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Research Article

Planting Times on Growth and Yield Performance Evaluation of Wheat

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Abstract

The experiment was conducted from November 2012 to March 2013 to find out the sowing date on growth and yield of wheat (BARI Gom-26). Three different sowing dates S_1: Sowing at 19 November, 2012; S_2: Sowing at 29 November, 2012 and S_3: Sowing at 09 December, 2012 were used in the experiment using Randomized Complete Block Design with three replications. Out of 3 different sowing dates November 19, 2012 (S_1) and November 29, 2012 (S_2) sowing was found to record statistically the higher results than that of December sowing (S_3). Again between 2 sowings in November, November 19th sowing (S_1) showed better performance than that of November 29th sowing (S_2). Maximum plant height (80.7 cm), number of tiller (4.7/hill), dry matter content (18.2 g/plant), CGR (12.6 g m^{-2}day^{-1}), RGR (0.022 g m^{-2} day^{-1}), number of spike (4.2/hill), number of spike lets (17.9/spike), spike length (18.6 cm), filled grains (30.2/spike), total grains (32.6/spike), 1000-grains weight (43.4 g) and yield (grain 3.3 t/ha, straw 5.6 t/ha and biological 8.9 t/ha) was found from S_1 which was statistically identical with S_2 whereas minimum from S_3.

Key Words: *Triticum Aestivum*; Sowing Dates; Growth And Yield Components.

Introduction

Wheat (*Triticum aestivum* L.) is grown across the exceptionally diverse range of environments. It is an important protein containing cereal with high amount of carbohydrate and is a staple food for two third of the total world population [1]. It is cultivated under different environmental conditions ranging from humid to arid, subtropical to temperate zone [2]. Generally, wheat is sown in November to ensure optimal crop growth and avoid high temperature. After that if wheat is sown in the field it faces high range of temperature for its growth and development as well as yield potential. Among different factor late sowing of wheat is one of the major reasons of yield reduction, because about 60% of the wheat is cultivated at late sowing conditions after harvesting of the transplanted aman rice [3]. Temperature is one of the major environmental factors that govern grain yields in wheat significantly. Photosynthesis in wheat is maximum between 22 and 25 ^{0}C [4] and decreases sharply above 35^{0}C [5]. But major wheat area under rice-wheat cropping system is late planted [3] including Bangladesh. Late planted wheat plants face a period of high temperature stress during reproductive stages causing reduced kernel number per spike [6, 7] and reduced kernel weight [8] as well as the reduction of seed yield [7]. Information on proper sowing time of wheat to optimize wheat production is inadequate in Bangladesh. So in the context of the above mentioned situation in respect of wheat cultivation in Bangladesh, the present piece of work was undertaken to determine the optimum sowing time of wheat.

Materials and Methods

The experiment was conducted in the experimental field of Sher-e-Bangla Agricultural University, Dhaka-1207, Bangladesh from November 2012 to March 2013 to find out the effect of single irrigation and sowing date on growth and yield of wheat (BARI Gom-26). Three different sowing dates viz. S_1: Sowing at 19 November, 2012; S_2: Sowing at 29 November, 2012 and S_3: Sowing at 09 December, 2012 was considered as three treatments following Randomized Complete Block Design with three replications. Seeds were sown continuous with maintaining 20 cm line to line distance and plant to plant 5 cm. Cow dung was applied 10 t/ha and fertilizers N, P, K and S were applied in the form of Urea (220 kg/ha), TSP (180 kg/ha), MP (50 kg/ha) and Gypsum (120 kg/ha) respectively. The entire amount of TSP, MP and Gypsum, 2/3rd of urea were applied during the final preparation of land. Rest of urea was top dressed after first irrigation [9]. Data were collected on plant height, number of tillers, dry matter content, Crop Growth Rate (CGR), Relative Growth Rate (RGR), days required from sowing to

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flowering, days required from sowing to maturity, number of spike, number of spike lets, spike length, number of filled grains, number of unfilled grains, number of total grains, weight of 1000-grain, grain yield, straw yield, biological yield and harvest index.

Data from five sample plants from each plot were collected and gently washed with tap water, thereafter soaked with paper towel. Then fresh weight was taken immediately after soaking by paper towel. After taking fresh weight, the sample was oven dried at 70^0C for 72 hours. Then oven-dried samples were transferred into desiccators and allowed to cool down to room temperature, thereafter dry weight of plant was taken and expressed in gram.

