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Impact of dates of sowing on growth and yield of wheat (*Triticum aestivum* L.)

Himanshu Singh and SC Vimal

Abstract
A field study was conducted at Student Instructional Farms of the Acharya Narendra Deva University of Agriculture & Technology, Kumarganj, Ayodhya, (UP) during Rabi season 2020-21 and 2021-22 to find out the impact of dates of sowing on growth and yield of 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 three replications (*var.* NW-5054). The results revealed that the wheat sown on 25th – 30th November produced maximum field emergence, plant height at 30, 60, 90DAS and at maturity, tillers/plant at 30, 60, 90DAS and at maturity, tillers/m^2, spike length, spikelet's/spike, seed/spike, straw yield, biological yield and seed yield followed by 10th – 15th December.

Keywords: Field emergence, Spikelet's, biological yield, seed yield

Introduction
Wheat (*Triticum aestivum*) also known as bread wheat, belongs to the family Triticeae in the grass family Poaceae (*Gramineae*). About 95% of the wheat produced is common wheat. Wheat is the first important and strategic cereal crop for the majority of world's populations. It is the most important staple food of about two billion people (36% of the world population). Worldwide, wheat provides nearly 55% of the carbohydrates and 20% of the food calories consumed globally. 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 tonnes. In India, wheat witnessed an acreage of 31.76 million hectares, respectively during the 2020-21 *rabi* season. The 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 tonnes 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).
Crop performance and yield is the ultimate result of interaction of a crop genotype and its environment. Among various stresses, abiotic stresses such as heat, drought and salinity are considered as major threats to sustainable wheat production in India. According to world estimates, average yield losses in agricultural crops up to 50% is mainly due to different abiotic stresses as a result of these changing climatic conditions (Theilert, 2006) [17]. Heat stress depends on heat intensity which is a measure of rise in temperature above the environmental temperature, duration of exposure to high temperature, rate of rise in temperature and the response of plant to high temperature at different developmental stages. In developing countries, about 7 million hectare of wheat is subjected to continual heat stress and terminal heat stress is poses serious threat to about 40 per cent of the temperate environments accounting for 36 million hectare of wheat. Spring wheat which is normally grown in these areas faces severe heat stress during certain phases of crop growth. The Indo-Gangetic Plains (IGP) of India, Nepal, Bangladesh and Pakistan is an important region of rice-wheat cropping system that covers about 13.5 million hectares area (Gupta and Seth, 2007) [6].
Temperature is an important determinant in physiological and morphological development influencing the growth, development and yield of crops. Heat stress adversely affects the wheat crop starting from the early stage of emergence in wheat. 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. (Jena *et al.*2017) [7].

Materials and Methods

This experiment was conducted with wheat variety (NW-5054) at Student Instructional Farms, Acharya Narendra Deva University of Agriculture and Technology (Kumarganj), Ayodhya. This university situated on Ayodhya to Raibareli road about 47 km away from Ayodhya Railway station at 26.47^0 N, latitude 82.12^0E longitudes and altitude of 113 meter MSL (mean sea level) in the north Indo-gangtic plain. Experiment was conducted in split plot design with three replications where 3 different dates of sowing which was 25-30 Nov. 10-15 Dec. and 01-05 Jan. as a main plot of experiment. 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. Growth and yield components recorded in this experiment.

Field observations

These observations recorded on field level condition which is follow as

1. Field emergence (%)

$$\text{Field Emergence (\%)} = \frac{\text{Normal Seedling Produced}}{\text{Number of Seeds Sown}} \text{ X } 100$$

2. 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 30th, 60th, 90thDAS and at harvest stage.

3. Number of effective tillers/plant

The number of tillers were counted per plant from five plant selected randomly in each plot at 30, 60, 90 days after sowing and at harvested stage. Then average value was worked out.

4. Number of tillers (m^2) row length (at harvest)

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. Spikelet's per spike

The number of spikelets in the main spike was counted.

7. Number of Seed/spike

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

8. Test Weight (1000-grain weight g)

Random grain samples were collected from the produce of each net plot and1000-grains were counted and weighed in gram with the help of electronic balance.

9. 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}.

10. 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}.

11. Seed yield (kg/ha^{-1})

The seeds ware obtained after threshing of the net plot area was weighed as seeds yield kg plot^{-1}.

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.

Results

Impact of dates of sowing on growth and yield

Field Emergence (%)

The field emergence has affected by statistically due to dates of sowing during both the year of experimentation. However, sowing done on 25th-30thNovember resulted significantly higher as compared to other dates of sowing. The highest field emergence recorded on 25th-30th November (84.47% and 84.93%) followed by 10th-15thDecember (77.53% and 78.73%) and lowest emergence of plant (71.20% and 71.80%) was recorded from 1th-05th January. The field emergence decreased significantly with delay in sowing during both the years.

