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Optimum Date of Sowing for Maximization of Seed Yield and its Quality Parameters in Wheat (*Triticum aestivum* L.)

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ABSTRACT: A field experiment was conducted in split plot design at Student Instructional Farms and Seed Testing Laboratory of the Acharya Narendra Deva University of Agriculture & Technology, Kumarganj, Ayodhya, (U.P.) during Rabi season 2020-21 and 2021-22 to find out the optimum date of sowing for maximization of seed yield and its quality parameters in wheat (*Triticum aestivum* L.). The experiment consists of three different dates of sowing which was 25-30 Nov., 10-15 Dec. and 01-05 Jan. with replications (*var.* NW-5054). Yield components and seed quality parameters recorded at harvest. The results revealed that the seed sown on 25th – 30th November produced maximum plant height (100.78cm and 97.03cm), tillers/m^2 (370.87 and 348.80), spike length (10.52 and 11.27cm), spike weight (2.71g and 2.70g), spikelet's/spike (19.53 and 20.13), seed/spike (43.47 and 43.87), seed weight/spike (1.90g and 1.97g), seed Index (3.72g and 3.73g), seed yield (3929.20 and 3931.0 kg/hac^{-1}), seed recovery (96.75% and 96.76%), harvest Index (42.65% and 42.65%), germination (92.73% and 92.60%), speed of germination (18.82 and 18.83), root length (20.43cm and 20.43cm), shoot length (14.15cm and 14.17cm), seedling length (35.47cm and 35.21cm), seedling dry weight (0.158g and 0.159g), vigour Index I (3416.73 and 3418.13) and vigour Index II (15.88 and 15.90) followed by 10th – 15th December.

Keyword: Seed, Seed Index, Seed Recovery, Harvest Index, Seedling Dry Weight and Vigour Index.

INTRODUCTION

Wheat (*Triticum aestivum* L.) is one of the important food grain crops of India. Wheat is also a primary important cereal in Asia and European countries. Wheat is the most widely cultivated cereal in the world (224.49 million hectares) for the year 2020-21. As per the estimates from the United States Department of Agriculture (2021), the global production of wheat is 792.40 million tones. In India, wheat witnessed an acreage of 31.76 million hectares, respectively during the 2020-21 *rabi* season. The wheat and barley nutri-rich cereals account for about 25 per cent of the total crop acreage contributing 36 per cent of the total food grains produced in India. During 2020-21, the wheat production reached 108.75 million tones with an average national productivity of 3424 kg/ha (III Advance Estimates of 2020-21, Directorate of Economics and Statistics, Ministry of Agriculture and Farmers' Welfare).

High temperature is considered to be most important factor to reduce the wheat yield among the various stresses. Heat stress adversely affects the wheat crop starting from the early stage of emergence in wheat. Exposure of wheat seedling to heat stress for a short period can also cause significant decrease of the root and shoot length, dry mass, chlorophyll content as well as membrane stability index which is a measure of tolerance of cell membrane to sustain in high temperature (Gupta *et al.,* 2013). Heat stress ultimately has detrimental effect on the production of wheat by causing reduction in biomass, tiller number, duration of grain filling, kernel size, etc. as a result of its adverse impact on days to appearance of first node, tiller per plant and spikelet's per plant, thereby resulting in reduction of sink capacity and future sources capability of the plant (Sharma and Tandon 1997).

Timely sowing of wheat crop is beneficial in mitigating heat stress as it gives higher yield than sowing the crop late in the season. Late sown wheat crop makes the ripening stage of the crop coinciding with high temperature stress. Late planting also causes reduction in the duration of tillering period and leads to forced maturity thus reducing the grain yield due to exposure to hot weather during the critical stage of crop growth that is the grain filling period. Planting technique of wheat that includes zero tillage, bed planting, conventional tillage with mulching and surface residue retention increases grain yield as compared to conventional tillage. Also provision of additional irrigation water at critical stages and skip ping during the dough and ripening stages increases the yield of

wheat under high temperature. Application of certain chemicals can help in mitigating the adverse impact of high temperature stress (Jena *et al.*, 2017).

