Effect of Sowing Dates and Varieties on Yield and Quality Performance of Wheat (Triticum aestivum L.)

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ABSTRACT
A field experiment conducted during Rabi season of 2017-18 at wheat research farm of CCS Haryana Agricultural University, Hisar, India to study the effect of sowing dates and varieties on yield and quality performance of wheat (Triticum aestivum L.). The experiment was laid out in split plot design with three replications containing four sowing dates viz. 5th November, 25th November, 15th December and 5th January as main plot treatments and seven wheat varieties i.e. HS 562, HD 2967, HD 3086, HI 1544, MACS 6222, WR 544 and WH 1105 as sub plot treatments. On the basis of one year study it was concluded that among sowing dates, 5th November sowing is the most economical and suitable than rest of the sowing dates. 5th November sown crop recorded significantly longer spike (11.7 cm), higher number of effective tillers (98.3 per mrl), grains per spike (48.6), test weight (39.9 g), grain appearance score (8.3), hectoliter weight (82.9 kg/hl), grain yield (5432 kg ha⁻¹) and harvest index (39.0%) compared to rest of the sowing dates, while highest protein content (12.9 %) was observed with 5th January sown crop. Maximum net return (Rs.54, 262 ha⁻¹) and B: C (1.73) were recorded with 5th November sowing. Among the varieties, HI 1544 recorded significantly higher number of effective tillers (94.6 per mrl), grains per spike (48.4), test weight (38.6 g), grain yield (4920 kg ha⁻¹) harvest index (39.2), grain appearance score (8.1) and hectoliter weight (82.0 kg/hl), while variety WH 1105 resulted in longer spike (11.5 cm) and WR 544 in higher protein content (12.6 %) as compared to rest of the varieties. While comparing the interaction of varieties with date of sowing, HI 1544 produced significantly higher grain higher yield (6007 kg ha⁻¹) of wheat sown at 5th November which was statistically at par with WH 1105 (5833 kg ha⁻¹) and HD 3086 (5616 kg ha⁻¹) at same date of sowing. Delayed sowing of HI 1544 from 5th November to 25th November reduced the grain yield by 9.1 per cent; to 15th of December by 21.0 per cent and to 5th January by 42.3 per cent.

Key words: Economics, Quality, Sowing dates, Wheat varieties, Yield attributes, Yield.

INTRODUCTION
Wheat (Triticum aestivum L.) is one of the major food grain crops of the world including India and India is the second largest wheat producing country after China which contributes more than 30% to the world wheat production. India produced about 97.4 million tons of wheat from an area of 30.7 million hectares with an average productivity of 3172 kg ha⁻¹ (ICAR-IIWBR, 2017). Haryana, which is one of the major wheat growing states, produced 11.5 million tons of wheat from 2.6 million hectares area with an average productivity of 4514 kg ha⁻¹ (Anonymous, 2017). Timely sowing of wheat provides optimum environment for crop growth to accumulate more biomass and finally higher grain yield. Under late sown condition wheat crop exposed to low temperature at the germination, which delayed the crop emergence, and to higher temperature at the reproductive phase leads to force maturity and resulted in reduction of the yield and yield attributes (Gupta et al., 2017). While too early sowing produced weak plants with poor root system which ultimately affected growth, yields attributes and yield of the crop adversely (Nahar et al., 2010).