Table 1: Effect of dates of sowing on Field Emergence (%)

Treatments	Field emergence (%)		
	2020-21	2021-22	Mean
Dates of sowing			
25-30 Nov. (D1)	84.47	84.93	84.7
10-15 Dec. (D2)	77.53	78.73	78.13
01-05 Jan. (D3)	71.20	71.80	71.5
SE. m ±	2.986	0.764	1.875
CD at 5%		2.982	2.982

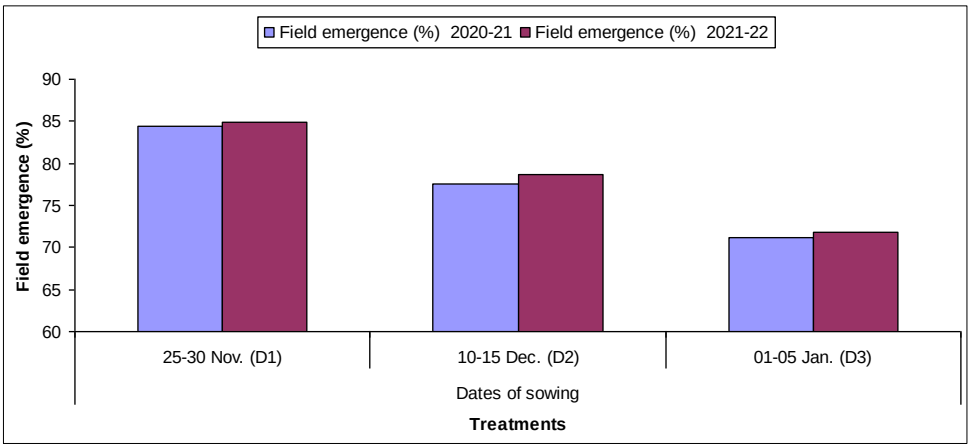

Fig 1: Effect of dates of sowing on field emergence (%)

Plant height at 30, 60, 90 DAS and at maturity

At 30 DAS 25th – 30th November recorded (21.74 cm and 21.73 cm) significantly higher plant height over 1th – 5th January (19.06 cm and 18.95 cm) and 10th – 15th December (17.48 cm and 17.48 cm). At 60 DAS 1th – 5th January recorded (59.26 cm and 59.06 cm) significantly higher plant height followed by 25th – 30th November (56.44cm and 56.51cm) and 10th – 15th December (55.34cm and 55.31cm). Later at 90 DAS 25th – 30th November recorded (93.71cm and 93.71cm) significantly highest plant height followed by 10th – 15th December (93.34cm and 93.32cm) and 1th – 5th January (83.01cm and 82.98cm). At maturity stage seed sown on 25th – 30th November recorded (100.78cm and 97.03cm) significantly highest plant height followed by 10th – 15th December (97.27cm and 97.17cm) and 1th – 5th January (81.97cm and 82.04cm). The plant height decreased significantly with delay in sowing. Lowest height of plant was recorded from January 1th–5th sowing.

Table 2: Effect of dates of sowing on plant height at different growth stages (30, 60, 90DAS and at maturity)

Treatments	Plant height (cm)											
	30 DAS			60 DAS			90 DAS			At harvest		
	2020-21	2021-22	Mean	2020-21	2021-22	Mean	2020-21	2021-22	Mean	2020-21	2021-22	Mean
Dates of sowing												
25-30 Nov. (D_1)	21.74	21.73	21.735	56.44	56.51	56.475	93.71	93.71	93.71	100.78	97.03	98.905
10-15 Dec. (D_2)	17.48	17.48	17.48	55.34	55.31	55.325	93.34	93.32	93.33	97.27	97.17	97.22
01-05 Jan. (D_3)	19.06	18.95	19.005	59.26	59.06	59.16	83.01	82.98	82.995	81.97	82.04	82.005
S.Em ±	0.071	0.072	0.0715	0.282	0.129	0.2055	0.560	0.469	0.5145	0.663	0.209	0.436
CD at 5%	0.278	0.282	0.28	1.100	0.504	0.802	2.188	1.831	2.0095	2.589	0.815	1.702