MATERIAL AND METHODS

This experiment was conducted in split plot design with wheat variety (NW-5054) at Student Instructional Farms and Seed Testing Laboratory of Acharya Narendra Deva University of Agriculture and Technology (Kumarganj), Ayodhya. The region receives a mean annual rainfall of about 1100mm. Out of which about 85 per cent is concentrated from mid-June to end of September. The winter months are very cold whereas summers are hot and dry. A western hot wind starts from the end of March and continues till the month of May. In this experiment 3 different dates of sowing as treatments, which was 25-30 Nov.(D_1), 10-15 Dec.(D_2) and 01-05 January (D_3) with replications. All the recommended cultural practices were adopted and the observations were recorded on five random plants from each replication. Other cultural practices followed as per recommendation and requirement of crop. Yield components and seed quality parameters recorded at harvest.

Field observations. These observations recorded on field level condition which is follow as

1. Days of 50% Heading: The days to 50% flowering was recorded as number of days taken from the date of sowing to appearance of flower on 50% plant population.

2. Days to maturity (DM): The maturity duration of the crop for each treatment was assessed by visual appearance of grains and colours of leaves particularly flag leaf. The crop is matured when flag leaf become yellowish and about half of other leaves were also yellow.

3. Plant height (cm): Five plants were randomly selected from each plot. The plant height was measured in cm from the soil surface to basal portion to flag leaf at harvest stage.

4. Number of tillers/m^2: Number of tillers were recorded one meter row length from three places in each plot at harvest stage of crop growth and averaged. Finally the tillers expressed in number of tillers /m^2.

5. Spike length (cm): The five spikes were selected randomly from each net plot area and their lengths were measured in cm from the base of spike to the tip of the last spikelet and average values were taken.

6. Spike weight: Five randomly selected spikes were weighted and values were recorded.

7. Spikelet's/spike: The number of spikelet's in the main spike was counted.

8. Seed/spike: Five randomly selected spikes were threshed and their seeds were counted and averaged and expressed as number of seed $spike^{-1}$.

9. Seed weight $spike^{-1}$: The seed of five spikes were weighted and values were recorded.

10. Seed Index: Random seed samples were collected from the produce of each net plot and 100-seeds were counted and weighted in gram with the help of electronic balance.

11. Test Weight (1000-grain weight g): Random grain samples were collected from the produce of each net plot and 1000-grains were counted and weighed in gram with the help of electronic balance.

12. Straw yield (qha^{-1}): The straw yield for each net plot was obtained after subtracting the seed yield from total biological yield and converted in to q ha-1.

13. Biological yield (kg/ha^{-1}): All the above ground biomass of experimental crop of each plot was harvest sun dried and weighed in kg $plot^{-1}$.

14. Seed yield (kg/ha^{-1}): The seeds ware obtained after threshing of the net plot area was weighed as seeds yield kg $plot^{-1}$.

15. Seed recovery:

$$\text{Seed recovery (\%)} = \frac{\text{Weight of the seed retained on sieve}}{\text{Total weight of seed}} \times 100$$

16. Harvest index (%): The ratio of seed yield to biological yield (dry matter) was considered as harvest index which expressed in percentage and calculated with the help of following formula.

$$\text{Harvest index (\%)} = \frac{\text{Seed Yield}}{\text{Biological Yield}} \times 100$$

17. Seed germination: To obtained the germination per cent of wheat seed by the between paper method with germination paper (ISTA, 1976). One hundred randomly selected seed in each replication from each treatment placed on already water soaked germination paper, which were rolled after covering them with another water soaked germination paper. The rolled germination papers were covered with butter paper and kept in seed germinator at 21.5°C and 75% RH. After 8^{th} days the germination per cent were recorded on the basis of normal seed ling emergence.

$$\text{Germination (\%)} = \frac{\text{Number of seed germinated}}{\text{Number of Seed plated}} \times 100$$

18. Speed of germination: The seeds are grown in 4 replicates of 50 seeds. Number of germinated seeds are counted daily and the index for the speed of germination is calculated by the formula suggested by Maguire (1962).

19. Root length: The length of the roots was measured from collar region down to the tip of the longest root of each seedling and the average was expressed in cm.

20. Shoot length: Ten normal seedling were randomly selected from each replication of the standard germination test on the 8^{th} day and length of shoots was measured from collar region to the tip of top most leaf and expressed in cm.

