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Effect Of Different Sowing Dates And Varieties Of Wheat (Triticum Aestivum L.) Crop Grown Under Agro-Climatic Conditions Of Eastern Uttar Pradesh

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Abstract
A field experiment was carried out at Agrometeorological Research Farm, Acharya Narendra Deva University of Agriculture & Technology, Kumarganj, Ayodhya (U.P.) during rabi season of 2021-22 and 2022-23 to investigate the influence of different date of sowing and varieties on wheat growth parameters, including phenophases occurrence, leaf area index (LAI), plant height, and dry matter accumulation at various stages of crop development. The experiment comprised nine treatment combinations and conducted in split plot design and replicated four times. Treatment consisted of three date of sowing viz.15th November,1st December and 15th December with three varieties viz, Wb2, K1317 and K9423. Results reveal that Plant height (cm), dry matter accumulation (gm^{-2}) and leaf area index increased significantly at all the stages of crop growth. Highest values are recorded with the crop sowing on 15th November followed by 1st December. Lowest values of all were recorded in 15th December date of sowing. Among the varieties, Wb2 took relatively longer duration for maturity compared to K1317 and K9423. These findings underscore the importance of carefully managing both dates of sowing and varieties to optimize wheat growth and development. This research contributes to the broader understanding of crop responses to date of sowing and provides valuable insights for selection of variety strategies aimed at improving crop yield and resilience in the face of changing climate conditions.
Key words: *Wheat; Phenophases; LAI; Plant height; Sowing dates; Wheat varieties*

Wheat (*Triticum aestivum* L.) appertains to the grass family *Poaceae* (*Gramineae*) and its origin is South West Asia. Planting wheat at the optimal time based on environmental conditions is the most effective way to enhance crop growth and yield. The influence of temperature on the crop's growth stages and average yield has been analyzed under field conditions using an accumulated heat unit system. The duration, growth, and yield of the crop are influenced by the thermal and photoperiod conditions it experiences throughout its life cycle. Each crop has specific environmental requirements to ensure proper growth, development, and yield. The amount of dry matter produced by a crop depends on the distribution of leaf area in relation to solar energy, which plays a key role in the growth of different crops and the prediction of grain yield and physiological maturity. (Ali *et al.* 2010)

The two most important elements influencing productivity in production are the choice of wheat variety and sowing timing. Late-sown wheat needs favorable moisture conditions for improved growth and development in late March and early April. It is susceptible to low temperatures in the early part of the growing season and hot temperatures in the later half. Due to exposure to high temperatures, late-sown wheat had a loss in grain yields as a result of the macro- and micro-sporogenesis process during reproductive development. Ram *et al.* (2012)

METHODOLOGY

The field experiment was carried out during *rabi* season of 2021-22 and 2022-23 at the Student Instructional Research Farm, Department of Agricultural Meteorology Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya (26°.47'N, 82°.12'E and 113 m above mean sea level). Experiment was

laid out with three date of sowings D1-15th November, D2-1st December, D3-15th December along with three varieties was (Wb2, K1317, K9423) under Split plot design, date of sowing as main plot treatment and varieties as sub plot treatment with four replication at semi-arid climatic condition of eastern plain zone of Uttar Pradesh zone.

The number of days required to reach different phenophases was recorded by visually observing five randomly selected plants from each plot. This was done by noting the number of days from sowing to the attainment of each phenophase until maturity. Data on daily maximum and minimum temperatures, relative humidity (both morning and evening), bright sunshine hours, rainfall, and open pan evaporation were collected using meteorological instruments at the Agrometeorological Observatory of the Department of Agricultural Meteorology, ANDAU&T, Kumarganj, Ayodhya.

Plant Height (cm)

Height of five randomly chosen plants from each plot were taken at 15-day intervals, starting from 15 days after sowing (DAS) till maturity. The plant height was measured from the base of plant to the tip of longest leaf (these plants were uprooted and used for dry matter production) the mean height was worked out.