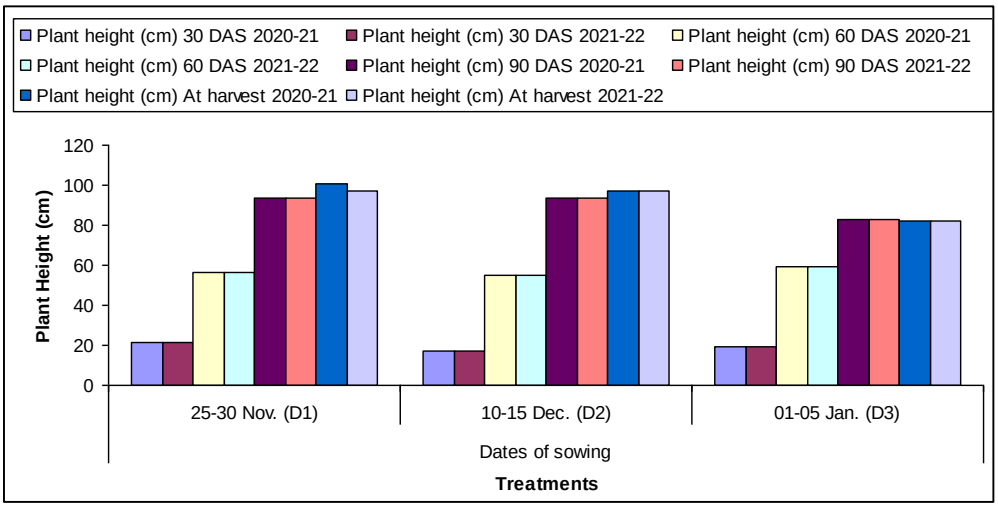

Fig 2: Effect of dates of sowing on plant height at different growth stages (30, 60, 90DAS and at maturity)

Tillers/Plant at 30, 60, 90 DAS and at maturity

At 30 DAS, 25th – 30th November produced significantly highest number of tillers per plant (1.60 and 1.61) over 10th – 15th December and 1th – 5th January sown wheat. 25th – 30th November followed by 10th – 15th December (1.49 and 1.51) and 1th – 5th January (1.12 and 1.11). At 60 DAS 25th – 30th November recorded (4.13 and 4.12) significantly higher number of tillers per plant followed by 1th – 5th January (3.70 and 3.70) and 10th – 15th December (3.69 and 3.68). Later at 90 DAS 25th – 30th November produced significantly highest number of tillers per plant (5.13 and 5.12) followed by 10th – 15th December (4.28 and 4.26) and 1th – 5th January (3.40 and 3.40) sown wheat and at maturity stage seed sown on 25th – 30th November recorded (6.18 and 6.19) significantly highest

number of tillers per plant followed by 10th – 15th December (4.60 and 4.59) and 1th – 5th January (4.56 and 4.52). The first date sown wheat followed by 10th – 15th December and 1th – 5th January crop at different stage of plant growth. The number of tillers per plant decreased significantly with delay in sowing during both the years of maturity.

Table 3: Effect of dates of sowing on tillers/plant at different growth stages (30, 60, 90DAS and at maturity) and tillers/m^2

Treatments	Tillers/plant														
	30 DAS			60 DAS			90 DAS			At harvest			Number of tillers per meter square		
	2020-21	2021-22	Mean	2020-21	2021-22	Mean	2020-21	2021-22	Mean	2020-21	2021-22	Mean	2020-21	2021-22	Mean
Dates of sowing															
25-30 Nov. (D_1)	1.60	1.61	1.605	4.13	4.12	4.125	5.13	5.12	5.125	6.18	6.19	6.185	370.87	348.80	359.835
10-15 Dec. (D_2)	1.49	1.51	1.5	3.69	3.68	3.685	4.28	4.26	4.27	4.60	4.59	4.595	261.93	261.60	261.765
01-05 Jan. (D3)	1.12	1.11	1.115	3.70	3.70	3.7	3.40	3.40	3.4	4.56	4.52	4.54	226.93	227.40	227.165
S.Em ±	0.005	0.006	0.0055	0.013	0.019	0.016	0.016	0.021	0.0185	0.019	0.015	0.017	0.744	0.787	0.7655
CD at 5%	0.020	0.023	0.0215	0.053	0.075	0.064	0.064	0.083	0.0735	0.074	0.059	0.0665	2.905	3.074	2.9895

