Journal of Agroforestry and Environment

Volume 17, Issue 2, 2024

Journal DOI: https://doi.org/10.55706/jae

Journal homepage: www.jagroforenviron.com

Effect of Date of Sowing and Nitrogen Level on the Yield of Wheat

Easin Ali[1], Md. Alamgir Kabir[1], Muhammad Salim[2], Ahmed Khairul Hasan[2], Md. Azihullah[2], Md. Omar Ali[2*], S. M. Abdul Alim[3], Md. Mohimenul Islam[4], Md. Shah Abdullah Al Mamun[5] and Md. Selim Reza[6]

[1]Department of Agricultural Extension, Ministry of Agriculture, Bangladesh
[2]Department of Agronomy, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
[3]Plant Breeding Division, Bangladesh Institute of Nuclear Agriculture, Mymensingh-2202, Bangladesh.
[4]Horticulture Division, Bangladesh Institute of Nuclear Agriculture, Mymensingh-2202, Bangladesh.
[5]Planning and Development Cell, Bangladesh Institute of Nuclear Agriculture, Mymensingh-2202, Bangladesh.
[6]Soil Science Division, Bangladesh Institute of Nuclear Agriculture, Mymensingh-2202, Bangladesh.

[*]Correspondence: omarali.38627@bau.edu.bd; Phone: +8801725741856

Received: 19/05/2024

Accepted: 31/08/2024

Available online: 07/09/2024

Abstract: An experiment to evaluate the growth and production of BARI Gom-26 was carried out at Bangladesh Agricultural University's Agronomy Field Laboratory from November 2022 to March 2023. The experiment compared various nitrogen amounts and planting dates. Five nitrogen levels (90, 100, 110, 120, and 130 kg N ha-1) were taken into consideration along with three planting dates (November 15, November 25, and December 5, 2022). Three replications of a Randomized Complete Block Design (RCBD) were used in the trial. On March 1, March 18, and March 28, 2023, respectively, harvesting was done independently. According to the findings, November 25th with 110 kg N ha-1 produced the highest grain yield (3.92 t ha-1). Furthermore, on November 25, 2022, 110 kg N ha-1 produced the highest scores of tillers per hill (6.11), effective tillers per hill (5.74), number of spikelets per spike (12.46), number of grain-1 (23.89), straw yield (7.07 t ha-1), and biological yield (11.00 t ha-1). On the other hand, on December 5 with 130 kg N ha-1, the lowest number per total tiller (3.54), number of effective tillers per hill (3.36), straw yield (3.46 t ha-1), and biological yield (6.22 t ha-1) were noted. As a result, November 25, 2022, was linked to the highest grain yield. On November 25, 2022, it was also observed that all three planting dates and all five nitrogen treatments worked effectively with 110 kg N ha-1. The best date to sow wheat was determined to be November 25, 2022, and this date is advised for wheat cultivation in Bangladesh in different agro-ecological zones.

Keywords: Wheat; Agro-ecological zone; Sowing date; Nitrogen level; Yield.

INTRODUCTION

In Bangladesh, wheat (*Triticum aestivum* L.) is the most important cereal crop next to rice. It comes from the genus Triticum, which is cultivated in several varieties around the world. It is superior to rice due to its high protein content, nutritional value and low cost of production. Wheat contributes 30% of global cereal production covering 218.5 million ha with an average productivity of 3.26 tons ha^{-1} (FAO, 2014). The average yield of wheat in Bangladesh in 2022-23 was estimated at 3.69 tons ha^{-1}, which was 7.07% higher than in 2021-22 (YAS, 2023). In Bangladesh, short winter environment and late sowing (Irfaq *et al*.,2007) would be the main reason for low wheat yield. Because the previously planted rice was planted later than expected, more than 60% of Bangladesh's wheat crop is growing later than expected (Badruddin et al., 2010). Since wheat thrives in the winter, there is a lot of potential for its production across a greater portion of Bangladesh. Because weather and disease dangers are few or nonexistent when cultivating this plant, the ideal temperature range is 10 to 20°C. Bangladesh's soil is also more suited for growing wheat. In 2014 and 2015, the total area under wheat crops was 4,36,814 hectares and 4,29,607 ha, respectively (BBS, 2015). This accounts for roughly 4% of the total planted land and 11% of the cultivated area during the Rabi season. It also makes up 7% of the food grains produced overall. This demonstrates how producing wheat can help to both conserve the nation's foreign exchange and dramatically address the food crisis. However, Bangladesh's wheat harvest is not up to par. Bangladesh's low wheat production can be attributed to a number of factors, including outdated agricultural methods,

inadequate crop management, incorrect crop densities, delayed planting, low-quality seed availability, utilization of native crops, climate risks, and intensity. Plant without replenishing the soil's nutrients; use insufficient fertilizer; inconsistent irrigation; manage fertilizer; and let weeds take over. Three primary nutrients are essential to the growth and development of wheat plants: nitrogen, phosphorus, and potassium. Among them, nitrogen is the most crucial. One essential component for the growth of wheat is nitrogen. It is crucial for expanding factories' capacity, which raises productivity. An ideal N supply raises the protein content, boosts the nutritional value of grains, and enhances stand quality. When N fertilizer levels are too high, plants experience excessive growth rather than reproduction, which lowers yield. Conversely, when N fertilizer levels are too low, plants do not receive the right nourishment. Applying fertilizers at the proper time, place, and dose for plant growth can reduce losses. The nitrogen demand varied from 33.61 to 179.24 kg ha-1, according to Kalimuddin (2016) and Gaffer (1974).