Leaf Area Index

Five plants were randomly chosen from each plot and cut down near the ground surface. The green parts were separated from the sheath portions. The leaf area of all the leaves was then measured using an automatic leaf area meter, and the average leaf area per plant was calculated. The leaf area index was determined using the following formula:

$$\text{Leaf Area Index (LAI)} = \frac{\text{Leaf Area}}{\text{Ground Area}}$$

Dry Matter Accumulation (gm^{-2})

The matter production was recorded at 30 days interval from 30 DAS to maturity by selecting 5 plants each time and average dry matter production per plants was workout. This was multiplied by the average number of plant/m^2 to obtain the dry matter production/m^2.

Statistical analysis of variance (ANOVA) of the experiment was carried out using Excel work sheet.

RESULTS AND DISCUSSION

Crop Phenology

The time durations from sowing to emergence, CRI, tillering, jointing, ear head emergence, 50 % flowering, milking, dough and harvest maturity of wheat varieties under different date of sowings in both the year are given in Table 1 and 2. The information provided in Tables indicate that days taken for emergence increased gradually from 6 days to 7 days when the sowing was delayed from 15th November to 15th December at 15 days interval. Across different date of sowing, various varieties showed minimal variation in the time required for emergence. The occurrence of phenological events in wheat crop was influenced by the different date of sowings. In comparison to other sowing treatments, the D1 crop sown on November 15th took longer duration to reach flowering, milking, and physiological maturity. This resulted from delayed sowing, which raised the temperature throughout the middle and late stages and shortened the length of the reproductive phases.

However days for these phenological events varied from variety to variety due to their distinct response to different date of sowing. It can be seen that the highest effect of thermal stress on phenological stages was observed in WB2 variety. The least effect of thermal stress was observed in K9423 (4 days) and followed by K1317 (6 days). Similarly duration of other phenological events decreased to a considerable extent in delayed sowing of 15 December as compare to sowing on 15 November. Singh *et al*. 2018 repoted that phenophases of crop affects by date of sowing.

Plant Height (cm)

The plant height of the different varieties at 15 days intervals from 15 days after sowing (DAS) to harvest has shown in Table 3 and 4. It can see from the table that at 15 DAS, D1 shows significantly higher plant height (15.63 cm) as compared to D3 while at par with D2 was significantly higher than the D3. In D1 (15th

November) sown wheat, plant height attained a maximum of 89.1 cm at harvest stage in *Rabi* 2021-22, whereas, this length was 87.7 cm in the next year crop. But under late sown (1st December) condition, the maximum height of wheat crop was only 88.2 cm and 86.6 cm in 2021-22 and 2022-23, respectively. This was most likely caused by the early-sown crop having a longer growing season than the later-sown crop. This proved that the wheat plant is responding to the timing of seeding. These results were also corroborated by Shahzad *et al.* reported that the plant height decreased with delay in sowing.

Significant difference was observed in varieties in plant height at 30 DAS. Highest plant height (24.9cm) was recorded in WB2 followed by K1317 (22.5cm) and K9423 (22.5cm) respectively. At 60 DAS, significantly highest plant height 60.88 cm was recorded in WB2 variety as compared to K9423 (51.7cm) while it was at par with K1317 (51.2cm). Significant difference was found in different cultivars at 90 DAS & maturity. At 90 DAS, highest plant height was recorded in WB2 (93 cm) followed by K1317 (91 cm) and K9423 (81.5 cm) respectively. Similarly, highest plant height was observed in WB2 (92.1, 90 cm) & lowest in K9423 (81.2, 80 cm) at maturity stage both the years.