Verma (2015) reported higher spike length, grains per spike and grain test weight with 11th November sowing as compared to 6th December sown crop. Singh et al. (2018) reported that under timely sown condition, wheat crop experienced prolonged favorable growth environment which resulted in higher accumulation of carbon photosynthates and ultimately enhanced the yield attributes positively. Torbica et al., (2008) expressed that sometimes early and timely sown crops, experienced low temperature before flowering stage as compared to late sown crop, which resulted in reduction of cell division and less accumulation of structural protein. However high temperature during grain filling period resulted higher accumulation of starch and less storage protein which is inversely related to carbohydrate accumulation. Kaur et al. (2010) reported that protein content of the wheat grain was higher under late sowing than timely sowing, while the hectoliter weight was higher in case of 15th November date of sowing. Also it was reported that in Hisar, delayed sowing resulted in significantly higher protein content (11.7 per cent) followed by early sowing (10.5 per cent) and the lowest protein content (10.4 per cent) was observed under normal date of sowing (Anonymous, 1993). Jat et al. (2013) and Eslami et al. (2014) reported higher amount of total protein with late sowing, due to higher temperature during grain filling period which induced higher nitrogen accumulation than photosynthates. In similar
trends, Waheddullah et al. (2018) reported that under delayed sown crop, maximum grain protein content and minimum hectoliter weight and grain appearance score were obtained.

Improper selection of varieties also affects crop yield because performance of varieties vary correspondingly with their genetic potential and adaptable environment, so there is scope for increasing yield of wheat with cultivation of climate resilient varieties (Hussain et al., 2012). Different genotypes have evolved various mechanisms to cope up with heat stress which are rolling, shedding and thickening of leaves, reduction in leaf size, short duration of growth period and transpirational cooling (Wahid et al., 2007). Wheat yield can be increased 10 to 80% through proper selection of sowing time and suitable cultivars (Coventry et al., 2011). Keeping the above facts in consideration, the current experiment was conducted in Rabi season of 2017-18 to study the effect of sowing dates and varieties on yield and quality performance of wheat (Triticum aestivum L.).

MATERIALS AND METHODS

The field experiment was conducted during Rabi season of 2017-18 at wheat research farm of CCS Haryana Agricultural University, Hisar, which is located at 29.09°N latitude and 75.46°E longitude in western Haryana with an elevation of 215 m above mean sea level. The experiment was laid out in split plot design with three replications containing four sowing dates viz. 5th November, 25th November, 15th December and 5th January as main plot treatments and seven wheat varieties viz. HS 562, HD 2967, HD 3086, HI 1544, MACS 6222, WR 544 and WH 1105 as sub plot treatments. Details of varieties are given in Table 1.

The experimental field soil was sandy loam in texture having 128 kg ha⁻¹, 18.5 kg ha⁻¹ and 243 kg ha⁻¹ nitrogen, phosphorus and potassium, respectively. Field was prepared on 5th November by two ploughing with harrow followed by cultivator and planking after pre-sowing irrigation and first sowing was done on the same day. For the rest sowing, the field was ploughed and prepared similarly on 25th November, 15th December and 5th January after application of pre-sowing irrigation. Seed of each variety at the rate of 100 kg per hectare was used in each sowing date. The seeds were sown by para method in 20 cm spaced rows in plots having the net size of 1.4m x 7.0m in each sowing dates. All agronomic practices recommend by CCHAU, Hisar were followed evenly irrespective to treatments in each sowing.

Yield attributes viz. number of effective tillers per meter row length, spike length (cm), grains per spike and grain test weight (g), quality parameters viz. grain appearance score, hectoliter weight (kg/ha) and grain protein content (%) were recorded. Grain yield was recorded by threshing of wheat bundles separately for each treatment after taking the biological weight. Economics of various treatments was calculated on the basis of approved inputs and practices cost fixed by Directorate of Farm, CCH AU, Hisar by using below formulas.

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\text{Net return} = \text{Gross return} - \text{cost of cultivation}
\]

\[
\text{B : C} = \frac{\text{Gross return (Rs./ha)}}{\text{cost of cultivation n (Rs./ha)}}
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RESULTS AND DISCUSSION