When various crops are planted at different times, their economic production increases without incurring additional costs since the variety is allowed to reach its full growth potential. In a country like Pakistan, where meteorological conditions are highly unpredictable and late sowing can reduce wheat production by 58.2 percent, the timing of wheat crop sowing is crucial. According to Khan et al. (2006), early sowing yields a higher crop than late sowing. Following the analysis of the planting date, the wheat crops were compared to those of Kumar et al. (2007), who found that the 20th of November produced a higher grain yield than the 1st or 10th of December. According to Iqbal et al. (2012), when wheat harvests were sown on December 15 and December 31, respectively, yield losses of 27 and 52 percent were seen. According to Akhtar et al. (2006), wheat produced better under Bahawalpur circumstances when planted after November 15 and before November 30, regardless of the variety. Ansari et al.'s (2004) study on the impact of planting date on wheat grain output revealed that wheat planted on November 10 produced the maximum yield (5777 kg ha-1), with November 1 and November 20 following closely behind (5411 kg and 5234 kg, respectively). He claimed that the amount of wheat produced has been greatly decreased by the ongoing planting delays following November 10. Four wheat cultivars were planted 15 days apart from October 24 to December 11 in an experiment by Shah et al. (2011). Wheat cultivars that were planted in the final week of October or the first week of November yielded superior results, according to a 2003 study by Hamed et al. According to research by Ali et al. (2004), the best planting dates for cotton-wheat crops in the Wehari district are November 1 through November 20. Similarly, in agroecological settings such as the Bahawalpur region, Akhtar et al. (2006) suggested mid-November seeding. The current study was conducted in light of the aforementioned facts to determine the impact of varying sowing dates and doses of nitrogen fertilizer on the growth and yield of wheat.

MATERIALS AND METHODS

From November 2022 to March 2023, the experiment was conducted at the Bangladesh Agricultural University's agronomy field laboratory in Mymensingh. The location of the experiment was 18 meters above sea level, at 24° 75′ N latitude and 90° 50′ E longitude. The soil type of the experiment was dark gray loam, which is found beneath the agro-colonial zone of the Old Brahmaputra floodplain: "AEZ 9". Both the height and texture of the sand are medium. With clay loam soil and a pH of 5.80, the experimental plot was a reasonably wide area. At the Agri-Humboldt Soil Testing Laboratory, Bangladesh Agricultural University, Mymensingh, the physical and chemical characteristics of the soil were examined (Table 1). A subtropical area with significant rainfall in the kharif season (April-September) and moderately low temperatures and little rainfall in the dry season (October-March) is part of the experimental site. Details about the hours of sunshine, variations in temperature and humidity, and patterns of rainfall during the experiment (Table 2). Five nitrogen doses (i) N1 = 90 kg N ha-1, ii) N2 = 100 kg N ha-1, iii) N3 = 110 kg N ha-1, iv) N4 = 120 kg N ha-1, v) N5 = 130 kg nitrogen ha-1) and three sowing dates (i) T1 = 15 November 2022, ii) T2 = 25 November 2022, iii) T3 = 5 December 2022) were used in this experiment. It was set up in a randomized complete block design with three replications. Consequently, there are 45 plots in total. Every plot has the dimensions of (2 m × 2.5 m = 5 m2). Plots were separated by 0.5 meters, while replicates were separated by 1.0 meters.

Table 1. The morphological, physical and chemical characteristics of the experimental field

A. Morphological characteristics of soil

Constituents		Constituents
Location	:	Agronomy Field Laboratory, BAU, Mymensingh
Soil tract	:	Old Brahmaputra Alluvium
Land type	:	Medium high land
General soil type	:	Non-calcareous dark grey floodplain
Soil series	:	Sonatola
Agro-ecological zone	:	Old Brahmaputra Floodplain (AEZ-9)
Topography	:	Fairly
Flood level	:	Above flood level
Soil colour	:	Dark grey
Drainage	:	Moderate
Vegetation	:	Cropped with rice, wheat, jute etc.

DOI: https://doi.org/10.55706/jae1715

B. Physical characteristics of soil

1.	Sand (%) (0.0-0.02 mm)	:	20
2.	Silt (%) (0.02-0.002 mm)	:	67
3.	Clay (%) (<0.002 mm)	:	13
4.	Soil textural class	:	Silt loam
5.	Particle density (g/cc)	:	2.60
6.	Bulk density (g/cc)	:	1.35
7.	Porosity (%)	:	46.67

C. Chemical properties ofthe initial soil (0-15 m depth)

1.	pH(soil : water= 1 : 2.5	:	6.40
2.	Organic matter (%)	:	1.670
3.	Total nitrogen (%)	:	0.101
4.	Available sulphur (ppm)	:	13.90
5.	Available phosphorous (ppm)	:	26.0
6.	Exchangeable potassium (me %)	:	0.14
7.	Available zinc	:	0.5

NB: Soil analysis was performed in the Department of Soil Science, Bangladesh Agricultural University, Mymensingh.

The Wheat and Maize Center, BARI, Bangladesh, developed BARI Gom-26, the test crop used in this experiment. On November 15, a motorized tiller was used to till the experimental field. It took 23 laddering to reach the required tilth after it was additionally ploughed four times and cross-ploughed four times. Large chunks of mud were broken apart and scraped from the landing place. To get ready for planting, the land was cleared of all weeds and bulbs. All experimental plots were separated while keeping the appropriate spacing between them before the seeds were sown. The day before planting, the plot was plowed to allow for the addition of the required amount of fertilizer and to soften the soil. The dams around individual plots were strong enough to control the movement of water between them.