Table 1: Effect of sowing dates and varieties on occurrence of different Phenophases (days after sowing) of wheat during 2021-2022

Treatment	Emer	CRI	Tillering	Jointing	Booting	Heading	Milking	Dough	Physiological maturity
Date of Sowing									
D1	7	21	43	62	73	83	95	107	118
D2	7	21	42	61	72	82	93	106	116
D3	7	21	42	60	71	82	92	104	115
Varieties									
Wb2	7	21	45	65	78	89	102	115	126
K1317	7	21	43	63	75	86	97	110	122
K9423	6	21	39	55	63	72	81	92	102

Table 2: Effect of sowing dates and varieties on occurrence of different Phenophases (days after sowing) of wheat during 2022-2023

Treatment	Emer	CRI	Tillering	Jointing	Booting	Heading	Milking	Dough	Physiological maturity
Date of Sowing									
D1	7	21	44	63	74	84	96	108	119
D2	7	21	43	62	73	83	94	107	117
D3	6	21	42	61	72	83	93	105	116
Varieties									
Wb2	7	21	45	66	79	90	103	116	127
K1317	7	21	44	64	76	87	98	111	123
K9423	6	21	39	55	63	73	82	93	103

Table 3: Effect of sowing dates and varieties on plant height (cm) of wheat during 2021-2022

Treatment	15 DAS	30DAS	45DAS	60DAS	75DAS	90DAS	Harvest Maturity
Date of Sowing							
D1	15.6	24.6	40.3	56.8	71.1	89.9	89.1
D2	15.1	23.7	38.3	54.6	67.6	88.6	88.2
D3	14.2	21.7	34.7	52.4	64.4	86.8	86.4

SEm±	0.09	0.11	0.23	0.29	0.37	0.49	0.29
CD at 5%	0.33	0.39	.82	1.11	1.32	1.74	1.04
Varieties							
Wb2	15.7	24.9	42.3	60.9	72.3	93.1	92.1
K1317	14.8	22.6	35.8	51.2	65.4	91.0	90.4
K9423	14.5	22.6	35.3	51.7	65.4	81.5	81.1
SEm±	0.062	0.147	0.217	0.271	0.367	0.61	0.61
CD at 5%	0.18	0.44	0.65	0.89	1.1	1.82	1.83

Table 4: Effect of sowing dates and varieties on plant height (cm) of wheat during 2022-2023

Treatment	15 DAS	30DAS	45DAS	60DAS	75DAS	90DAS	Harvest Maturity
Date of Sowing							
D1	15.1	24.3	39.8	55.9	70.6	87.9	87.7
D2	14.7	23.2	38.1	54.2	67.3	86.7	86.6
D3	13.9	21.2	34.3	51.8	63.9	86.2	85.8
SEm±	0.03	0.06	0.30	0.28	0.30	0.63	0.56
CD at 5%	0.13	0.23	1.07	1.12	1.04	2.23	NS
Varieties							
Wb2	15.2	24.5	41.8	60.3	71.9	91.2	90.6
K1317	14.5	22.6	35.5	50.6	64.8	90.0	89.4
K9423	14.2	22.6	34.8	51.1	65.0	80.6	80.0
SEm±	0.051	0.117	0.215	0.295	0.393	0.478	0.564
CD at 5%	0.15	0.35	0.64	1.11	1.18	1.43	1.69

Table 5: Effect of sowing dates and varieties on LAI of wheat during 2021-2022

Treatment	30DAS	60DAS	90DAS
Date of Sowing			
D1	0.94	2.84	4.25
D2	0.93	2.78	3.99
D3	0.90	2.61	3.69
SEm±	0.003	0.016	0.026
CD at 5%	0.009	0.055	0.09
TS	S	S	S
Varieties			
Wb2	0.95	2.84	4.14
K1317	0.92	2.74	3.83
K9423	0.90	2.64	3.63
SEm±	0.004	0.014	0.024
CD at 5%	0.011	0.042	0.072

Table 6: Effect of sowing dates and varieties on LAI) of wheat during 2022-2023

Treatment	30DAS	60DAS	90DAS
Date of Sowing			
D1	0.94	2.83	4.15
D2	0.92	2.77	3.92
D3	0.90	2.61	3.55

SEm±	0.002	0.013	0.024
CD at 5%	0.007	0.046	0.085
Varieties			
Wb2	0.94	2.84	4.04
K1317	0.92	2.73	3.73
K9423	0.90	2.63	3.53
SEm±	0.004	0.015	0.19
CD at 5%	0.012	0.045	0.58

