the future wheat productivity. Wheat is sensitive to heat stress, but the adverse effect of temperature can be minimized by sowing wheat within the recommended dates and employing heat-tolerant genotypes.

Cultivation of wheat on raised beds is gaining popularity in Bangladesh. In this technique, the raised beds are prepared by a single pass using a bed planter machine that simultaneously seeds and fertilizes two rows of wheat on top of the beds. Irrigation water is applied through the furrows between the beds. Typically, the bed planter is connected to a power tiller that is commonly used in all over Bangladesh. These techniques have been reported to result in higher grain production, as well as reduced costs by 25% as ploughing and seeding are done by one or two passes only in comparison to 3-4 passes under conventional system. By irrigation in furrows rather than by flooding, irrigation water can also be saved. Hobbs *et al.* (1998) explained that bed-planted systems have several important advantages which include improved water distribution and efficiently, alternative methods and improved access for weed control, a reduction in the lodging of plants not exposed to soft soil conditions and increased penetration of light into the lower canopy, resulting increased photosynthesis and healthier plants. Bed panting also can reduce seeding rates by around 10% over broadcasting method. Fahong *et al.* (2004) found that bed-planting systems improved grain quality and increased grain yield by more than 10%. Wheat sown on beds saves 30% irrigation water, provides longer spikes, greater number of grains per spike and increases yields by 10–18% over conventional tilled wheat (Hossain *et al.* 2004; Talukder *et al.* 2002; Talukder *et al* 2004).

Considering the above points a trial was conducted to determine the performance of new wheat genotypes under bed planting compared to conventional tillage wheat for the Faridpur region.

2. Materials and Methods

The trial was conducted in greater Faridpur region, Bangladesh under CSISA-CIMMYT Faridpur hub during the 2012-13 *rabi* season to observe the performance of wheat varieties under two cultivation techniques: bed planting and conventional tillage. Four wheat cultivars including BARI Gom 25, BARI Gom 26, Prodip and Shatabdi were compared under each crop establishment system. Nine farmers from three districts across Faridpur, Rajbari and Gopalganj participated in the study. The trial was laid out in a randomized complete block (RCB) design. Bed planter temporally provided by CIMMYT was used by the local service providers (LSPs). The LSPs used the bed planters by replacing their existing tillers in their own two wheel tractors (2WT) for ploughing, seeding and preparing beds simultaneously. Unit plot size was 400 m^2. The seeds were sown during 20-27 November 2012 in both bed planting and conventional tillage systems irrespective of location. In conventional system farmers used around 150 kg/ha wheat seeds, while in bed planting the seed rate was 120 kg/ha. Fertilizers were applied as 115-32-45-22.5-1.25 kg/ha N-P-K-S-B following recommended application methods. The crop was irrigated 2-3 times. The first one was provided 16-24 days after sowing (DAS), the second one during 45-55 DAS and the third and last one at 70-83 DAS based on moisture status of soil. Weeding was done once in all the replicates during 20-32 days after sowing (DAS). No remarkable pest infestation was observed. The crop was harvested during 15-22 March 2013. The data on plant population were measured considering two square meter area from three places randomly selected from each treatment plot and then averaged as one m^2. Plant height and spike lengths were measured with a measuring scale, grains per spike was counted manually. The 1000-grain was weighed with an electronic balance and the grain yield recorded plot wise. The collected data were analyzed using Cropstat statistical tool. The cost and return comparing bed planting with conventional tillage was also analyzed. The analysed data are stated in Tables 1-4.

3. Results and Discussion

3.1 Effect of variety

Table 1 reveals that yield and yield contributing attributes varied significantly due to varieties tested. The highest grain yield (4.72 t/ha) was recorded from BARI Gom 26 and that of the lowest in Shatabdi (3.84 t/ha). The tallest plant (87.89 cm) was obtained in variety Shatabdi, while it was the shortest in BARI Gom 26 (84.59 cm). The largest number of grains per spike (44) was found in BARI Gom 26 and it was the lowest in Shatabdi (38/spike). The 1000-grain weight was the highest in BARI Gom 25 (43.33g) which was at par with BARI Gom 26 (42.39g), and the lowest grain weight was in Shatabdi (38.67g). The large number of grains per spike and

1000-grain weight was in BARI Gom 26 indicating that these factors contributed to its significantly higher grain yield. This variety has been identified as heat tolerant by Islam (2009) and Poulton and Rawson (2011), which may have conferred additional advantages.