Yield performance

Yield of wheat crop is directly related to yield attributes of the crop. Higher the values of the yield attributes more will be the crop yield. Sowing dates influenced significantly yield attributes and yield of the crop (Table 2). Among the sowing dates, 5th November sown crop resulted in significantly higher yield attributes and yield. Number of effective tillers, number of grains per spike and harvest index in 5th November sowing were significantly higher than 15th December and 5th January sowings although yield attributes statistically at par with 25th November sown crop while spike length, test weight and grain yield were significantly higher with 5th November sown crop as compared to rest of the sowing dates. Reduction in number of effective tiller (per meter row length), spike length (cm), number of grains (per spike), grain test weight (g), grain yield (kg ha⁻¹) and harvest index (%) were up to 24.5, 12.8, 11.1, 18.8, 39.0 and 2.8 per cent, respectively when sowing was delayed by each 20 days interval up to 5th January compared to 5th November sowing. Higher yield attributes and yield with 5th November sowing might be due to favourable climatic condition, which prolonged vegetative as well as reproductive phases of the crop and resulted in more interception of solar radiation and translocation of assimilated photosynthates from source (leaves and stalk) to sink, which caused the plant to produce higher yield.

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**Table 1:** Details of varieties.

| Variety | Date of release | Recommended zone | Pedigree | Origin       |
|---------|-----------------|------------------|----------|--------------|
| HS 562  | 29.06.2016      | NHZ              | OASIS/SKAUZ/4°BCN/3°2°PASTOR | IARI RS, Shimla |
| HD 2967 | 10.10.2011      | Irrigated, timely sown conditions of NWPZ | ALD/COC/URES/HD2160M/HD2278 | IARI, N. Delhi |
| HD 3086 | 24.01.2014      | Irrigated, timely sown conditions of NWPZ | DBW14/HD2733//HUW468 | IARI, N. Delhi |
| HI 1544 | 08.05.2008      | Irrigated, timely sown conditions of CZ | HINDI62/BOBWHITE/CPAN 2099 | IARI RS, Indore |
| MACS 6222 | 01.04.2010   | Irrigated, timely sown conditions of PZ | HD 2189°2//MACS2496 | ARI, Pune |
| WR 544  | 05.11.2005      | Delhi state      | KALYANSONA/HD1999//HD2204/DW 38 | IARI, N. Delhi |
| WH 1105 | 10.04.2013      | Irrigated, timely sown conditions of NWPZ | MILAN/S87230//BABAX | CCS HAU, Hisar |
attributes and viable pollen which affected directly grain set up and ultimately resulted in higher grain yield. The results are in line with Kamroozaman et al. (2016), Baloch et al. (2012) and Spink et al. (2000).

Wheat varieties also varied significantly in relation to the yield attributes and yield while performance of varieties in relation to harvest index was found non-significant (Table 3). Variety HI 1544 being at par with HD 3086 resulted in significantly higher number of effective tillers, test weight and grain yield as compared to HD 2967, WH 1105, HS 562, MACS 6222 and WR 544 varieties. Variety WH 1105 recorded significantly higher spike length than HD 3086 and WR 544 but it was statistically at par with rest of the varieties. Variety HI 1544 resulted in significantly higher number of grains per spike than HS 562, MACS 6222 and WR 544 but it was statistically at par with rest of the varieties. The variation among the varieties in relation to yield attributes and yield could be due to their genetic makeup and somehow could be due to environmental conditions. The results are supported by those of Amrawat ef al. (2013), Kaur (2017) and Mahajan et al. (2018).