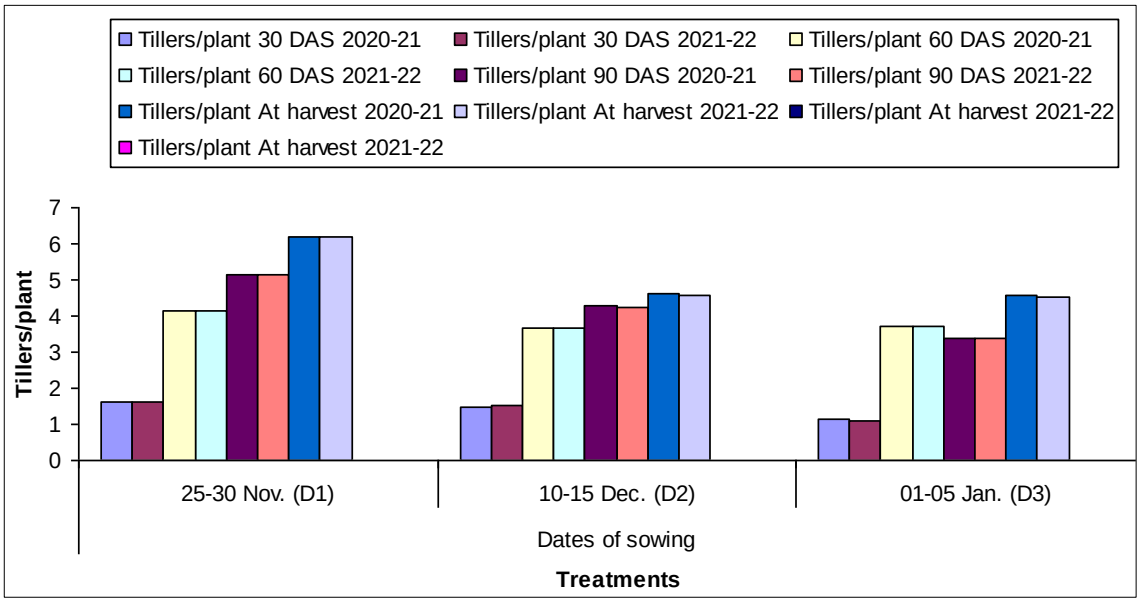

Fig 3: Effect of dates of sowing on tillers/plant at different growth stages (30, 60, 90DAS and at maturity)

Tillers/m^2

Tillers/m^2 was recorded highest on 25th – 30th November as compared to other dates of sowing. Reductions in number of tillers/m^2 were also seen with delay in sowing during both years.25th – 30th November recorded highest number of tillers/m^2 (370.87 and 348.80) followed by 10th – 15th December (261.93 and 261.60) and 1th – 5th January sown wheat (226.93 and 227.40). The lowest number of tillers/m^2 (226.93 and 227.40) was recorded with last sowing date on 1th – 5thJanuary during experimentation.

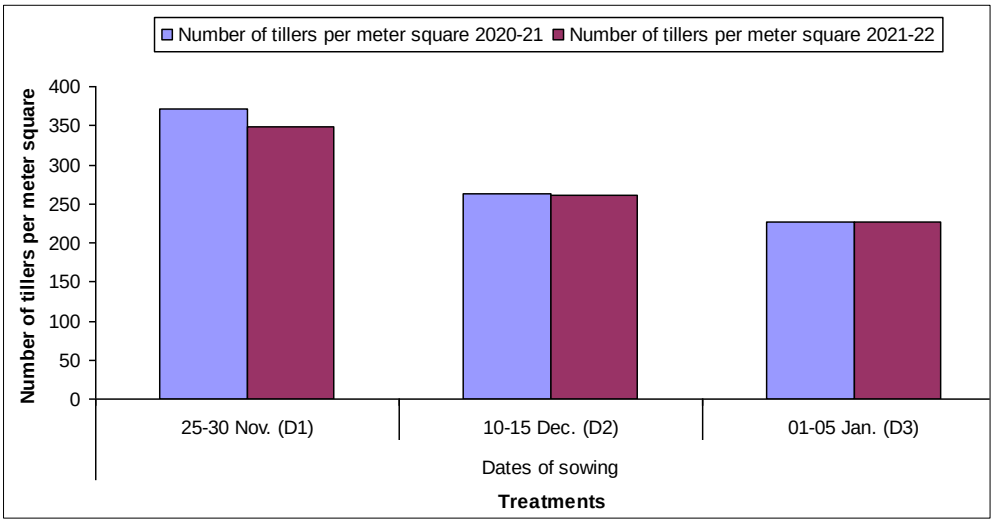

Fig 4: Effect of dates of sowing on tillers/m2

Spike Length (cm)

The first date of sowing on 25th – 30th November resulted highest spike length (10.52cm and 11.27cm) respectively and followed by10th – 15th December (10.56cm and 10.77cm) and 1th – 5thJanuary sown wheat (9.67cm and 9.80cm). Minimum spike length (9.67cm and 9.80cm) was recorded with last date of sowing on 1th – 5th January.