Table 2. Monthly record of air temperature, rainfall, relative humidity and sunshine of the experimental site during the growing season (October 2022 to March 2023) at the Bangladesh Agricultural University Campus

Month	** Air temperature (^{0}C)			** Relative humidity (%)	**Rainfall (mm)	* Sunshine (hrs)
	Maximum	Minimum	Average			
October	32.5	23.2	27.9	82.9	63.47	204.23
November	29.57	18.5	23.4	78.54	4.3	188.67
December	22.66	15.47	19.3	83.4	0.0	117.9
January	23.91	12.02	17.99	0.59	84.35	126.79
February	27.84	17.40	23.18	0.30	83.00	140.07
March	31.14	20.17	25.57	3.38	73.19	149.73

Source: World Weather Data Record, Mymensingh, Bangladesh

Different amounts of urea were applied to the soil to fertilize it evenly. There are various amounts of nitrogen available: 90 kg, 100 kg, 110 kg, 120 kg, and 130 kg; additionally, there is 160 kg of triple super phosphate (TSP), 45 kg of potassium muriate (MoP), and 115 kg of gypsum ha-1. During the last stages of land preparation, each plot received the entire recommended dosage of TSP, MoP, and gypsum, and the fertilizer was well combined with the soil. In 28 early-stage watersheds, 46 early-stage watersheds, and 64 reproductive-stage watersheds, respectively, urea was applied in three equal portions. The Bangladesh Agricultural Research Institute (BARI) provided the wheat seeds, which were then planted three times in 2022: on November 15, November 25, and December 5, with a 25 cm line spacing between each seeding. When necessary, thinning and intercultural operations were carried out. Three times, on March 1, 2023, March 18, 2023, and March 28, 2023, respectively, were the experimental plants harvested at reaching maturity. Each field's harvests were gathered, identified, and delivered to the spotless threshing floor. The seeds were cleaned, threshed, and the bundles were sun-dried. Yields of grain and straw were measured for each plot and expressed in tons ha-1. Following that, information was gathered on the following parameters from the sample plots: growth parameters, yield, and yield components (Growth parameters: 1) Height of plant (cm), The quantity of tillers hill-1 in total, yield, and yield components: 1) Height of plant (cm), 2) Total number of tillers hill-1, 3) Effective number of tillers hill-1, 4) Hill 1's number of ineffective tillers 5) Spikelets per number: spike-1, 6) Spike count of grains (1)7) The number of spikelets that are empty, spike-1 8) Weight in grains (g), Harvest index (%), biological yield (t ha-1), grain yield (t ha-1), straw yield (t ha-1), and other yields are listed in order.

Data analysis

To prepare for statistical analysis, the captured data were collated and tabulated. An analysis of variance was conducted using the MSTAT-C software suite. The Duncan's Multiple Range Test was used to determine the mean differences between the treatments.

DOI: https://doi.org/10.55706/jae1715

RESULTS AND DISCUSSION

Effects of sowing date on growth parameters of wheat

Plant height (cm): Due to varietal differences, plant height was considerably impacted on days 15, 30, and 45 following planting (Table 3). The tallest plant (46.63 cm, 74.86 cm, and 85.35 cm) was created at 15, 30, and 45 DAS that indicated 1st November, while the least plant height (22.47 cm, 43.23 cm, and 78.37 cm) was obtained from 19 December. **Total number of tillers hill^{-1}**: At every observation day, the variety displayed a considerable variance in the total number of tillers hill-1 (Table 3). It was discovered that at 15 DAS, first November seeded wheat produced the greatest number of tillers hill-1 (3.12); at 30 and 45 DAS, same date sown wheat produced the maximum number of tillers (3.93 and 4.16). The 19 December sown wheat had the lowest values (2.32, 2.90, and 3.93) at 15, 30, and 45 DAS.

Table 3. Effect of sowing date on the 15, 30 and 45 DAS

Sowing date	Plant height (cm)			Number of tiller		
	15DAS	30DAS	45DAS	15DAS	30DAS	45DAS
15st November (T_1)	46.63 a	74.86 a	85.35 a	3.121 a	3.931 a	4.165 a
25th November (T_2)	35.32 b	65.90 b	82.73 b	2.590 b	3.520 b	4.110 a
5th November (T_3)	22.47 c	43.23 c	78.37 c	2.320 c	2.900 c	3.926 b
$LSD_{(0.05)}$	1.66	3.50	1.56	0.10	0.16	0.16
CV (%)	6.38	7.64	2.54	5.43	6.38	5.47

In a column, figures with same letter (s) or without letter do not differ significantly whereas figures with dissimilar letter differ significantly (as per LSD)
**= Significant at 1% level of probability

Effect of nitrogen on growth parameters of wheat

Plant height (cm): Varietal differences did not significantly alter plant height measurements at 15, 30, and 45 days after planting (DAS) (Table 4). Numerically, the application of 90 kg nitrogen ha-1 in 15 DAS resulted in the tallest plant (36.14 cm), followed by the application of 100 kg nitrogen ha-1 in 30 DAS, the tallest plant (63.17 cm), and the highest plant (82.43 cm) produced by the application of 110 kg nitrogen ha-1 in 45 DAS. The shortest plant (33.25 cm) was created in 15 DAS by applying 130 kg of nitrogen ha-1; the shortest plant (57.75 cm) was produced in 45 DAS by applying 120 kg of nitrogen ha-1; and the shortest plant (81.81 cm) was produced in 45 DAS by applying 100 kg of nitrogen ha-1.

