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# Response of different wheat genotypes to different sowing time in relation to GDD accumulation

K.M. DESHMUKH, S.K. NAYAK[2], RUPALI DAMDAR[1] AND S.S. WANJARI[1]

AUTHORS' INFO
**Associated Co-author :**
[1]Department of Agronomy, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, AKOLA (M.S.) INDIA

[2]Department of Agronomy, Vasantrao Naik Marathwada Krishi Vidyapeeth, PARBHANI (M.S.) INDIA

**Author for correspondence:**
**K.M. DESHMUKH**
Department of Agronomy, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, AKOLA (M.S.) INDIA

**A**BSTRACT : An experiment on response of different wheat genotype to different sowing time in relation to GDD accumulation was carried out in *Rabi* season of 2010-11 at the research field of Wheat Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola (M.S.). The treatments consisted of two sowing dates 45th MW, 48th MW and twenty wheat genotypes AKDW-4021, AKDW-2997-16, AKDW-4749, AKDW-4750, AKDW-4132-2, AKDW-3931-2, HD-2189, HIDW-295, NIAW-34, AKAW-4627, LOK-1, MACS -1967, AKAW-3997, AKAW-4073, AKAW-4210-6, AKAW-4493, AKAW-4705, AKAW–4731, AKAW–4636 and AKAW-4739. The experiment was laid out in a Factorial Randomized Blocked Design with three replications. The soil was clayey with pH 7.89 containing N-206.00, P-15.86 and K- 303.43 kg $ha^{-1}$ value after harvest. The growth, yield attributes and yield observations showed significant increase when wheat crop was sown at 45th MW than 48th MW. Grain yield obtained was significantly higher at 45th MW sowing. Wheat crop sown at 48th MW required significantly lower cumulative growing degree days (GDD) and helio thermal units for completion of reproductive phase than 45th MW sown crop. Correlation studies reveal that correlation between straw yield and bright sunshine hours found to be significant showing the negative correlation and correlation between straw yield and relative humidity was observed to be significant showing the positive correlation. Sowing of wheat crop at 45th meteorological week was recorded most economical under different date of sowing condition.Out of genotypes, AKAW- 4647 was superior over others in respect of tillers $m^{-2}$, chlorophyll content $plant^{-1}$, dry matter accumulation $plant^{-1}$, number of grains $earhead^{-1}$, yield per day per plant (g), rate of grain filling, grain yield (q $ha^{-1}$), straw yield (q $ha^{-1}$) and test weight.

**K**EY **W**ORDS : Genotypes, Sowing time, Wheat

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The main species of wheat are common wheat (*Triticum aestivum* L.), durum wheat (*Triticum durum* Desf.), emmer wheat (*Triticum dicoccum Schrank*). It is grown across a wide range of environments around the world and has the highest adaptation among all the crop species. Worldwide more land is devoted to the production of wheat than any other crop. Wheat is rich source of protein, minerals and vitamins among all the cereals. It contributes about 60 per cent of daily protein requirement and more calories to world human diet than any other food crops (Mattean *et al.*, 1970). In India, more than 80 per cent of the total

area of wheat is under *Triticum aestivum* L. whereas the area under *Triticum durum* Desf. and *Triticum dicoccum* Schrank is only 12 per cent and one per cent, respectively. In India wheat is second important food crop next to rice. It is the crop that brought the green revolution and paved the way for the food security in India. It contributes about 25 per cent of the total food grain production of the India. Wheat is grown all over the India from sea level up to the elevation of 3568 meters in the Himalaya (*Rao et al.,* 1992). This is primarily due to rising of temperature in late February coinciding with heading which adversely influences grain filling. The adverse effect of temperature could be minimized by adjusting sowing time to an optimum date to ensure high grain yield. Therefore, the study was undertaken to estimate the performance of some wheat genotypes particularly under late sown condition and to evaluate the losses or reduction in yield and different yield attributes due to delayed sowing of wheat. Attempts were also made to identify genotypes with lower rate of decline in yield and different physiological parameters and, therefore, more capable germplasm tolerate late heat without substantial loss in grain yield (Chowdhury and Wardlaw, 1978). Wheat has relatively high content of 'niacin' and 'thiamine'. It contains the characteristics substance 'gluten' which helps in providing structural framework for the spongy cellular structure of bread, chapatti and other baken products of bakery.