3.2 Effect of tillage systems

Plant population, spike length, grains per spike, 1000-grain weight and grain yield were influenced by tillage systems (Table 2). A larger plant population was found in plots tilled conventionally (264/m^2). However, spike length (9.79 cm), grains per spike (42) and 1000-grain weight (43.24g) were all higher in plots cultivated with the bed planter. As such, the grain yield 4.62 t/ha) obtained by bed planting was around 14% higher than that of the conventional tillage system (4.05 t/ha). Hossain *et al*. (2004), Talukder *et al*. (2002) and Talukder *et al*. (2004) reported that wheat sown on beds provides longer spikes, greater number of grains per spike and increases yields by 10–18% over conventional tilled. The present results corroborate with their findings. Hasan *et at*. (1998) reported significant variation in grain yield of wheat genotypes under different management systems that agree with the present findings. Similarly, Fahong *et al*. (2004) obtained an increased grain yield by more than 10% under bed planting system over that of conventional tillage.

3.3 Interaction effect of variety and tillage systems

In interaction (Table 3), BARI Gom 26 produced the highest grain yield of 4.98 t/ha along with the bed planting technique, while yields were the lowest in Shatabdi cultivated under conventional tillage (3.62 t/ha). As BARI Gom 26 has the higher yield potentiality genetically, it provided highest yield under better tillage system that is in bed planting was logical.

3.4 Cost comparison

In comparison of production costs, Table 4 reveals that the bed planting technique reduces the tillage, irrigation, seed sowing and weeding cost by 34%, 19%, 100% and 24% respectively. As such, the total production cost reduced in bed planting system by around 30%. The results also agree with the findings of Hobbs *et al*. (1998) who explained that bed-planted systems have advantages which include improved water distribution efficiently, an alternative for weed control with the ability to cultivate the furrows resulting in stronger plants and allows for dramatic reductions in seeding rates.

4. Conclusion

The results indicated that bed planting reduced the total production cost by around 30% and increased the grain yield by 14% over that of the conventional tillage. However, it was the findings of one year trial; a concrete decision may be taken after repeating one year trail.

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Table 1. Effects of variety on the yield and yield attributes of wheat at Faridpur during 2012-13

Variety	Plant height (cm)	Spikes/m^2 (no.)	Spike length (cm)	Grains/ spike (no.)	1000-grain weight (g)	Yield (t/ha)
BARI gom 25	85.60	259	9.91	41	43.33	4.58
BARI gom 26	84.59	258	9.18	44	42.39	4.72
Prodip	84.94	261	9.31	39	41.43	4.17
Shatabdi	87.89	264	10.04	38	38.67	3.84
LSD (5%)	3.35	5	0.78	2	1.16	0.11
CV (%)	5.9	3.1	12.1	5.6	4.2	4.0

Table 2. Effects of tillage method on the yield and yield attributes of wheat at Faridpur during 2012-13

Tillage System	Plant height (cm)	Spikes/ m^2 (no.)	Spike length (cm)	Grains/ pike (no.)	1000-grain weight (g)	Yield (t/ha)
Bed Planting	85.76	257	9.79	42	43.24	4.61
Conventional Tillage	85.75	264	9.43	39	39.67	4.05
LSD (5%)	2.37	4	0.55	1	0.82	0.08
CV (%)	5.9	3.1	12.1	5.6	4.2	4.0

Table 3. Interaction of variety and tillage method on the yield and yield attributes of wheat at Faridpur during 2012-13

Tillage system	Variety	Plant height (cm)	Spikes/ m^2 (no.)	Spike length (cm)	Grains/ spike (no.)	1000-grain weight (g)	Yield (t/ha)
Bed Planting	**BARI gom 25**	85.00	257	9.84	42	45.49	4.86
	BARI gom 26	83.45	260	9.54	45	43.02	4.98
	Prodip	85.20	255	9.43	41	44.04	4.52
	Shatabdi	89.40	255	10.37	40	40.41	4.06
Conventional Tillage	**BARI gom 25**	86.19	260	9.97	40	41.17	4.30
	BARI gom 26	85.74	256	8.82	42	41.75	4.46
	Prodip	84.68	267	9.20	37	38.83	3.81
	Shatabdi	86.37	274	9.71	36	36.93	3.62
LSD (5%)		4.74	8	1.10	2	1.64	0.16
Cv (%)		5.9	3.1	12.1	5.6	4.2	4.0

Table 4. Comparison of production cost under bed planting technique and conventional tillage at Faridpur during 2012-13

Event	Tillage (no.)	Tillage cost (Tk/ha)	Fertilizer (Tk/ha)	Irrigation (no.)	Irrigation cost (Tk/ha)	Seed sowing cost (Tk/ha)	Weeding cost (Tk/ha)	Total cost (Tk/ha)	Cost reduction over conventional tillage (%)
Bed planting	1	3705	9967	3	3275	0	2550	9530	29.61
Conventional tillage	3	5575	9967	3	4025	563	3375	13538	

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Different stages of Bed Planting wheat production in Bangladesh