Number of tillers hill^{-1}: Nitrogen at different days after sowing (DAS) did not significantly alter the number of tiller hill-1. In terms of numbers, it was discovered that at 15, 30, and 75 DAS, 120 kg of nitrogen ha^{-1} produced the greatest number of tillers hill^{-1} (2.72, 3.53, and 4.15). At 15 DAS, 110 kg nitrogen ha^{-1} produced the lowest (2.64) number of tillers hill^{-1}, while at 30 and 45 DAS, 90 kg nitrogen ha^{-1} produced the lowest (3.35 and 3.95) number of tillers hill^{-1}.

Table 4. Effect of nitrogen on the 15, 30 and 45 DAS (Days after sowing).

Nitrogen	Plant height (cm)			Number of tillers hill^{-1}		
	15DAS	30DAS	45DAS	15DAS	30DAS	45DAS
N_1	36.14	62.49	82.08	2.70	3.35	3.95
N_2	35.56	63.17	81.81	2.66	3.43	4.05
N_3	34.35	61.75	82.43	2.64	3.40	4.10
N_4	34.73	57.75	82.39	2.72	3.53	4.15
N_5	33.25	61.49	82.08	2.65	3.52	4.06
$LSD_{(0.05)}$	2.14	4.52	2.01	0.13	0.21	0.21
CV (%)	6.38	7.64	2.54	5.43	6.38	5.47

In a column, figures with same letter (s) or without letter do not differ significantly whereas figures with dissimilar letter differ significantly (as per LSD), NS= Not significant. N_1= 90 kg N ha^{-1}, N_2= 100 kg N ha^{-1}, N_3= 110 kg N ha^{-1}, N_4= 120 kg N ha^{-1}, N_5 =130 kg nitrogen ha^{-1}

Effects of Interaction of sowing date and nitrogen on growth parameters of wheat

There was no significant influenced of plant height and number of tiller hill^{-1} by interaction of sowing date and nitrogen at all DAS.

Table 5. Effect of interaction between sowing date and nitrogen on 15, 30 and 45DAS

DOI: https://doi.org/10.55706/jae1715

Interaction	Plant height (cm)			Number of tillers hill^{-1}		
	15DAS	30DAS	45DAS	15DAS	30DAS	45DAS
T_1N_1	48.75	75.46	84.50	3.18	3.78	4.08
T_1N_2	47.83	76.16	85.92	2.94	3.81	4.07
T_1N_3	46.58	74.33	85.25	3.11	3.82	4.16
T_1N_4	45.75	73.91	84.83	3.23	4.07	4.29
T_1N_5	44.25	74.44	86.25	3.13	4.15	4.21
T_2N_1	36.83	66.58	81.58	2.58	3.42	3.96
T_2N_2	37.00	67.20	81.67	2.72	3.51	4.03
T_2N_3	34.83	65.79	83.83	2.53	3.48	4.17
T_2N_4	35.58	64.18	83.50	2.57	3.63	4.17
T_2N_5	32.33	65.78	83.08	2.54	3.55	4.20
T_3N_1	22.82	45.45	80.17	2.35	2.85	3.81
T_3N_2	21.85	46.15	77.83	2.31	2.97	4.07
T_3N_3	21.64	45.13	78.08	2.28	2.89	3.97
T_3N_4	22.86	35.17	78.83	2.35	2.90	3.98
T_3N_5	23.18	44.25	76.92	2.29	2.87	3.78
$LSD_{(0.05)}$	3.71	7.83	3.49	0.24	0.36	0.37
CV (%)	6.38	7.64	2.54	5.43	6.38	5.47

NS= Not significant, T_1 = 15th November, T_2 = 25th November, T_3= 5th December and N_1= 90 kg N ha^{-1}, N_2= 100 kg N ha^{-1}, N_3= 110 kg N ha^{-1}, N_4= 120 kg N ha^{-1}, N_5 =130 kg nitrogen ha^{-1}

Effects of sowing date on plant characters of wheat

Plant height and total tiller hills^{-1}: Different sowing dates had a substantial impact on the plant characteristics of wheat, including plant height and total tiller hills-1 (Table 6). The tallest plant height (87.29 cm) was measured on November 19, the day of sowing, and November 15, the date of sowing. The plant with the shortest length (82.96 cm) was sown on December 5th. Conversely, the 25th of November had the greatest number of tiller hills-1, and the 5th of December had the lowest amount. Alam (2012) suggested that the genetic composition as observed in field settings could be the cause of the variation between plant height and the total number of tiller hills-1.

Effective tillers hill^{-1} and Non-effective tillers hill^{-1}: According to Table 6, there were notable variations in the number of effective tillers hill-1 between the sowing dates, ranging from 4.935 to 3.786. In November 25th sown wheat, the maximum number of effective tillers hill-1 was recorded, and in December 5th, the lowest number. The wheat that was sown on November 15th, however, produced the greatest amount of ineffective tillers (0.63). In Table 6, the seeding date of November 25th had the lowest non-effective tiller number. According to a 2009 study by Alam et al., the date of sowing and the application of nitrogen may have an impact on the differences between non-effective and effective tillers hill-1.