## RESEARCH PROCEDURE

The experiment was conducted on wheat at farm of Wheat Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during *Rabi* 2011. The experimental soil was medium black having initial status of 215.15 kg N $ha^{-1}$, 16.72 kg P $ha^{-1}$ and 327.22 kg K $ha^{-1}$. The experiment was laid out in a Factorial Randomized Block Design with three replications. Two sowing dates *viz.*, November 45$^{th}$ MW and December 48$^{th}$ MW as first factor and second factor consisting of twenty genotypes *viz.*, AKDW-4021,A KDW-2977-16, AKDW-4749, AKDW-4750, AKDW-4132-3, AKDW-3931-2, HD-2189, HIDW-295, NIAW-34, AKAW-4647, LOK-1, MACS-1967, AKAW-3997, AKAW4073, AKAW-4210-6, AKAW-4493, AKAW-4705, AKAW-473, AKAW-636, AKAW-4739. The crop was subjected to recommended package of agronomic and plant protection practices to obtain a healthy crop.

## RESEARCH ANALYSIS AND REASONING

The findings of the present study as well as relevant discussion have been presented under following heads :

**Number of effective tillers $m^{-2}$:**

Data regarding number of effective tillers $m^{-2}$ recorded at different crop growth stages as affected by various treatments. The highest number of tillers $m^{-2}$ was observed at 60 days after sowing then it was slowed down to maturity. Number of effective tillers $m^{-2}$ was influenced significantly at all the stages of crop growth due to different sowing dates. Sowing on $D_1$ (45$^{th}$ MW) was significantly superior over $D_2$ (48$^{th}$ MW). The reduction in number of effective tillers $m^{-2}$at delayed sowing might be attributed to delayed emergence of seedlings resulted in the curtailing of the number of days available from the emergence to maturity. Similar results were reported by Randhawa *et al.* (1981); Phadanwis and Saini (1992); Nainwal and Singh (2000).At 60 DAS the genotype $G_{10}$ (AKAW- 4627) recorded significantly more number of tillers $m^{-2}$and genotype $G_{12}$ (MACS-1967) recorded significantly less numbers of tillers $m^{-2}$ among the 20 genotypes under study.

**Dry matter accumulation $plant^{-1}$ (g) :**

The mean dry matter accumulation $plant^{-1}$ continued to increase upto maturity of the crop but the increase was relatively higher only up to 90 days after sowing and then it was slowed down to maturity.The mean value of $D_1$ (45$^{th}$ MW) and $D_2$ (48$^{th}$ MW) was recorded 12.97

**Table 1 : Correlation of 48th (GDD) correlation of weather parameters with grain and straw yield**

| GDD | CRI | Tillering | Jointing | Panical | 50 % flow | Dough stage | 50% maturity | Harvesting |
|---|---|---|---|---|---|---|---|---|
| Grain yield | 0.450 | 0.564 | 0.550 | 0.584 | 0.345 | 0.209 | 0.233 | 0.177 |
| Sig. | * | * | * | * | * | * | * | * |
| Straw yield | 0.445 | 0.559 | 0.543 | 0.581 | 0.340 | 0.206 | 0.229 | 0.174 |
| Sig. | * | * | * | * | * | * | * | * |

Note: * and ** indicate significance of values at P=0.05 and 0.01, respectively

(g) plant$^{-1}$at the time of harvesting. There was favorable temperature experienced by wheat crop sown on $D_1$ (45$^{th}$ MW) during early growth or immediately after seedling emergence might have resulted in accumulation of higher dry matter. Similar results were reported by Mishra *et al.* (2003) and Kumar and Sharma (1999).At the time of harvesting genotype $G_{10}$ (AKAW-4627) recorded significantly higher dry matter accumulation plant$^{-1}$ (g). Genotype $G_{12}$ (MACS-1967) recorded significantly lower dry matter accumulation plant$^{-1}$ (g) (Table 2).