Interaction effect of sowing dates and wheat varieties was significant in terms of grain yield (Table 4). Variety HI 1544 being at par with WH 1105, HD 3086 and HD 2967 in 5th November sowing and with HD 3086, HD 2967, WH 1105, HS 562 and MACS 6222 in 25th November sowing resulted in significantly higher grain yield as compared to rest of the varieties in both sowings. HD 3086 resulted in significantly higher grain yield than WH 1105, HS 562 and WR 544 but at par with HI 1544, HD 2967 and MACS 6222 in 15th December sowing while the recorded grain yield with HD 3086 in 5th January sowing was statistically at par with all the varieties. All varieties resulted in significantly higher grain yield than WH 1105, HS 562 and WR 544 varieties. Variety WH 1105 recorded significantly higher spike length than HD 3086 and WR 544 but it was statistically at par with rest of the varieties. Variety HI 1544 resulted in significantly higher number of effective tillers, test weight and grain yield as compared to rest of the varieties. Which might be due to increase in temperature during growth phase of the crop and resulted in development of less leaf area which caused less interception of solar radiation and ultimately reduced photosynthesys sink and prevailing of hot wind and high temperature during grain filling period, which resulted in small and shriveled grains. The results are in line with those of Waheddullah et al. (2018) and Kuar et al. (2010). While very late sowing (5th January) resulted in significantly higher protein content as compared to rest of the sowing dates. Which might be due to increase in temperature during growth phase of the crop and resulted in development of less leaf area which caused less interception of solar radiation and ultimately reduced photosynthesys sink and prevailing of hot wind and high temperature during grain filling period, which resulted in small and shriveled grains. The results are in line with those of Waheddullah et al. (2018) and Kuar et al. (2010). While very late sowing (5th January) resulted in significantly higher protein content as compared to rest of the sowing dates.

Quality parameters of wheat grain were significantly influenced by sowing dates (Table 5). 5th November sown crop being at par with 25th November sowing date resulted in significantly higher grain appearance score (8.3) and hectolitre weight (82.9 kg/hl) as compared to rest of the sowing dates. Lower grain appearance score and hectolitre weight with late sowings might be due to lesser leaf area (source) to intercept light radiation and insufficient photosynthesis synthesis, reduced translocation of assimilates to sink and prevailing of hot wind and high temperature during grain filling period, which resulted in small and shriveled grains. The results are in line with those of Waheddullah et al. (2018) and Kuar et al. (2010). While very late sowing (5th January) resulted in significantly higher protein content as compared to rest of the sowing dates. Which might be due to increase in temperature during growth phase of the crop and resulted in development of less leaf area which caused less interception of solar radiation and ultimately reduced photosynthesys sink and prevailing of hot wind and high temperature during grain filling period, which resulted in small and shriveled grains. The results are in line with those of Waheddullah et al. (2018) and Kuar et al. (2010). While very late sowing (5th January) resulted in significantly higher protein content as compared to rest of the sowing dates. Which might be due to increase in temperature during growth phase of the crop and resulted in development of less leaf area which caused less interception of solar radiation and ultimately reduced photosynthesys sink and prevailing of hot wind and high temperature during grain filling period, which resulted in small and shriveled grains. The results are in line with those of Waheddullah et al. (2018) and Kuar et al. (2010). While very late sowing (5th January) resulted in significantly higher protein content as compared to rest of the sowing dates. Which might be due to increase in temperature during growth phase of the crop and resulted in development of less leaf area which caused less interception of solar radiation and ultimately reduced photosynthesys sink and prevailing of hot wind and high temperature during grain filling period, which resulted in small and shriveled grains. The results are in line with those of Waheddullah et al. (2018) and Kuar et al. (2010). While very late sowing (5th January) resulted in significantly higher protein content as compared to rest of the sowing dates. Which might be due to increase in temperature during growth phase of the crop and resulted in development of less leaf area which caused less interception of solar radiation and ultimately reduced photosynthesys sink and prevailing of hot wind and high temperature during grain filling period, which resulted in small and shriveled grains. The results are in line with those of Waheddullah et al. (2018) and Kuar et al. (2010). While very late sowing (5th January) resulted in significantly higher protein content as compared to rest of the sowing dates. Which might be due to increase in temperature during growth phase of the crop and resulted in development of less leaf area which caused less interception of solar radiation and ultimately reduced photosynthesys sink and prevailing of hot wind and high temperature during grain filling period, which resulted in small and shriveled grains. The results are in line with those of Waheddullah et al. (2018) and Kuar et al. (2010). While very late sowing (5th January) resulted in significantly higher protein content as compared to rest of the sowing dates. Which might be due to increase in temperature during growth phase of the crop and resulted in development of less leaf area which caused less interception of solar radiation and ultimately reduced photosynthesys sink and prevailing of hot wind and high temperature during grain filling period, which resulted in small and shriveled grains. The results are in line with those of Waheddullah et al. (2018) and Kuar et al. (2010). While very late sowing (5th January) resulted in significantly higher protein content as compared to rest of the sowing dates. Which might be due to increase in temperature during growth phase of the crop and resulted in development of less leaf area which caused less interception of solar radiation and ultimately reduced photosynthesys sink and prevailing of hot wind and high temperature during grain filling period, which resulted in small and shriveled grains.