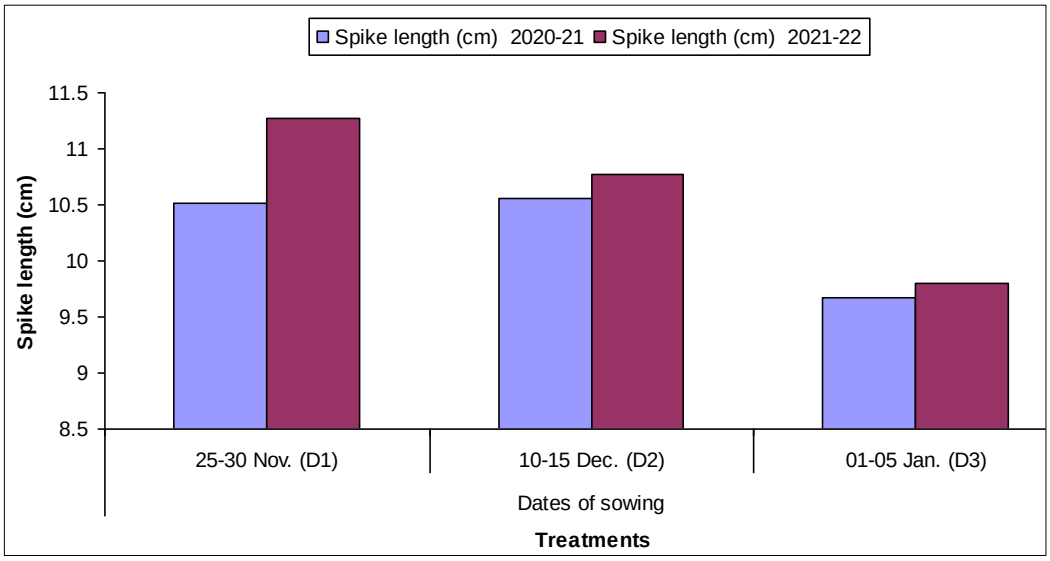

Fig 5: Effect of dates of sowing on spike length (cm)

Spikelet's/spike and Seed/spike

A downfall in numbers of spikelet's/spike and seed/spike were recorded with delay in sowing during both years of experiment. The first dates of sowing resulted highest numbers of spikelet's/spike (19.53 and 20.13) and seed/spike (43.47 and 43.87) in both years respectively followed by December 10th – 15th (15.07 and 14.73 spikelet's/spike and 40 and 40.27 seed/spike) and January 1th – 5th sown wheat (14.67 and 14.47 spikelet's/spike and 36.13 and 36.87 seed/spike) during 2020-21 and 2021-22. 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 1th – 5thJanuary.

Table 4: Effect of dates of sowing on Spike length (cm), Spikelet/spike and Seed/spike

Treatments	Spike length (cm)			Spikelet /spike			Seed / spike		
	2020-21	2021-22	Mean	2020-21	2021-22	Mean	2020-21	2021-22	Mean
Dates of sowing									
25-30 Nov. (D_1)	10.52	11.27	10.895	19.53	20.13	19.83	43.47	43.87	43.67
10-15 Dec. (D_2)	10.56	10.77	10.665	15.07	14.73	14.9	40.00	40.27	40.135
01-05 Jan. (D_3)	9.67	9.80	9.735	14.67	14.47	14.57	36.13	36.87	36.5
S.Em ±	0.049	0.031	0.04	0.04	0.08	0.06	0.17	0.13	0.15
CD at 5%	0.190	0.122	0.156	0.17	0.32	0.245	0.66	0.51	0.585