21. Seeding length: At the end of the germination test, ten normal seedlings from each replication were carefully removed at random and seedling length was measured from the tip of leaf to the tip of the primary root excluding the seed region and the mean value was calculated and expressed in cm.

22. Seedling dry weight: The randomly selected seeding for measuring seedling length obtained after final count were dried at 70 $\pm$1°C for 24 hours in hot air oven, and dry weight in milligrams was determined by weighing them in an electronic balance.

23. Seed vigour Index: Seed vigour index was calculated by adopting the following formula as suggested by Abdul-Baki and Anderson (1973) and was expressed in whole number.

Seed Vigour Index(I) = Mean Germination (%) × Mean Seedling length (cm)

Seed Vigour Index(II) = Mean Germination (%) × Mean Seedling Dry Weight (mg)

Statistical Analysis: An experiment will be conducted under split plot design with three replications under field conditions. The data obtained from various experiments subjected to statistical analysis as per recommended. **1. Standard error (SE):** The standard error is a statistical term that measures the accuracy with which a simple represents a population. In statistics, a sample mean deviates from the actual mean of the population this deviation is the standard error. **2. Critical difference (CD):** Which refers to a value indicating the least significant difference at values greater than all the differences are significant is present.

RESULT

Days of 50% Flowering and Maturity. 50% flowering and maturity was recorded maximum days in 25^{th} – 30^{th} November as compared to other date of sowing. A series of reduction in days of 50% flowering and maturity was recorded with delay in sowing during both years. The first date of sowing has been taken highest number of days in 50% flowering (84.07 and 84.73) and maturity (127.33 and 128.33) both years respectively followed by December 10^{th} – 15^{th} (50% flowering 73.53 and 74.60 days and maturity 110.0 and 109.87 days) and January 1^{th} – 5^{th} sown wheat (50% flowering 63 and 64 days and maturity 87.40 and 86.13 days). Minimum days of 50% flowering (63 and 64 days) and maturity (87.40 and 86.13 days) was recorded with last sowing date on 1^{th} – 5^{th} January.

Table 1: Effect of different dates of sowing on 50% flowering and days to maturity.

Treatments	Days to 50% Heading			Days to maturity (DM)		
	2020-21	2021-22	Mean	2020-21	2021-22	Mean
Dates of sowing						
25-30 Nov. (D_1)	84.07	84.73	84.4	127.33	128.33	127.83
10-15 Dec. (D_2)	73.53	74.60	74.065	110.00	109.87	109.935
01-05 Jan. (D_3)	63.00	64.00	63.5	87.40	86.13	86.765
SE.m ±						
CD at 5%						

Plant Height and Tillers/m^2. 25^{th} – 30^{th} November recorded highest height (100.78cm and 97.03cm) and number of tillers/m^2 (370.87 and 348.80) in plants of wheat in both years respectively followed by10^{th} – 15^{th} December (97.27cm and 97.17cm plant height and 261.93 and 261.60 tillers/m^2) and 1^{th} – 5^{th} January sown wheat (81.97cm and 82.04cm plant height and 226.93 and 227.40 tillers/m^2). The lowest plant height (81.97cm and 82.04cm) and number of tillers/m^2 (226.93 and 227.40) was recorded with last sowing date on1^{th} – 5^{th} January.

Spike Length (cm) and Spike Weight (g). The first date of sowing on 25^{th} – 30^{th} November resulted highest spike length (10.52cm and 11.27cm) and spike weight (2.71g and 2.70g) respectively and followed by10^{th} – 15^{th} December (10.56cm and 10.77cm spike length and 2.28g and 2.28g spike weight) and 1^{th} – 5^{th} January sown wheat (9.67cm and 9.80cm spike length and 1.71g and 1.71g spike weight). Minimum spike length (9.67cm and 9.80cm) and spike weight (1.71g and 1.71g) was recorded with last date of sowing on1^{th} – 5^{th}January during both years.

Spikelet's/Spike and Seed/Spike. First date of sowing resulted highest number of spikelet's/spike (19.53 and 20.13) and seed/spike (43.47 and 43.87) in both years respectively followed by December 10^{th} – 15^{th} (15.07 and 14.73 spikelet's/spike and 40 and 40.27 seed/spike) and January 1^{th} – 5^{th} sown wheat (14.67 and 14.47 spikelet's/spike and 36.13 and 36.87 seed/spike). The lowest numbers of spikelet's/spike (14.67 and 14.47) and seed/spike (36.13 and 36.87) was recorded with last date of sowing on 1^{th} – 5^{th} January.