Table 7: Effect of sowing dates and varieties on dry matter accumulation (g/m^2) of wheat during 2021-2022

Treatment	30DAS	60DAS	90DAS	At harvest
Date of Sowing				
D1	149.7	405.1	727.2	1007.5
D2	141.7	391.3	715.8	1002.2
D3	139.8	388.63	706.9	998.5
SEm±	0.482	3.257	3.178	1.79
CD at 5%	1.702	11.491	11.213	6.33
Varieties				
Wb2	119.8	329.6	665.9	1017.8
K1317	106.8	317.8	656.8	1015.2
K9423	204.6	537.7	827.2	975.2
SEm±	0.723	2.008	5.296	5.34
CD at 5%	2.164	6.012	15.858	16.01

Table 8: Effect of sowing dates and varieties on dry matter accumulation (g/m^2) of wheat during 2022-2023

Treatment	30DAS	60DAS	90DAS	At harvest
Date of Sowing				
D1	148.8	403.9	726	1006.1
D2	140.8	390.7	715.1	1001.1
D3	138.88	387.44	729.5	997.4
SEm±	1.153	2.042	3.389	6.485
CD at 5%	4.069	7.205	NS	NS
Varieties				
Wb2	118.8	328.1	664.6	1016.3
K1317	106.2	316.9	656.1	1014.2
K9423	203.4	536.7	849.9	973.9
SEm±	1.107	1.329	3.891	5.952
CD at 5%	3.315	3.978	11.65	17.821

Leaf Area Index

Among the three date of sowings, D1 (15th November) crop recorded maximum LAI production during all the phenophases. LAI were recorded at par in D2, lowest under D3 crop. The maximum LAI was recorded at 90 DAS D1 (4.25 and 4.15) and lowest under D3 (3.69 & 3.55) date of sowing in the both the years, respectively (Tables 5 and 6). This may be because D1 sown crops have a longer growing period offered to them than other sown dates. Comparable results are confirmed by Jat et al. and Alam et al. (2013).

Changes in temperature also affect the varietal characteristics. The maximum leaf area index was recorded in WB2 (4.14 and 4.04) and lowest leaf area index was recorded in K9423 (3.63 and 3.53) in both the years,

which were significantly higher than the rest of the varieties.

Dry Matter Accumulation (gm^{-2})

Three thermal regimes differ significantly in producing dry matter at all the phenophases. Consequently, the maximum dry matter (gm^{-2}) was recorded at physiological maturity during both the years. The highest dry matter was obtained in treatment D1 (1007.5 and 1006.1 gm^{-2}) followed by D2 (1002.2 and 1001.1 gm^{-2}) while the lowest in D3 (998.5 and 997.4 gm^{-2}) during the year 2021-22 and 2022-23, respectively. However, during 2021-22 accumulated dry matter was more as compared to 2022-23 in all the phenophases. Higher temperatures during the D1 crop caused early germination, which increased the number of plants and, additionally, ensured increased production of dry matter. These results are further supported by the findings of Dalirie et al., Reddy et al. and Additionally, Schwarte et al. verified that delayed sowing lowers the generation of dry matter.

Among the different varieties, Wb2 consistently exhibited the highest dry matter accumulation across all phenophases compared to K1317, K9423, and the lowest observed in K9423 during both growing years. Specifically, I4 consistently produced the highest dry matter, with values of 1017.8 and 1016.3 gm^{-2}, while I1 treatments yielded the lowest dry matter accumulation, with values of 975.2 and 973.9 gm^{-2} in the respective years.

The decline in dry matter under delayed sowing was due to the hormonal stress tolerance capacity of a particular variety to higher temperature.

CONCLUSION

In these two year studies, the maximum plant height, dry matter accumulation at harvest stage observed with 15th November. In conclusion, both sowing dates and varieties significantly influence wheat growth parameters, with date of sowing D1 and variety Wb2 generally resulting in longer durations for growth stages. These findings highlight the importance of carefully managing both temperature through date of sowing and type of variety to optimize wheat growth and development.

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