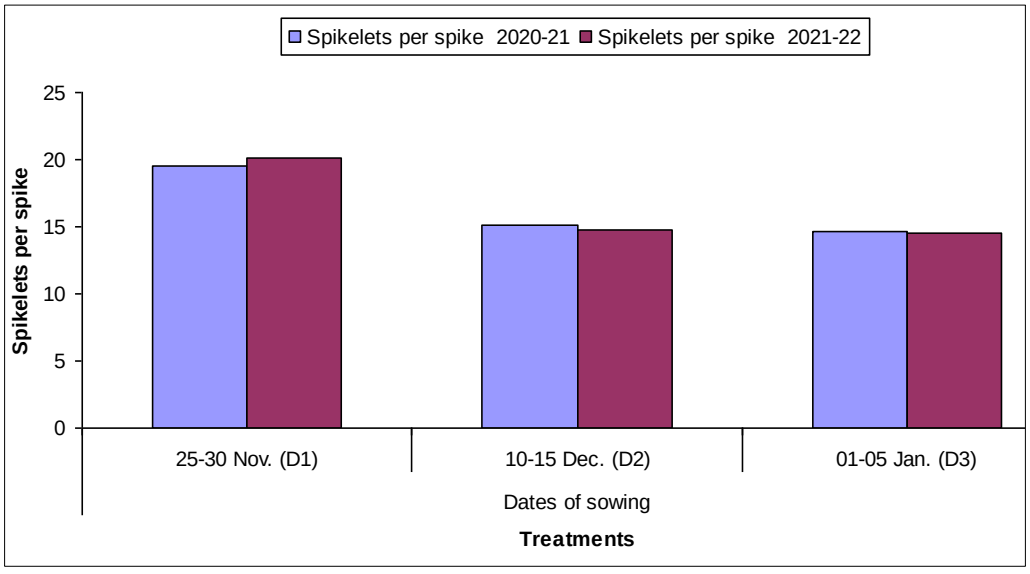

Fig 6: Effect of dates of sowing on spike let's/ spike

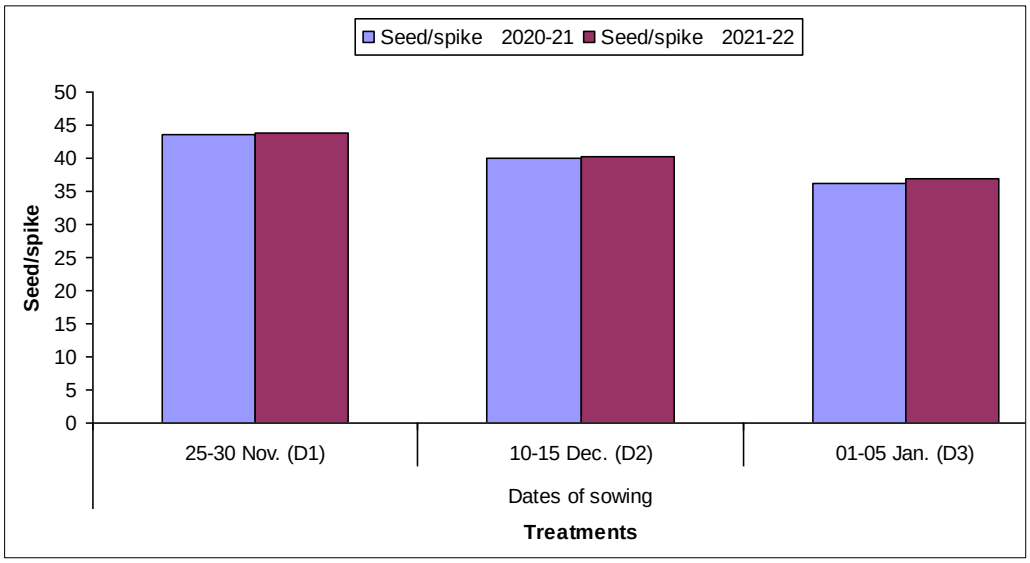

Fig 7: Effect of dates of sowing on seed/spike

Test weight (g.) 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 in both years respectively 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 – 5thJanuary.

Biological Yield (kg/ha^{-1}) and Seed Yield (kg/ha^{-1})

25th-30th November resulted highest biological yield (9111.2 and 9133.6 kg/ha^{-1}) and seed yield (3929.20 and 3931.0 kg/ha^{-1}) in both years respectively over 10th – 15th December (8219.3 and 8226.8 kg/ha^{-1} biological yield and seed yield 3407.07 and 3393.60 kg/ha^{-1}) and 1th – 5thJanuary sown wheat (6804.0 and 6827.1 kg/ha^{-1} biological yield and seed yield 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.

Table 5: Effect of dates of sowing on Test Weight (1000 seeds), Straw yield (q/ha), Biological yield (kg/ha^{-1}) and Seed yield (kg/ha^{-1})

Treatments	Test Weight (g.)			Straw yield (q/ha)			Biological yield (kg/ha^{-1})			Seed yield (kg/hac^{-1})		
	2020-21	2021-22	Mean	2020-21	2021-22	Mean	2020-21	2021-22	Mean	2020-21	2021-22	Mean
Dates of sowing												
25-30 Nov. (D1)	35.89	36.11	36	70.86	70.95	70.905	9111.2	9133.6	9122.4	3929.20	3931.00	3930.1
10-15 Dec. (D2)	36.59	36.61	36.6	66.96	67.00	66.98	8219.3	8226.8	8223.05	3407.07	3393.60	3400.34
01-05 Jan. (D3)	28.12	28.04	28.08	61.86	61.79	61.825	6804.0	6827.1	6815.55	2959.40	2956.00	2957.7
S.Em ±	0.09	0.09	0.09	0.267	0.104	0.1855	44.8	22.5	33.65	18.21	9.05	13.63
CD at 5%	0.36	0.33	0.345	1.044	0.406	0.725	174.8	87.7	131.25	71.10	35.34	53.22