Table 2: Effect of different dates of sowing on plant height and tillers/m^2.

Treatments	Plant height (cm)			Tillers/m^2		
	2020-21	2021-22	Mean	2020-21	2021-22	Mean
Dates of sowing						
25-30 Nov. (D_1)	100.78	97.03	98.905	370.87	348.80	359.835
10-15 Dec. (D_2)	97.27	97.17	97.22	261.93	261.60	261.765
01-05 Jan. (D_3)	81.97	82.04	82.005	226.93	227.40	227.165
SE.m ±				0.74	0.79	0.765
CD at 5%				2.91	3.07	2.99

Table 3: Effect of different dates of sowing on Spike length and Spike weight.

Treatments	Spike length (cm)			Spike weight (g)		
	2020-21	2021-22	Mean	2020-21	2021-22	Mean
Dates of sowing						
25-30 Nov. (D_1)	10.52	11.27	10.895	2.71	2.70	2.705
10-15 Dec. (D_2)	10.56	10.77	10.665	2.28	2.28	2.28
01-05 Jan. (D_3)	9.67	9.80	9.735	1.71	1.71	1.71
SE.m ±	0.049	0.031	0.04	0.008	0.011	0.0095
CD at 5%	0.190	0.122	0.156	0.031	0.043	0.037

Table 4: Effect of different dates of sowing on Spikelets/spike and Seed/spike.

Treatments	Spikelets/spike			Seed / spike		
	2020-21	2021-22	Mean	2020-21	2021-22	Mean
Dates of sowing						
25-30 Nov. (D_1)	19.53	20.13	19.83	43.47	43.87	43.67
10-15 Dec. (D_2)	15.07	14.73	14.9	40.00	40.27	40.135
01-05 Jan. (D_3)	14.67	14.47	14.57	36.13	36.87	36.5
SE.m ±	0.04	0.08	0.06	0.17	0.13	0.15
CD at 5%	0.17	0.32	0.245	0.66	0.51	0.585

Seed Weight/Spike and Seed Index (100 Seeds Weight). 25th – 30th November recorded highest seed weight/spike (1.90g and 1.97g) and seed Index (3.72g and 3.73g weight) followed by 10th – 15th December (1.62g and 1.67g seed weight/spike and 3.63g and 3.63g seed index) and 1th – 5th January sown wheat (1.50g and 1.51g seed weight/spike and 2.64g and 2.67g seed index). The minimum seed weight/spike (1.50g and 1.51g) and seed Index (2.64g and 2.67g weight) was recorded with last sowing date on 1th – 5th January during both the experiment.

Test Weight (1000 Seeds) and Straw Yield (q/ha^{-1}). The second date of sowing resulted maximum test weight (36.59g and 36.61g) followed by 25th – 30th November (35.89g and 36.11g) and January 1th – 5th sown wheat (28.12g and 28.04g) and straw yield (q/ha^{-1}) was recorded maximum (70.86 and 70.95 q/ha^{-1}) on 25th – 30th November followed by December 10th – 15th (66.96 and 67 q/ha^{-1}) and January 1th – 5th (61.86 and 61.79 q/ha^{-1}) sown wheat during years of 2020-21 and 2021-22. The minimum test weight (28.12g and 28.04g) and straw yield (61.86 and 61.79 q/ha^{-1}) was recorded with last date of sowing on 1th – 5th January during both years.

Biological Yield (kg/ha^{-1}) and Seed Yield (kg/ha^{-1}). First date of sowing resulted highest biological yield (9111.2 and 9133.6 kg/ha^{-1}) and seed yield (3929.20 and 3931.0 kg/ha^{-1}) over 10th – 15th December (8219.3 and 8226.8 kg/ha^{-1} biological yield and 3407.07 and 3393.60 kg/ha^{-1}) and 1th – 5th January sown wheat (6804.0 and 6827.1 kg/ha^{-1}biological yield and 2959.40 and 2956.0 kg/ha^{-1}). The lowest biological yield (6804.0 and 6827.1 kg/ha^{-1}) and seed yield (2959.40 and 2956.0 kg/ha^{-1}) was recorded with last date of sowing on 1th – 5thJanuary during both years.