Using the data on the leaf area and dry matter from each specific treatment, the following growth parameters were derived with the following mentioned calculation [10]:

$$CGR = [(1 \div GA) \times \{(W_2 - W_1) \div (T_2 - T_1)\}] \text{ g m}^{-2}\text{day}^{-1}$$

Where, GA = Ground area (m^2), W_1 = Total dry weight at previous sampling date (T_1), W_2 = Total dry weight at current sampling date (T_2), T_1 = Date of previous sampling and T_2 = Date of current sampling

$$RGR = \{(LnW_2 - LnW_1) \div (T_2 - T_1)\} \text{ g g}^{-1}\text{day}^{-1}$$

Where, W_1 = Total dry weight at previous sampling date (time T_1), W_2 = Total dry weight at current sampling date (time T_2), T_1 = Date of previous sampling, T_2 = Date of current sampling, Ln = Natural logarithm

Grains and straw obtained from 1 m^{-2} from each unit plot were sun-dried and weighed carefully. Dry weight of central 1 m^2 area used to record grain yield m^{-2} and converted this into t ha^{-1}.

Biological yield was calculated with the following formula

Biological yield = Grain yield + Straw yield

Harvest index was calculated using the following formula-

HI (%) = [{Economic yield (grain weight)} ÷ {Biological yield (Total dry weight)}] × 100

Collected data were statistically analyzed using MSTAT-C computer package program. Mean were calculated and significance of difference among treatment means was estimated by Duncan Multiple Range Test (DMRT) at 5% level of probability [11].

Results and Discussion

Plant height: Plant height varied significantly at different days after sowing (DAS) and harvest was due to different sowing date. Tallest plant was found from S_1 (80.7 cm) which was statistically similar to S_2 (78.1) cm while shortest from S_3 (74.2 cm) at harvest (Figure 1a).

Seeds sowing at November 19th ensure tallest plant than early and delay sowing of seeds. BARI [12] reported that tallest plant (76.8 cm) when sowing was done on 20th November. The result of our study was quite similar to the report of BARI. El- Nakhlawy [13] found tallest plant in November 15th planting (91.40 cm) and minimum from 31st December planting (76.21 cm). Early sown crop may have benefit from the better environmental conditions especially the temperature and solar radiation which resulted to tallest plants [14].

Number of tillers: Number of tillers of wheat showed significant variation at different DAS due to different sowing date. Maximum number of tillers was found S_1 (4.7/hill) minimum from S_3 (4.2/hill) which was statistically similar to S_2 (4.6/hill) at harvest (Figure 1b). Seeds sowing at November 19th ensured the maximum tiller than early and delay sowing of seeds. BARI [12] reported that 20th November sowing produced the highest number of effective tillers/plant. Sowing date of 15th November produced the highest value of the number of tillers per unit area [15]. Mohammed et al. [16] also found significant variation in number of tiller production of wheat at different planting dates. Less number of tillers was found from late sowing which occurs due to low temperature. Temperature was not according to the tillering requirement and delayed sowing which results in less number of tillers [17,18].

Dry matter content: Significant variation for dry matter content of wheat was found at different DAS due to different sowing date. Maximum dry matter content was found from S_1 (18.2 g/plant) which was statistically similar with S_2 (17.9 g/plant) while minimum from S_3 (17.0 g/plant) at harvest (Figure 1c). Timely planted wheat had more time for the dry matter accumulation [14,19] so seed sowing at 19th November may be the good time for wheat.

Crop growth rate (CGR) and relative growth rate (RGR): CGR of wheat was not varied significantly among the different sowing date at different DAS. Maximum CGR was found from S_1 (12.6 $gm^{-2}day^{-1}$) followed by S_2 (12.4 $gm^{-2}day^{-1}$) and S_3 (11.9 $gm^{-2}day^{-1}$) at 65-85 DAS (Figure 2a). RGR of wheat was not varied significantly among the different sowing date at different DAS. Maximum RGR was found from S_1 (0.022 $gm^{-2}day^{-1}$) followed by S_2 (0.021 $gm^{-2}day^{-1}$) and S_3 (0.020 $gm^{-2}day^{-1}$) at 65-85 DAS (Figure 2b). Growth rate generally differs due to the differential plant growth regulator production such as cytokinins [20,21]. Therefore, early sowing may have induced higher cytokinins than late.