DOI: https://doi.org/10.55706/jae1715

Table 6. Effect of sowing date on crop characters, yield components and yield of wheat

Sowing date	Plant height (cm)	Number of total tillers hill^{-1}	Number of effective tillers hill^{-1}	Number of non-effective tillers hill^{-1}	Number of spikelets spike^{-1}	Number of grains spike^{-1}	Number of sterile spikelets spike^{-1}	Grain Yield (t ha^{-1})	Straw Yield (t ha^{-1})	Biological Yield (t ha^{-1})	Harvest index (%)
T_1	85.35 a	4.850 b	4.219 b	0.6313 a	10.11 b	19.85 b	1.08	3.047 b	5.371 b	8.418 b	36.30 b
T_2	87.29 a	5.321 a	4.935 a	0.3853 b	11.65 a	21.91 a	1.01	3.453 a	6.090 a	9.543 a	36.46 b
T_3	82.96 b	4.197 c	3.786 c	0.4113 b	10.18 b	19.60 b	0.98	3.085 b	4.977 c	8.063 c	38.73 a
$LSD_{(0.05)}$	2.37	0.11	0.11	0.10	0.17	1.01	0.16	0.08	0.12	0.12	0.97
CV (%)	3.72	3.16	3.42	28.89	2.24	6.60	21.46	3.46	2.93	1.88	3.50

Table 7. Effect of nitrogen on crop characters, yield components and yield of wheat

Nitrogen	Plant height (cm)	Number of total tillers hill^{-1}	Number of effective tillers hill^{-1}	Number of non- effective tillers hill^{-1}	Number of spikelets spike^{-1}	Number of grains spike^{-1}	Number of sterile spikelets spike^{-1}	Grain Yield (t ha^{-1})	Straw Yield (t ha^{-1})	Biological Yield (t ha^{-1})	Harvest index (%)
N_1	86.03 a	4.184 d	3.840 d	0.3444 c	10.35 b	21.83 a	1.01	2.752 e	4.343 e	7.096 e	38.73 a
N_2	81.05 b	4.480 c	3.957 cd	0.5233 ab	10.30 b	19.67 bc	0.96	3.146 c	5.674 c	8.820 c	35.70 bc
N_3	87.47 a	5.568 a	4.973 a	0.5944 a	10.95 a	20.99 ab	0.93	3.674 a	6.761 a	10.44 a	35.20 c
N_4	86.02 a	5.242 b	4.752 b	0.4900 ab	10.77 a	19.44 c	1.19	3.373 b	5.851 b	9.224 b	36.66 b
N_5	85.43 a	4.472 c	4.044 c	0.4278 bc	10.86 a	20.32 bc	1.02	3.030 d	4.767 d	7.797 d	39.53 a
$LSD_{(0.05)}$	3.06	0.14	0.14	0.13	0.23	1.30	0.21	0.10	0.15	0.15	1.25
CV (%)	3.72	3.16	3.42	28.89	2.24	6.60	21.46	3.46	2.93	1.88	3.50

In a column, figures with same letter (s) or without letter do not differ significantly whereas figures with dissimilar letter differ significantly (as per DMRT), T_1 = 15st November, T_2 = 25th November, T_3= 5th December

**= Significant at 1% level of probability,
NS= Not significant

DOI: https://doi.org/10.55706/jae1715

Number of spikelets spike^{-1}, Number of sterile spikelets spike^{-1}, Number of grains spike^{-1} and grain yield: Different planting dates resulted in a substantial variation in the number of spikelets spike-1 (Table 6). The 25th of November was the sowing date with the largest number of spikelets spike-1 (11.65), while the 15th of November had the lowest number of spikelets spike-1 (10.11). Table 6 indicates that there was no significant difference in the number of sterile spikelets spike-1 of wheat based on the sowing date. However, the date of sowing on December 5th appears to have yielded the highest (1.08) number of sterile spikelets spike-1. Different planting dates had a considerable impact on the total number of grains spike-1 (Table 6). The grains varied in number from 21.91 to 19.60. The 25th of November was the sowing date that produced the greatest grain number (21.91). Conversely, the day of sowing on December 5th was noted for having the fewest grains. The 25th of November was the sowing date that produced the highest yield (3.45 t ha-1). The wheat planted on November 1st yielded the lowest yield (3.05 t ha-1), which is statistically equivalent to sowing on December 5th. According to Kabir (2009), the control of wheat weeds and the varietal influence could be the cause of the variations.

Straw yield and Biological yield: Similar to grain yield, different sowing dates had a substantial impact on wheat straw yield (Table 6). The output of straw varied between 6.09 and 4.98 t ha-1. The 25th of November was the sowing date that produced the highest yield (6.09 t ha-1). The straw yield that was lowest (4.98 t ha-1) was noted on the planting date of December 5. The results for this character are in good agreement with those of Kabir (2009) and Alam (2009). In the meantime, it was noted that biological yield varied significantly among varieties (Table 6). The sowing date of November 25th yielded the maximum biological yield (9.54 t ha-1), while the date of December 5th yielded the lowest (8.06 t ha-1).

Harvest index (%): Considerable effects of the planting date were noted for the harvest index (Table 4). The sowing date of December 5th yielded the greatest value (38.73%). The 15th November sowing date had the lowest figure (36.30%), which was somewhat smaller than the 25th November sowing date (36.46%). According to Chandra and Das (2000) and Cui et al. (2000), there was a considerable rise in both grain yield and 1000-grain weight when the harvest index increased.