Seed Recovery (%) and Harvest Index (%). 25th – 30th November recorded maximum percentage in seed recovery (96.75% and 96.76%) and harvest index (42.65% and 42.65%) followed by 10th – 15th December (93.02% and 92.74% seed recovery and 40.16% and 40.16% harvest index) and 1th – 5th January (87.42% and 87.55% seed recovery and 36.21% and 36.21% harvest index). The minimum percentage in seed recovery (87.42% and 87.55%) and harvest index (36.21% and 36.21%) was recorded with last sowing date on 1th – 5th January during both years of experiment.

Table 5: Effect of different dates of sowing on Seed weight/spike and Seed index.

Treatments	Seed weight/spike			Seed index (100 seeds weight)		
	2020-21	2021-22	Mean	2020-21	2021-22	Mean
Dates of sowing						
25-30 Nov. (D_1)	1.90	1.97	1.935	3.72	3.73	3.725
10-15 Dec. (D_2)	1.62	1.67	1.645	3.63	3.63	3.63
01-05 Jan. (D_3)	1.50	1.51	1.505	2.64	2.67	2.655
SE.m ±	0.009	0.006	0.0075	0.011	0.018	0.0145
CD at 5%	0.037	0.022	0.0295	0.042	0.072	0.057

Table 6: Effect of different dates of sowing on Test weight and straw yield.

Treatments	Test weight (1000 seeds)			Straw yield (q/ha)		
	2020-21	2021-22	Mean	2020-21	2021-22	Mean
Dates of sowing						
25-30 Nov. (D_1)	35.89	36.11	36	70.86	70.95	70.905
10-15 Dec. (D_2)	36.59	36.61	36.6	66.96	67.00	66.98
01-05 Jan. (D_3)	28.12	28.04	28.08	61.86	61.79	61.825
SE.m ±	0.09	0.09	0.09	0.267	0.104	0.1855
CD at 5%	0.36	0.33	0.345	1.044	0.406	0.725

Table 7: Effect of different dates of sowing on Biological yield and Seed yield.

Treatments	Biological yield (kg ha^{-1})			Seed yield (kg/hac.)		
	2020-21	2021-22	Mean	2020-21	2021-22	Mean
Dates of sowing						
25-30 Nov. (D_1)	9111.2	9133.6	9122.4	3929.20	3931.00	3930.1
10-15 Dec. (D_2)	8219.3	8226.8	8223.05	3407.07	3393.60	3400.34
01-05 Jan. (D_3)	6804.0	6827.1	6815.55	2959.40	2956.00	2957.7
SE.m ±	44.8	22.5	33.65	18.21	9.05	13.63
CD at 5%	174.8	87.7	131.25	71.10	35.34	53.22

Table 8: Effect of different dates of sowing on Seed recovery and Harvest index.

Treatments	Seed recovery (%)			Harvest index (%)		
	2020-21	2021-22	Mean	2020-21	2021-22	Mean
Dates of sowing						
25-30 Nov. (D_1)	96.75	96.76	96.755	42.65	42.65	42.65
10-15 Dec. (D_2)	93.02	92.74	92.88	40.16	40.16	40.16
01-05 Jan. (D_3)	87.42	87.55	87.485	36.21	36.21	36.21
SE.m ±	0.33	0.29	0.31	0.087	0.118	0.1025
CD at 5%	1.29	1.12	1.205	0.341	0.461	0.401

Germination (%) and Speed of Germination. Germination (%) and speed of germination was recorded highest on 25th – 30th November as compared to other dates of sowing. A slight reduction in germination (%) and speed of germination were observed with late sown wheat seed during both years of experiment. The first date of sowing wheat resulted highest germination (92.73% and 92.60%) and speed of germination (18.82 and 18.83) over 10th – 15th December (88.33% and 88% germination and 17.81 and 17.81 speed of germination) and 1th – 5th January sown wheat (84.93% and 85.13% germination and 16.07 and 16.06 speed of germination). The lowest germination (84.93% and 85.13%) and speed of germination (16.07 and 16.06) was recorded with last date of sowing wheat seed on 1th – 5th January during both years simultaneously.