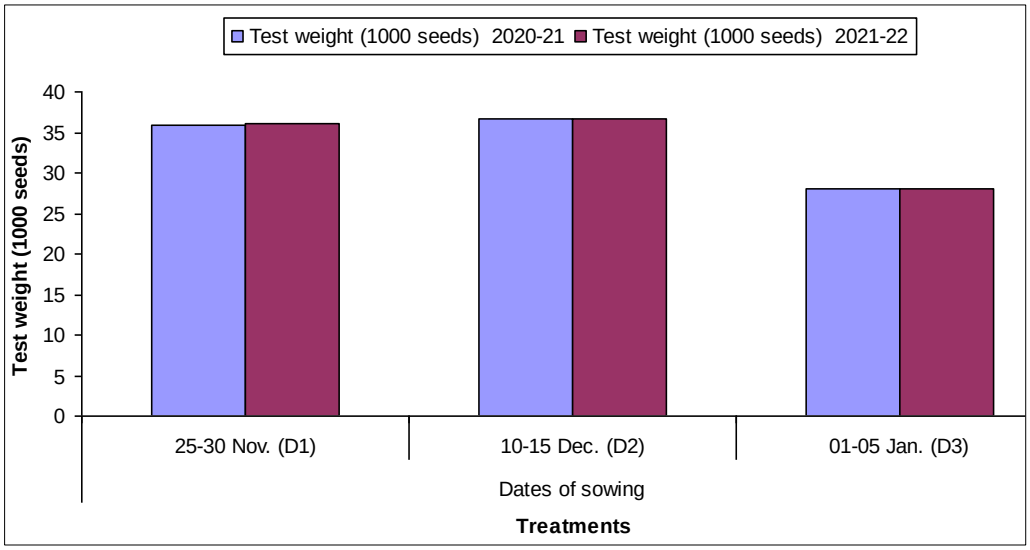

Fig 8: Effect of dates of sowing on test weight (g.)

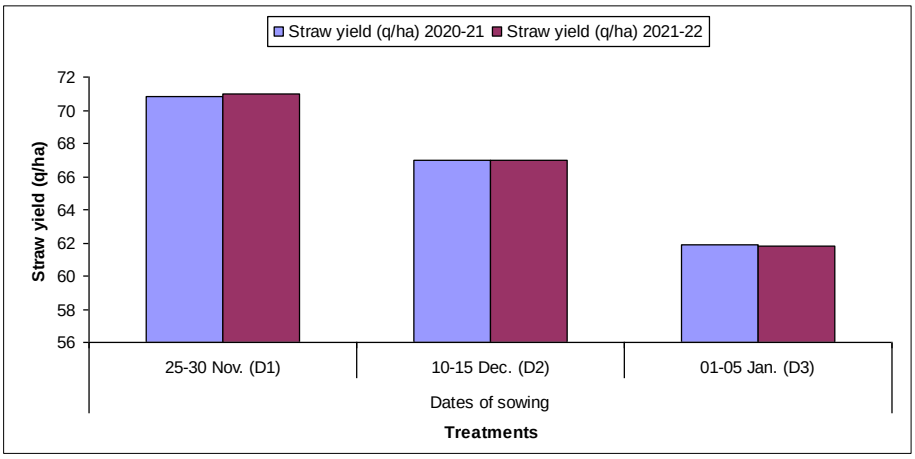

Fig 9: Effect of dates of sowing on straw yield (qha-1)

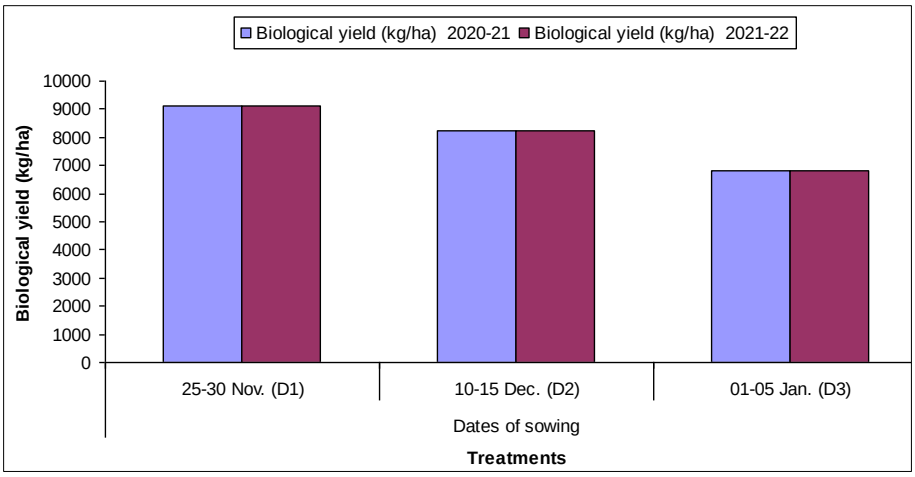

Fig 10: Effect of dates of sowing on biological yield (kg/ha.)