Days required from sowing to flowering and maturity: Early flowering was found from S_1 (66.8 days) whereas late from S_2 (70.2 days) which was statistically identical with S_3 (68.7 days) (Table 1). Early maturity was found from S_2 (117.3 days) while late from S_3 (120.0 days) (Table 1). Similar variation was also found in wheat by Suleiman et al. [22], Sial et al. [23], Khan et al. [24], Tahir et al. [25], Nahar et al. [26] and Refay [27]. Delay planting caused late reproductive phase such as flowering and maturity [28].

Number of spikes: Maximum number of spikes was found from S_1 (4.2/hill) which was statistically similar with S_2 (4.1/hill) while minimum from S_3 (4.0/hill) (Table 1). Maximum number of spike was obtained when the plants were sown on 15th November [17, 29]. Optimum sowing date provide favorable environment at tillering stage which produced more number of spikes [19,30].

Number of spikelets: Maximum number of spikelets was found from S_1 (17.9/spike) which was statistically similar with S_2 (16.8/spike) whereas minimum from S_3 (15.8/spike) (Table 1). Salem [26] and El-Shami et al. [31] were also found maximum number of spike lets/spike at the sowing dates on 15th November which supports the result of the current experiment.

Spike length (cm): Longest spike was found from S_1 (18.6 cm) which was statistically identical with S_2 (18.4 cm) while shortest

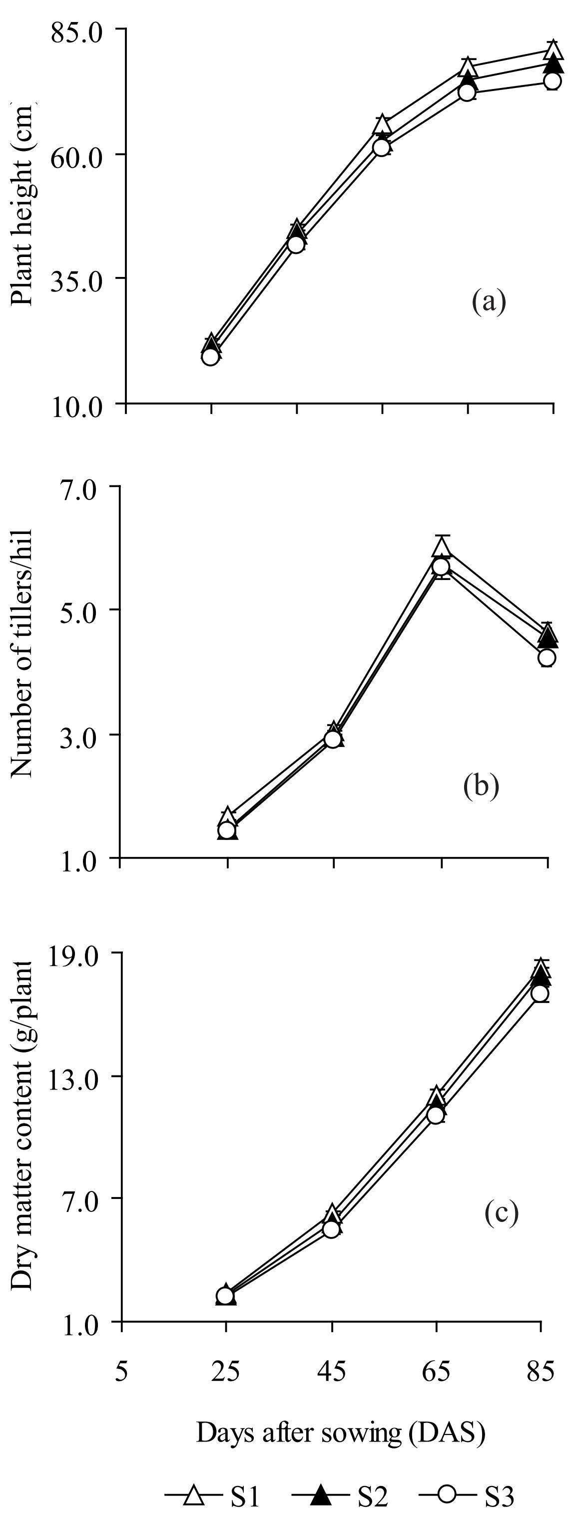

Fig. 1: Effect of seed sowing dates on (a) plant height, (b) number of tillers and (c) dry matter content to wheat