Root Length (cm) and Shoot Length (cm). First date sown wheat seed resulted highest root length (20.43cm and 20.43cm) and shoot length (14.15cm and 14.17cm) in both years respectively followed by 10th – 15th December (18.03cm and 18.05cm root length and 12.57cm and 12.59cm shoot length) and 1th – 5th January sown wheat (15.76cm and 15.77cm root length and 11.69cm and 11.71cm shoot length). The lowest root length (15.76cm and 15.77cm) and shoot length (11.69cm and 11.71cm) was recorded with last date sown wheat seed on 1th – 5th January during both years.

Seedling Length (cm) and Seedling Dry Weight (g). A trend of decrease rate in seedling length (cm) and seedling dry weight (g) was recorded with late sown wheat seeds during both years of experimentation. The first date of sowing on 25th – 30th November recorded highest seedling length (35.47cm 35.21cm) and seedling dry weight (0.158g and 0.159g) followed by 10th– 15th December (32.85cm and 32.76cm seedling length and 0.137g and 0.139g) and 1th – 5th January sown wheat (29.88cm and 29.86cm seedling length and 0.123g and 0.125g). Minimum seedling length (29.88cm and 29.86cm) and seedling dry weight (0.123g and 0.125g) was recorded with last date sown wheat seed on 1th – 5th January.

Table 9: Effect of different dates of sowing on Germination and speed of germination

Treatments	Germination %			Speed of germination		
	2020-21	2021-22	Mean	2020-21	2021-22	Mean
Dates of sowing						
25-30 Nov. (D_1)	92.73	92.60	92.665	18.82	18.83	18.825
10-15 Dec. (D_2)	88.33	88.00	88.165	17.81	17.81	17.81
01-05 Jan. (D_3)	84.93	85.13	85.03	16.07	16.06	16.065
SE.m ±	0.36	0.34	0.35	0.044	0.023	0.0335
CD at 5%	1.39	1.34	1.365	0.171	0.090	0.1305

Table 10: Effect of different dates of sowing on Root length and Shoot length.

Treatments	Root length (cm)			Shoot length (cm)		
	2020-21	2021-22	Mean	2020-21	2021-22	Mean
Dates of sowing						
25-30 Nov. (D_1)	20.43	20.24	20.335	14.15	14.17	14.16
10-15 Dec. (D_2)	18.03	18.05	18.04	12.57	12.59	12.58
01-05 Jan. (D_3)	15.76	15.77	15.765	11.69	11.71	11.7
SE.m ±	0.070	0.046	0.058	0.052	0.070	0.061
CD at 5%	0.272	0.179	0.2255	0.202	0.271	0.2365

Table 11: Effect of different dates of sowing on Seedling length and Seedling dry weight.

Treatments	Seedling length (cm)			Seedling dry weight (g)		
	2020-21	2021-22	Mean	2020-21	2021-22	Mean
Dates of sowing						
25-30 Nov. (D_1)	35.47	35.21	35.34	0.158	0.159	0.1585
10-15 Dec. (D_2)	32.85	32.76	32.805	0.137	0.139	0.138
01-05 Jan. (D_3)	29.88	29.86	29.87	0.123	0.125	0.124
SE.m ±	0.08	0.13	0.105	0.00	0.00	0
CD at 5%	0.31	0.52	0.415	0.00	0.00	0

Vigour Index I and Vigour Index II: 25th – 30th November resulted highest vigour Index I (3416.73 and 3418.13) and vigour Index II (15.88 and 15.90) followed by 10th – 15th December (3304.87 and 3305.73 vigour index I and 12.86 and 12.87 vigour index II) and 1th – 5th January sown wheat (3106.53 and 3107.13 vigour index I and 10.38 and 10.39 vigour index II). Lowest vigour Index I (3106.53 and 3107.13) and vigour Index II (10.38 and 10.39) was recorded with last date sown wheat seed on 1th – 5th January during both years.

Table 12: Effect of different dates of sowing on Vigour Index I and Vigour Index II.