Effects of nitrogen on plant characters of wheat

Plant height, Total tillers hill^{-1}, Effective tillers hill^{-1}, Non-effective tillers hill^{-1}, Number of spikelets spike^{-1}, Number of sterile spikelets spike^{-1}, Number of grains spike^{-1}, Grain yield, Straw yield and Biological yield: Nitrogen had a major impact on plant height among the wheat plant characteristics (Table 7). In terms of numbers, the tallest plant (87.47 cm) was discovered in the 110 kg N ha-1 treatment, which was statistically equivalent to the 90 kg N ha-1, 120 kg N ha-1, and 130 kg N ha-1 treatments. Under the treatment of 100 kg N ha-1, the shortest plant measured 81.05 cm. The results indicated that the treatment of 110 kg N ha-1 produced the greatest number of tillers (5.56) and the treatment of 90 kg N ha-1 produced the lowest number of tillers (4.18). Between the non-effective and effective tillers Hills-1, there was a noticeable difference. The treatment of 110 kg N ha-1 produced the highest (4.97) and lowest (3.84) numbers of effective tillers per hectare, respectively, while the treatment of 90 kg N ha-1 produced the highest (0.59) number of non-effective tillers. The treatment of 90 kg N ha-1 produced the lowest non-effective tiller number (0.34). With varying N dosages, there were substantial differences in the number of spikelets spike-1 (Table 7). The treatment of 110 kg N ha-1 produced the highest spikelet spike-1 (10.95), which was statistically equivalent to the treatments of 120 kg N ha-1 and 130 kg N ha-1, whereas the treatment of 100 kg N ha-1 produced the lowest (10.30). Nitrogen had no discernible impact on the quantity of sterile spikelets in the first wheat crop (Table 7). However, under the 120 kg N ha-1 treatment, the greatest (1.19) sterile spikelets spike-1 was discovered. The nitrogen treatment has a considerable impact on grain size (Table 7). There was a range of 21.83 to 19.44 grains. The treatment with 90 kg N ha-1 produced the highest grain yield (21.83). Conversely, the treatment with 120 kg N ha-1 yielded the lowest grain (19.44). Grain yield showed significant variance (Table 5) as a result of various nitrogen treatments. The treatment with 110 kg N ha-1 produced the best yield (3.67 t ha-1). The treatment with 90 kg N ha-1 had the lowest yield (2.75 t ha-1). Similar to grain yield, various nitrogen treatments had a substantial impact on wheat grain yield (Table 7). The range of wheat yield was 6.76 to 4.34 t ha-1. The treatment with 110 kg N ha-1 produced the best yield (6.76 t ha-1). The treatment with 90 kg N ha-1 had the lowest straw yield (4.34 t ha-1). It was found that biological production was significantly impacted by varying nitrogen dosages (Table 7). The treatment with 110 kg N ha-1 produced the maximum biological output (10.44 t ha-1). The treatment with 90 kg N ha-1 had the lowest biological yield (7.09 t ha-1).

Harvest index (%): The harvest index showed a considerable impact from nitrogen treatment (Table 7). As the treatment with 130kilogram N ha-1 was statistically equivalent to the treatment with 90 kg nitrogen ha-1, it yielded the greatest value (39.53%). After treating with 110 kg N ha-1, the lowest value (35.20%) was discovered. With an increasing yield index (HI), grain yield and 1000 grain weight increased significantly, according to Chandra and Das (2000) and Cu-ji et al. (2000).

Interaction effects of sowing date and nitrogen on plant characters of wheat

Plant height, Total tillers hill^{-1}, Effective tillers hill^{-1}, Non-effective tillers hill^{-1}, Number of spikelets spike^{-1}, Number of sterile spikelets spike^{-1}, Number of grains spike^{-1}, Grain yield, Straw yield and Biological yield: Interactions between wheat plant traits had a considerable impact on plant height (Table 8). On November 25, a plant with 88.67 cm in height