### Table 2: Effect of sowing dates on yield attributes and yield of wheat.

| Treatments          | Effective tillers/ mrl (No) | Spike length (cm) | Grains/spike/ (No) | Test weight (g) | Grain yield (kg ha⁻¹) | Harvest index (%) |
|---------------------|-----------------------------|-------------------|--------------------|-----------------|-----------------------|------------------|
| 5th November        | 108.4                       | 11.7              | 48.6               | 39.9            | 5432                  | 39.0             |
| 25th November       | 106.1                       | 11.2              | 46.8               | 36.7            | 5071                  | 38.7             |
| 15th December       | 100.3                       | 10.9              | 45.0               | 34.8            | 4403                  | 38.0             |
| 5th January         | 81.8                        | 10.2              | 43.2               | 32.4            | 3315                  | 37.9             |
| SEm ±               | 1.4                         | 0.1               | 0.6                | 0.3             | 95.1                  | 0.2              |
| CD at 5%            | 5.0                         | 0.4               | 2.0                | 1.2             | 335.6                 | 0.6              |

### Table 3: Effect of varieties on yield attributes and yield of wheat.

| Treatments          | Effective tillers/ mrl (No) | Spike length (cm) | Grains/spike/ (No) | Test weight (g) | Grain yield (kg ha⁻¹) | Harvest index (%) |
|---------------------|-----------------------------|-------------------|--------------------|-----------------|-----------------------|------------------|
| HS 562              | 94.8                        | 11.5              | 45.3               | 34.2            | 4434                  | 37.8             |
| HD 2967             | 101.3                       | 11.3              | 48.4               | 36.6            | 4697                  | 38.6             |
| HD 3086             | 105.0                       | 10.7              | 47.7               | 38.4            | 4842                  | 39.0             |
| HI 1544             | 105.6                       | 11.2              | 47.8               | 38.6            | 4920                  | 39.2             |
| MACS 6222           | 94.4                        | 11.3              | 45.3               | 35.2            | 4513                  | 38.8             |
| WR 544              | 91.3                        | 9.8               | 38.5               | 33.0            | 3838                  | 37.0             |
| WH 1105             | 101.5                       | 11.5              | 48.3               | 35.8            | 4645                  | 38.4             |
| SEm ±               | 1.2                         | 0.1               | 0.5                | 0.3             | 71.9                  | 0.8              |
| CD at 5%            | 3.5                         | 0.3               | 1.4                | 1.0             | 205.2                 | NS               |
Effect of sowing dates and varieties on yield and quality performance of wheat (*Triticum aestivum* L.)

Table 4: Interaction effect of sowing dates and wheat varieties on grain yield (kg ha⁻¹).

| Varieties | Sowing dates | 5⁻th November | 25⁻th November | 15⁻th December | 5⁻th January | Mean |
|-----------|--------------|---------------|----------------|----------------|--------------|------|
| HS 562    |              | 5320          | 5065           | 4204           | 3146         | 4434 |
| HD 2967   |              | 5510          | 5395           | 4578           | 3306         | 4697 |
| HD 3086   |              | 5616          | 5401           | 4830           | 3520         | 4842 |
| HI 1544   |              | 6007          | 5463           | 4745           | 3466         | 4920 |
| MACS 6222 |              | 5412          | 5027           | 4483           | 3129         | 4513 |
| WR 544    |              | 4330          | 4068           | 3660           | 3296         | 3838 |
| WH 1105   |              | 5833          | 5078           | 4323           | 3344         | 4645 |
| Mean      |              | 5432          | 5071           | 4403           | 3315         |      |