Treatments	Vigour Index I			Vigour Index II		
	2020-21	2021-22	Mean	2020-21	2021-22	Mean
Dates of sowing						
25-30 Nov. (D_1)	3416.73	3418.13	3417.43	15.88	15.90	15.89
10-15 Dec. (D_2)	3304.87	3305.73	3305.3	12.86	12.87	12.865
01-05 Jan. (D_3)	3106.53	3107.13	3106.83	10.38	10.39	10.385
SE.m ±	9.31	13.09	11.2	0.05	0.08	0.065
CD at 5%	36.34	51.11	43.725	0.20	0.30	0.25

DISCUSSION

The first date of sowing has been taken highest number of days in 50% flowering (84.07 and 84.73) and maturity (127.33 and 128.33) followed by December 10th – 15th (50% flowering 73.53 and 74.60 days and maturity 110.0 and 109.87 days). Minimum days of 50% flowering (63 and 64 days) and maturity (87.40 and 86.13 days) was recorded with last sowing date on 1th– 5th January. These results were also supported by Singh *et al.* (2021). Plant height and number of tillers/m^2 were recorded maximum on 25th – 30th November (100.78cm and 97.03cm plant height and 370.87 and 348.80 number of tillers/m^2) followed by10th – 15th December (97.27cm and 97.17cm plant height and 261.93 and 261.60 tillers/m^2). The lowest plant height (81.97cm and 82.04cm) and number of tillers/m^2 (226.93 and 227.40) was recorded with last sowing date on 1th – 5th January. Above findings have been reported by several workers, Dar *et al.* (2018); Kamrozzaman *et al.,* (2016); Madhu *et al.* (2018); Bashir *et al.* (2016). Spike length and spike weight were recorded maximum on 25th – 30th November (10.52cm and 11.27cm spike length and spike weight 2.71g and 2.70g respectively) followed by 10th – 15th December (10.56cm and 10.77cm spike length and 2.28g and 2.28g spike weight). Minimum spike length (9.67cm and 9.80cm) and spike weight (1.71g and 1.71g) was recorded with last date of sowing on1th – 5th January. Above results have been reported by several workers, Madhu *et al.* (2018), Praveen *et al.* (2018) and Singh *et al.*(2021). The numbers of spikelet's/spike (19.53 and 20.13) and seed/spike (43.47 and 43.87) recorded maximum on 25th – 30th November followed by December 10th – 15th (15.07 and 14.73 spikelet's/spike and 40 and 40.27 seed/spike) and lowest on January 1th – 5th sown wheat (14.67 and 14.47 spikelet's/spike and 36.13 and 36.87 seed/spike). Above results also supported by Madhu *et al.* (2018); Praveen *et al.* (2018); Singh *et al.* (2021); Kamrozzaman *et al.* (2016). Seed weight/spike (1.90g and 1.97g) and seed Index (3.72g and 3.73g weight) was recorded maximum on 25th – 30th November followed by 10th – 15th December (1.62g and 1.67g seed weight/spike and 3.63g and 3.63g seed index). The minimum seed weight/spike (1.50g and 1.51g) and seed Index (2.64g and 2.67g weight) was recorded with last sowing date on 1th – 5th January.Above results also supported by Shirinzadeh *et al.* (2017); Madhu *et al.*(2018); Kamrozzaman *et al.* (2016); Pathania *et al.* (2018); Singh *et al.* (2021). Test weight (36.59g and 36.61g) was recorded maximum on 10th – 15th December followed by 25th – 30th November (35.89g and 36.11g) and January 1th – 5th (28.12g and 28.04g) and straw yield (q/ha^{-1}) was recorded maximum (70.86 and 70.95 q/ha^{-1}) on 25th – 30th November followed by December 10th – 15th (66.96 and 67 q/ha^{-1}) and January 1th – 5th (61.86 and 61.79 q/ha^{-1}). The minimum test weight (28.12g and 28.04g) and straw yield (61.86 and 61.79 q/ha^{-1}) was recorded with last date of sowing on 1th – 5th January. Above finding also have been reported by Madhu *et al.* (2018); Kamrozzaman *et al.* (2016); Pathania *et al.* (2018); Singh *et al.* (2021); Singh *et al.* (2017); Akram *et al.* (2016); Thorat *et al.* (2015). However, Biological yield (kg/ha^{-1}) and seed yield (kg/ha^{-1}) were recorded highest on 25th – 30th November (9111.2 and 9133.6 kg/ha^{-1} biological yield and seed yield 3929.20 and 3931.0 kg/ha^{-1}) over 10th – 15th December (8219.3 and 8226.8 kg/ha^{-1} biological yield and 3407.07 and 3393.60 kg/ha^{-1} seed yield). The lowest biological yield (6804.0 and 6827.1 kg/ha^{-1}) and seed yield (2959.40 and 2956.0 kg/ha^{-1}) was recorded with last date of sowing on 1th – 5th January. Above finding also have been reported by Singh *et al.*(2021); Akram *et al.* (2016); Shirinzadeh *et al.* (2017); Ali *et al.* (2017); Singh *et al.* (2021); Wahid *et al.* (2017); Verma *et al.* (2016). The seed recovery (%) and harvest index (%) was recorded maximum on 25th – 30th November (96.75% and 96.76% seed recovery and harvest index 42.65% and 42.65%) followed by 10th – 15th December (93.02% and 92.74% seed recovery and 40.16% and 40.16% harvest index). The minimum percentage in seed recovery (87.42% and 87.55%) and harvest index (36.21% and 36.21%) was recorded with last sowing date on 1th – 5th January during both years. These results also supported by Vishwanath *et al.* (2019); Singh *et al.* (2021); Akram *et al.* (2016); Dhaka *et al.* (2006). Germination (92.73% and 92.60%) and speed of germination (18.82 and 18.83) was recorded maximum on 25th – 30th November over 10th – 15th December (88.33% and 88% germination and 17.81 and 17.81 speed of germination). The lowest germination (84.93%