DOI: https://doi.org/10.55706/jae1715

and 110 kg of nitrogen ha-1 was discovered. With the application of 100 kg of nitrogen ha-1 on November 15, the plants reached their smallest height of 77.01 cm. The interaction has a considerable impact on the total number of hill-1 (Table 8). According to the results, on November 25 with 110 kg of nitrogen ha-1, the greatest number of seedlings (6.11) was discovered, and on December 5 with 130 kg of nitrogen ha-1, the lowest number (3.54). The number of functional seedlings ranged from 5.75 to 3.33 depending on the interaction between planting date and nitrogen dose (Table 8). On November 25, with 110 kg of nitrogen ha-1, the greatest number of effective tillers hill-1 (5.75) was recorded; on December 5, with 130 kg of nitrogen ha-1, the lowest number (3.33) was recorded. The tested species' genetic makeup may have something to do with the discrepancy. The planting date significantly affected the number of non-effective tillers on hill 1. Starting on November 15, the application of 100 kg nitrogen ha-1 produced the most non-effective tillers hill-1 (0.85). With 130 kg of nitrogen ha-1, the lowest number of ineffective tillers hill-1 (0.18) was discovered on December 5. With varying planting date and nitrogen dose interaction effects, the number of spikelets spike-1 varied dramatically (Table 8). With 110 kg of nitrogen applied ha-1, the largest spikelet spike-1 (12.46) was obtained on November 25. With 100 kg of nitrogen ha-1, the lowest (9.04) was measured on November 15. Nitrogen and planting date had no significant effects on the quantity of sterile spikelets spike-1 (Table 8). But on November 25, after receiving a 120 kg nitrogen ha-1 treatment, the greatest number (1.34) of sterile spikelets spike-1 was discovered. The total number of grains spike-1 was influenced considerably by the date of sowing and the amount of nitrogen treated (Table 8). There were 23.89 to 16.43 grains in the range. On November 25, when 110 kg of nitrogen per hectare was applied, the greatest grain number (23.89) was observed. However, on November 15th, after applying 100 kg of nitrogen ha-1, the lowest grain number (16.43) was observed. Grain yield showed significant variance (Table 8) as a result of the various effects of nitrogen treatment and planting date. November 25th had the best yield (3.92 t ha-1) when 110 kg of nitrogen were applied ha-1. On November 15th, the lowest yield (2.41 t ha-1) was seen with the application of 90 kg nitrogen ha-1. Similar to grain yield, the various exposures had a substantial impact on straw yield. (Table Eight). The range of straw yields was 7.07 to 3.46 t ha-1. With 110 kg of nitrogen ha-1, the greatest output (7.07 t ha-1) was seen on November 25. With the application of 130 kg of nitrogen ha-1 on December 5, the lowest straw yield (3.46 t ha-1) was noted. It was noted that biological yield was significantly impacted by various exposures (Table 8). With 110 kg of nitrogen ha-1, the greatest biological yield (11.00 t ha-1) was noted on November 25. December 5th had the lowest biological yield (6.22 t ha-1) with 130 kg of nitrogen applied to the field

. **Harvest index (%)**

For the yield index, a significant interaction between the nitrogen treatment and planting date was found (Table 8). With the application of 130 kg of nitrogen ha-1 on December 5, the greatest value (44.32%) was discovered. With the application of 100 kg nitrogen ha-1 on November 15, the lowest figure (34.43%) was discovered. A notable increase in grain yield, 1000 grain weight, and yield index was observed by Chandra and Das (2000).

DOI: https://doi.org/10.55706/jae1715

Table 8. Effect of interaction between sowing date and nitrogen on crop characters, yield components

Interaction	Plant height (cm)	Number of total tillers hill^{-1}	Number of effective tillers hill^{-1}	Number of non-effective tillers hill^{-1}	Number of spikelets spike^{-1}	Number of grains spike^{-1}	Number of sterile spikelets spike^{-1}	Grain Yield (t ha^{-1})	Straw Yield (t ha^{-1})	Biological Yield (t ha^{-1})	Harvest index (%)
T_1N_1	87.48 a	3.863 g	3.437 gh	0.4267 c-g	10.48def	21.73abc	1.10	2.41 h	4.34 hi	6.75 j	35.66 efgh
T_1N_2	77.01 d	4.510 e	3.663 fg	0.8467 a	9.04 h	16.43g	1.08	2.96 ef	5.64 f	8.60 f	34.43 h
T_1N_3	86.70 abc	5.803 b	5.027 c	0.7767 ab	10.19efg	20.62b-e	1.05	3.56 bc	6.71bc	10.27bc	34.66 gh
T_1N_4	88.91 a	5.540 bc	5.060 c	0.4800 c-f	10.26 ef	19.58c-f	1.06	3.36 cd	5.55 f	8.92 e	37.72 cde
T_1N_5	86.64 abc	4.533 de	3.907 ef	0.6267 a-d	10.58 de	20.90b-e	1.09	2.93 efg	4.59 h	7.53 h	39.00 bcd
T_2N_1	86.14 abc	4.123 f	3.863 f	0.2600 fg	10.75 d	21.14bcd	1.07	2.91 fg	4.210 i	7.12 i	40.87 b
T_2N_2	85.46 abc	5.290 c	4.873 c	0.4167 c-g	11.34 c	22.62ab	0.83	3.35 d	6.13 e	9.48 d	35.34 efgh
T_2N_3	88.67 a	6.113 a	5.747 a	0.3667 d-g	12.46 a	23.89a	0.82	3.92 a	7.07 a	11.00 a	35.65 efgh
T_2N_4	87.77 a	5.733 b	5.327 b	0.4067 c-g	11.97 b	20.92b-e	1.34	3.68 b	6.79 b	10.48 b	35.19 fgh
T_2N_5	88.44 a	5.343 c	4.867 c	0.4767 c-f	11.72 bc	20.97b-e	1.03	3.39 cd	6.24de	9.63 d	35.26 efgh
T_3N_1	84.46 abc	4.567 de	4.220 d	0.3467 efg	9.81 g	22.62ab	0.873	2.93 efg	4.47 hi	7.41 h	39.65 bc
T_3N_2	80.69 cd	3.640 gh	3.333 h	0.3067 fg	10.51def	19.97c-f	0.980	3.12 e	5.24 g	8.37 fg	37.33 cdef
T_3N_3	87.06 ab	4.787 d	4.147 de	0.6400 abc	10.20efg	18.46efg	0.926	3.54 bcd	6.49cd	10.04 c	35.29 efgh
T_3N_4	81.37 bcd	4.453 e	3.870 f	0.5833 b-e	10.07 fg	17.83fg	1.18	3.06 ef	5.20 g	8.27 g	37.07 defg
T_3N_5	81.21 bcd	3.540 h	3.360 h	0.1800 g	10.29 ef	19.10def	0.936	2.75 g	3.46 j	6.22 k	44.32 a
$LSD_{(0.05)}$	5.30	0.25	0.24	0.23	0.39	2.25	0.37	0.18	0.26	0.26	2.17
CV (%)	3.72	3.16	3.42	28.89	2.24	6.60	21.46	3.46	2.93	1.88	3.50