Factors: Sowing dates, Varieties

Varieties at same level of sowing dates: 25.17, 205.2

Sowing dates at same level of varieties: 163.7, 504.2

Table 5: Effect of sowing dates and varieties on quality and economics of wheat.

| Treatments     | Grain appearance score | Hectolitre weight (kg/ha) | Protein content (%) | Gross return (Rs/ha) | Net return (Rs/ha) | B : C |
|----------------|------------------------|----------------------------|---------------------|----------------------|--------------------|-------|
| Sowing dates   |                        |                            |                     |                      |                    |       |
| 5⁻th November | 8.3                    | 82.9                       | 9.6                 | 129,114              | 54,262             | 1.73  |
| 25⁻th November| 8.0                    | 81.6                       | 10.5                | 121,103              | 46,750             | 1.63  |
| 15⁻th December| 7.6                    | 79.2                       | 11.4                | 106,025              | 31,673             | 1.43  |
| 5⁻th January  | 7.0                    | 77.8                       | 12.9                | 79,967               | 6,115              | 1.08  |
| SEm ±         | 0.1                    | 0.9                        | 0.1                 | 2,262                | 2,262              | 0.03  |
| CD at 5%      | 0.3                    | 3.0                        | 0.4                 | 7,978                | 7,978              | 0.11  |
| Varieties     |                        |                            |                     |                      |                    |       |
| HS 562        | 7.4                    | 79.6                       | 10.4                | 107,135              | 32,782             | 1.44  |
| HD 2967       | 7.8                    | 80.8                       | 11.2                | 112,103              | 37,785             | 1.51  |
| HD 3086       | 8.1                    | 81.2                       | 10.7                | 114,834              | 40,482             | 1.54  |
| HI 1544       | 8.1                    | 82.0                       | 10.3                | 116,886              | 42,515             | 1.57  |
| MACS 6222     | 7.5                    | 79.8                       | 11.1                | 107,557              | 33,204             | 1.45  |
| WR 544        | 7.1                    | 78.8                       | 12.6                | 93,602               | 19,249             | 1.26  |
| WH 1105       | 7.8                    | 80.5                       | 11.5                | 111,233              | 36,881             | 1.49  |
| SEm ±         | 0.1                    | 1.4                        | 0.1                 | 1,428                | 1,428              | 0.02  |
| CD at 5%      | 0.3                    | NS                         | 0.3                 | 3,558                | 3,558              | 0.05  |

Economics

Gross return, net return and benefit cost ratio (B: C) were significantly influenced by sowing dates (Table 5). Among sowing dates, 5⁻th November sown crop resulted in significantly higher gross return as compared to 25⁻th November, 15⁻th December and 5⁻th January sowings while in case of net return and B: C ratio, 5⁻th November sown crop being at par with 25⁻th November sowing resulted in significantly higher net return and B: C as compared to rest of the sowing dates. 5⁻th November sown crop recorded 38.1, 88.7 and 37.3 percent higher gross return, net return and B: C compared to 5⁻th January sown crop. Mukherjee (2012) reported higher gross return, net return and B: C with early sowing as compared to late sown crops.

Varieties significantly influenced gross return, net return and B: C (Table 2). Variety HI 1544 being at par with HD 3086 resulted in significantly higher gross return, net return and B: C as compared to rest of the varieties which might be attributed to high yielding ability of the variety. The results are supported with those of Verma et al. (2015) and Bachhao et al. (2018).

**Conclusion**

Based on one year research study it was concluded that 5⁻th November is the best sowing time for wheat crop to obtain higher yield, quality (except protein content) and economic returns. Among varieties, HI 1544 performed best in terms of yield and economic returns. All varieties resulted in significantly higher grain yield with 5⁻th November sowing as compared to 15⁻th December and 5⁻th January sowings but it was at par with 25⁻th November sowing except in case of HI 1544 and WH 1105.
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