from S_3 (18.0 cm) (Table 1). Chowdhury [32] conducted an experiment with four sowing dates and reported that spike length decreased with delay in sowing date from 15th November and the lowest spike length were recorded in 15th December sown plants. Longest spike length was observed as a result of sowing on 15th November while shortest one was produced by sowing wheat on 1st November and 15th December. Increase in spike length resulted from sowing on 15th November might be due to longer time available for maximum reproductive growth as vegetative growth was terminate at proper time and the crop utilize the soil nutrients efficiently for reproductive growth and flowering growth rate were bigger by second sowing than before or after this date which caused higher spike length. These results are in agreement with those obtained by Shahzad et al. [33] and Salem [29].

Number of filled grains and unfilled grains: Maximum number of filled grains was found from S_1 (30.2/spike) whereas minimum from S_3 (24.3/spike) which was statistically identical with observed in S_2 (25.8/spike) (Table 2). Sowing at 15th November has the chance of wide vegetative period than late and early sown one because the crop has the chance to produce more metabolite translocation to grains which could be due to the prevailing temperatures in the growing season [34]. Seleiman et al. [34] also found that grains on the 15th November shorted the effective filling period more than the others tested sowing dates. Maximum unfilled grains were found from S_3 (3.2/spike) while minimum from S_1 (2.5/spike) (Table 2).

Number of total grains: Number of grains was varied significantly among the different sowing date. Maximum number of total grains was found from S_1 (32.6/spike) while minimum from S_3 (27.6/spike) which was statistically identical with S_2 (28.5/spike) (Table 2). Chowdhury [32] conducted an experiment with four sowing dates and reported that grains spike^{-1} decreased with delay in sowing date from November 15th and the lowest grains spike^{-1} were recorded in December 15th sown plants. Less number of grains per spike in late sowing [35,36] was due to less production of photosynthesis due to shorter growing period [14].

Weight of 1000-grain: Maximum 1000 grain weight of wheat was found from S_1 (43.4 g) while minimum from S_3 (40.4 g) which was statistically identical with S_3 (41.5 g) (Table 2). Chowdhury [32] conducted an experiment with four sowing dates and reported that 1000-grain weight decreased with delay in sowing date from November 15th and the lowest 1000-grain weight were recorded in December 15th sown plants. The early sowing resulted in better development of the grains due to longer growing period [14, 19, 36] that resulted for the maximum weight of 1000-grains. The 1000 grain weight was by delay planting that might be for shorter grain filling period [37, 38, 39]. On the other hand, late sowing plants doesn't get the sufficient time for better development that resulted less number of tillers, less number of grains/spike and lower 1000-grain weight which ultimately caused decreased 1000-grain weight.

Grain yield: Grain yield of wheat showed significant variation due

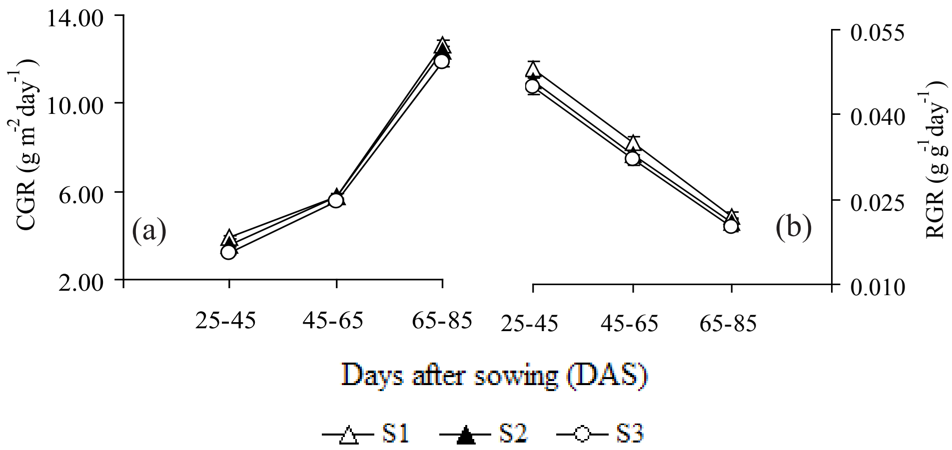

Fig. 2: Effect of seed sowing dates on (a) CGR and (b) RGR to wheat

Table 1: Effect of seed sowing dates on duration and spike related characters [x]