In a column, figures with same letter (s) or without letter do not differ significantly whereas figures with dissimilar letter differ significantly (as per DMRT) **= Significant at 1% level of probability,

T_1 = 15th November
T_2 = 25th November
T_3= 5th December

N_1 = 90 kg N ha^{-1}
N_2 = 100 kg N ha^{-1}
N_3 = 110 Kg N ha^{-1}
N_4 = 120 kg N ha^{-1}
N_5= 130 kg N ha^{-1}

DOI: https://doi.org/10.55706/jae1715

CONCLUSION

Plant height and seedling count are strongly influenced by the planting date. There is no discernible relationship between the nitrogen treatment and the sowing date. For a high yield of 110 kg N ha-1, November 25 is the ideal date. To achieve the promised wheat yield in our nation, however, more research is required to pinpoint the exact combination of sowing date and nitrogen dose.

Conflict of Interest

The authors declared there are no conflict of interests.

REFERENCES

Akhtar M, Cheema MS, Jamil M, Ali L 2006: Effect of time of sowing on some important characters of wheat, *Triticum aestivum genotypes. J. Agri. Res.* 44(4) 255-259.

Alam AKMK 2009: Effect of irrigation and variety on the growth and yield of wheat. MS thesis, Department of Agronomy, Bangladesh Agricultural University, Mymensingh.

Alam MS 2012: Effect of sowing patterns and nitrogen rates on quality traits and yield of wheat. *J. Environ. Sci. & Natural Resources* 5(1) 267-272.

Ali MA, Ali M, Din QM 2004: Determination of grain yield of different wheat varieties as influenced by planting dates in agro-ecological conditions of Vehari. Pak. *J. Life Soc. Sci.* 2(1) 5-8.

Ansari AH 2004: Influence of seeding time on grain yield, its components and their interrelation in bread wheat (*Triticum aestivum L.*) varieties. *Pak. J. Agric. Res.* 17(1) 7-12.

Badruddin, Sauders DA, Siddique AB, Hossain MA, Ahmed MO, Rahman MM, Parveen S 2010: Determining yield constraints forwheat production in Bangladesh. In pages 265-271. Saunders DA and Hettel GP(eds). Wheat in heat stressed environments, irrigated, dry areas and rice-wheat farming systems. Mexico.

YAS (Year Book of Agricultural Statistics) 2023: Statistical agricultural year book of Bangladesh. Bangladesh Bureau, Statistics division, Ministry of Planning, Government of the people's republic of Bangladesh, Dhaka, Bangladesh 80.

Chandra K and Das AK 2000: Correlation and inter correlation of Physiological parameters in rice under rainfed transplanted condition. Crop Research Center, Hisar, Assam Agricultural University. 19(2) 251-254.

Cui J, Kusutani A, Toyata M, Asanuma K 2000: Studies on the varietal differences of harvest index and morphological characteristics of rice. *Jap. J. Crop Sci.* 69(3) 359-364.

FAO 2014: Production year book Food and Agriculture Organization Rome. 54 79.

Gaffer MA 1974: Effect of NPK and seedling method on wheat. A Masteral Thesis of Agronomy, BAU, Mymensingh.

Hameed E, Shah WA, Shad AA, Bakht J, Muhammad T 2003: Effect of different planting dates, seed rates and nitrogen levels on wheat. *Asian J. Plant Sci.* 2 (6) 464-474.

Iqbal J, Hayat K, Hussain S, Ali A, Bakhsh MAAHA 2012: Effect of seeding rates and nitrogen levels on yield and yield components of wheat (*Triticum aestivum L.*). *Pakistan Journal of Nutrition* 11(7) 531-536.

Irfaq-Khan M, Mohammad T, Subhan F, Amin M, Tariq-Shah S 2007: Agronomic evaluation of different bread wheat cultivars for terminal heat stress. *Pakistan J. Bot.* 39 2415-2425.

Kabir MM 2009: Effect of variety and weed management on the yield and yield component wheat. MS Thesis. Department of Agronomy, Bangladesh Agricultural University, Mymensingh.

Kalimuddin A 2016: Agriculture in East Pakistan. Ahmed Brothers Publication, 2, J. K. Mandir Road Dacca 134.

Khan, A and M. Salim. 2006: Grain yield as influenced by seeding dates in wheat in NWFP. *Pak. J. Agric. Res.* 7(1) 14-16.

Kumar S, Bangarwa AS, KadianVS 2007: Response of wheat varieties to sowing dates and nitrogen levels. *Ann. Agric. Biol. Res.* 5(1) 99-103. Haryana Agric. Univ. Hisar, India.

Shah SSM and Akmal M 2002: Effect of different sowing dates on yield and yield components of wheat varieties. *Sarhad J. Agric.* 18(2) 143-149.

Shah WA, Bakht J, Ullah T, Khan AW, Zubir M, Khakwani AA 2011: Effect of sowing dates on the yield and yield components of different wheat varieties. *J. Agron.* 5(1) 106-110.

Tahir M, Ali A, Nadeem MA, Hussain A, Khalid F 2009: Effect of different sowing dates on growth and yield of wheat (*Triticum aestivum L.*) varieties in district jhang, Pakistan. *Pak. j. life soc. sci.* 7(1) 66-69