and 85.13%) and speed of germination (16.07 and 16.06) was recorded with last date of sown wheat seed on 1^{th} – 5^{th} January. Above finding also have been reported by Praveen *et al.* (2018); Ali *et al.* (2018); Chaithra *et al.* (2017). Root length (20.43cm and 20.43cm) and shoot length (14.15cm and 14.17cm) was recorded maximum on 25^{th} – 30^{th} November followed by 10^{th} – 15^{th} December (18.03cm and 18.05cm root length and 12.57cm and 12.59cm shoot length). The lowest root length (15.76cm and 15.77cm) and shoot length (11.69cm and 11.71cm) was recorded with last date sown wheat seed on 1^{th} – 5^{th} January. Above finding also have been supported by Ali *et al.* (2018); Shaheb *et al.* (2016); Chaithra *et al.* (2017). The seedling length (cm) and seedling dry weight (g) was recorded highest on 25^{th} – 30^{th} November sown wheat seed (35.47cm 35.21cm seedling length and seedling dry weight 0.158g and 0.159g) followed by 10^{th} – 15^{th} December (32.85cm and 32.76cm seedling length and 0.137g and 0.139g seedling dry weight). Minimum seedling length (29.88cm and 29.86cm) and seedling dry weight (0.123g and 0.125g) was recorded with last date sown wheat seed on 1^{th} – 5^{th} January. Above finding also have been reported by Ali *et al.* (2018); Shaheb *et al.* (2016); Chaithra *et al.* (2017). Vigour Index I and vigour Index II were recorded highest on 25^{th} – 30^{th} November (3416.73 and 3418.13 vigour Index I and vigour Index II 15.88 and 15.90) followed by 10^{th} – 15^{th} December (3304.87 and 3305.73 vigour index I and 12.86 and 12.87 vigour index II). Lowest vigour Index I (3106.53 and 3107.13) and vigour Index II (10.38 and 10.39) was recorded with last date sown wheat seed on 1^{th} – 5^{th} January. Above finding also have been supported by Ali *et al.* (2018); Shaheb *et al.* (2016); Chaithra *et al.* (2017).

CONCLUSION

25^{th} – 30^{th} November has been taken maximum days to 50% flowering, maturity and produced maximum plant height, tillers/m^2, spike length, spike weight, spikelet's/spike, seed/spike, seed weight/spike, seed Index, seed yield, seed recovery (%), harvest Index, germination %, speed of germination, root length, shoot length, seedling length, seedling dry weight, vigour Index I and vigour Index II followed by 10^{th} – 15^{th} December.

Therefore, present investigation showed that seed sown on 25^{th} – 30^{th} November followed by 10^{th} – 15^{th} December should be effective for achieving higher seed yield and quality parameters in wheat.

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