Seed sowing dates	Days required from sowing to				Number of				Spike length (cm)	
	flowering		maturity		spikes/hill		spikelets /spike			
S_1	66.8	b	118.2	ab	4.2	a	17.9	a	18.6	a
S_2	70.2	a	117.3	b	4.1	ab	16.8	ab	18.4	ab
S_3	68.7	a	120.0	a	4.0	b	15.8	b	18.0	b
LSD 0.05	1.6		1.9		0.1		1.2		0.4	
CV (%)	5.8		4.8		4.7		8.5		5.4	

[x] In a column means having similar letter (s) are statistically identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability

to different sowing date. Maximum grain yield was found from S_1 (3.3 t/ha) while minimum from S_3 (3.0 t/ha) which was statistically identical with S_2 (3.1 t/ha) (Table 2). Less number of tillers, less number of grains/spike and lower 1000-grain weight ultimately caused lower grain yield at late sowing period and vice versa for the early sowing [17,19]. Tahir et al. [25], Baloch et al. [40], Yajam and Madani [41], Khokhar et al. [42], Suleiman et al. [43] and Mahboob et al. [43] also found variation on growth and yield of wheat at different planting time. Late sowing of crop affect the development of plant organs and cause the reduction in plant height, numbers of days taken to heading, maturity, grain filling and yield and yield component [14,19].

Straw yield: Maximum straw yield was found from S_1 (5.62 t/ha) while minimum from S_3 (5.3 t/ha) which was statistically identical with (5.30 t ha^{-1} obtained from S_2 (Table 2). Early sowing caused maximum plant height, number of tiller, dry matter content, CGR and RGR which may resulted the maximum straw yield [44].

Biological yield: Maximum biological yield was found from S_1 (8.9 t/ha) while minimum from S_3 (8.3 t/ha) which was statistically identical with S_2 (8.4 t/ha) (Table 2). Early planting increases biological yield while late planting decreases biological yield [45,46]. Biomass production varied significantly due to sowing times [21].

Harvest index: There was no significant variation for harvest index of wheat due to different sowing date. Numerically, maximum harvest index was found from S_1 (37.1%) whereas minimum from S_3 (36.2%) (Table 2). Samuel et al. [47] reported that late sowing condition (6^{th} January 1997) reduce harvest index (36.1%) from (41.5%) of normal sowing condition (29^{th} November 1996) in

Table 2: Effect of seed sowing dates on yield related characters and yield of wheat [x]

Seed sowing dates	Grains/spike						1000 -grains weight (g)		yield (t/ha)						Harvest index (%)	
	filled		unfilled		total				grain		straw		biological			
S_1	30.2	a	2.5	c	32.6	a	43.4	a	3.3	a	5.6	a	8.9	a	37.1	a
S_2	25.8	b	2.7	b	28.5	b	41.5	b	3.1	b	5.3	b	8.4	b	36.5	a
S_3	24.3	b	3.2	a	27.6	b	40.4	b	3.0	b	5.3	b	8.3	b	36.2	a
LSD0.05	1.6		0.1		1.0		1.3		0.1		0.2		0.4		1.5	
CV (%)	7.2		7.6		6.8		4.8		6.8		6.2		4.8		5.9	

[x] In a column means having similar letter (s) are statistically identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability

wheat. planting times affect harvest index significantly [45,46].

In overall discussion, it can talk about that planting time fix on the growth habit of the crop as climatic conditions which are generally varied from optimum conditions. Cereals respond significantly to environmental features regarding growth and development that is mostly temperature and moisture dependent [48]. Radiation interception strongly dependent to plant response to leaf initiation, level of appearance and leaf number [49] which indirectly contribute towards grain development and yield improvement. Reduction of wheat yield with late planting date was the effect of exposure of plants to high temperature, which decreased season length [22]. Planting at inappropriate time may cause severe decrease in wheat yield [50]. Heat stress and dry winds during grain filling period resulted in forced maturity of crop which shorten the reproductive stage and consequently grain size [51].

Conclusion

Based on the experimental results, it may be concluded here that morphological growth, yield attributes and yield of wheat were related with time of sowing and November sowing of wheat is found better than December sowing in relation to the crop performance.

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