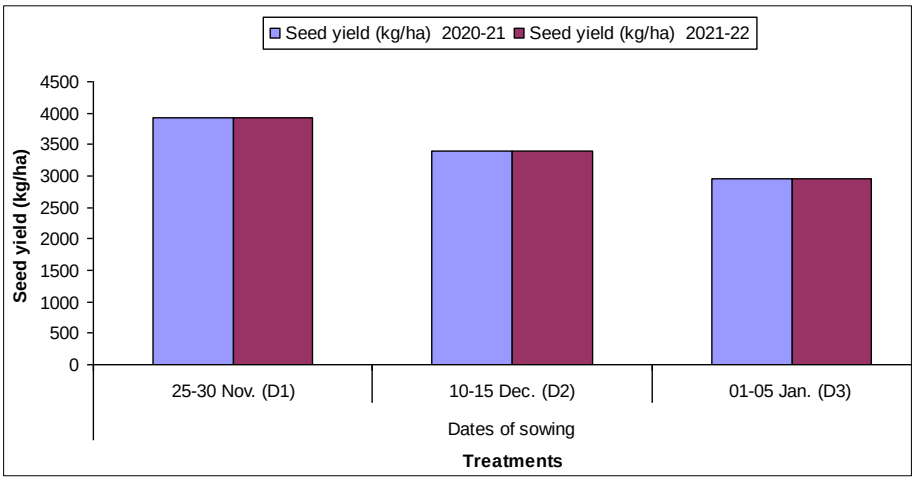

Fig 11: Effect of dates of sowing on seed yield (kg/ha.)

Discussion

25th-30th November resulted highest field emergence (84.47% and 84.93%) followed by 10th-15thDecember (77.53% and 78.73%) and lowest emergence of plant (71.20% and 71.80%) was recorded from 1th-05th January. Above results were also supported by Nainwal and Singh (2000) [12]. At 30, 60, 90 DAS and at harvest, Plant height recorded maximum on 25th - 30th November followed by 10th – 15th December and 1th – 5th January. These results were also supported by Kumar *et al.* (2016) [9], Praveen *et al.* (2018) [14], Dar *et al.* (2018) [5] and Kamrozzaman *et al.* (2016) [8] and at 30, 60, 90 DAS and at harvest, tillers/plant recorded maximum on 25th - 30th November followed by 10th – 15th December and 1th – 5th January at different stages of plant growth. Above findings have been reported by several workers, Dar *et al.*(2018) [5], Mishra *et al.* (2000) [11], Wahid *et al.*, (2017) [20], Praveen *et al.* (2018) [14] and Singh *et al.* (2021) [16]. November 25th-30th was recorded highest tillers/m^2 (370.87 and 348.80) over December 10th – 15th (261.93 and 261.60). The lowest number of tillers/m^2 (226.93 and 227.40) was recorded with January

1th – 5th. Above findings have been reported by several workers, Madhu *et al.* (2018) [10] and Bashir *et al.* (2016) [10]. Significantly spike length were recorded maximum on 25th – 30th November (10.52cm and 11.27cm) followed by10th – 15thDecember (10.56cm and 10.77cm). Minimum spike length (9.67cm and 9.80cm) was recorded with last date of sowing on1th – 5thJanuary. Above results have been reported by several workers, Madhu *et al.* (2018) [10], Praveen *et al.* (2018) [14] and Singh *et al.* (2021) [16]. 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) [10], Praveen *et al.* (2018) [14], Singh *et al.* (2021) [16] and Kamrozzaman *et al.* (2016) [8]. 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 – 5thJanuary. Above finding also have been reported by Madhu *et al.* (2018) [10], Kamrozzaman *et al.*(2016) [8], Pathania *et al.* (2018) [13], Singh *et al.*(2021) [16], Akram *et al.* (2016) [1] and Thorat *et al.* (2015) [18]. 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 – 5thJanuary during both years. Above finding also have been reported by Singh *et al.*(2021) [16], Akram *et al.* (2016) [1], Shirinzadeh *et al.* (2017) [15], Ali *et al.*(2017) [2], Singh *et al.* (2021) [16], Wahid *et al.* (2017) [20] and Verma *et al.* (2016) [19].

Conclusion

Thus, present investigation showed that wheat may be sown on 25th – 30th November produced maximum plant growth and seed yield.

25th – 30th November resulted maximum field emergence (%), plant height at 30, 60, 90DAS and at maturity, tillers/plant at 30, 60, 90DAS and at maturity, tillers/m^2, spike length, spikelet's/spike, seed/spike, test weight, straw yield, biological yield and seed yield followed by 10th – 15th December.

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