**Chlorophyll content index (%) :**

The mean chlorophyll contentindex (%) continued to increase upto 60 days after sowing and then it declined towards maturity. Different sowing dates significantly influenced the chlorophyll content index (%) at all crop growth stages. The reason for highest chlorophyll content index in timely sowing *i.e.* $D_1$ (45$^{th}$ MW) may be the enhanced vegetative development of crop. Similar results were reported by Rahman *et al.* (2009). At 60 days after sowing genotype $G_6$ (AKAW-3931-2) recorded significantly higher chlorophyll content index (%). Genotype $G_{11}$ (LOK-1) recorded significantly lower chlorophyll content index (%) (Table 2).

**Number of grains plant$^{-1}$:**

The higher number of grains plant$^{-1}$ was 161.35 recorded in $D_1$ (45$^{th}$ MW) which was significantly superior over 137.90 recorded with $D_2$ (48$^{st}$ MW) (Table 2). Delayed emergence of seedlings caused by low temperature at sowing time and early maturity due to high temperature during reproductive phase with lesser time available for expression of various phenophases particularly the process of grain filling in case of $D_2$ (48$^{st}$

**Table 2 : Response of wheat genotypes to different sowing dates**

| Treatments | No. of tillers m$^2$ (At 60 DAS) | Dry matter accumulation (g) plant$^{-1}$ | Chlorophyll content index (%)(At 45 DAS) | No. of grain plant$^{-1}$ | Yield / day/ plant (g) | Rate of grain filling (%) | Helio thermal unit (o$^c$ day hr$^{-1}$) | Test wt. (g) | Grain yield (q ha$^{-1}$) | Straw yield (q ha$^{-1}$) |
|---|---|---|---|---|---|---|---|---|---|---|
| $D_1$- 45$^{th}$MW | 644.9 | 14.00 | 26.76 | 161.35 | 0.072 | 88.01 | 15784.51 | 41.67 | 38.49 | 71.39 |
| $D_2$- 48$^{th}$ MW | 634.58 | 11.94 | 22.01 | 137.90 | 0.068 | 85.83 | 11215.57 | 38.30 | 35.35 | 63.82 |
| S.E. ± | 0.18 | 0.42 | 0.56 | 2.90 | 0.0016 | 0.32 | 245.14 | 0.34 | 0.54 | 0.64 |
| C.D. (P=0.05) | 0.52 | 1.38 | 1.34 | 8.05 | 0.0044 | 0.88 | 690.19 | 0.96 | 1.52 | 1.82 |
| **Genotypes** | | | | | | | | | | |
| $G_1$-AKDW-4021 | 628.5 | 11.92 | 28.43 | 141.83 | 0.070 | 86.16 | 14764.34 | 37.51 | 35.83 | 67.1 |
| $G_2$-AKDW-2977-16 | 638.5 | 12.88 | 24.22 | 150.67 | 0.072 | 88.33 | 13545.33 | 38.39 | 36.97 | 69.36 |
| $G_3$-AKDW-4749 | 638.5 | 12.66 | 25.42 | 144.83 | 0.072 | 87.16 | 12915.63 | 38.36 | 36.85 | 68.80 |
| $G_4$-AKDW-4750 | 636.16 | 12.24 | 29.34 | 143.50 | 0.070 | 86.83 | 14620.18 | 38.31 | 36.45 | 67.62 |
| $G_5$-AKDW-4132-2 | 642.66 | 13.24 | 31.41 | 188.50 | 0.072 | 88.33 | 11256.00 | 38.98 | 37.19 | 69.67 |
| $G_6$-AKDW-3931-2 | 624.16 | 13.54 | 32.08 | 118.67 | 0.064 | 83.83 | 14613.44 | 36.91 | 34.96 | 63.06 |
| $G_7$-HD-2189 | 628.33 | 11.98 | 21.44 | 135.17 | 0.067 | 85.33 | 14334.3 | 36.77 | 35.62 | 65.33 |
| $G_8$-HIDW-295 | 617.5 | 11.10 | 23.71 | 105.17 | 0.058 | 82.83 | 14187.30 | 34.16 | 34.51 | 60.71 |
| $G_9$-NIAW-34 | 659.5 | 15.54 | 24.09 | 188.50 | 0.079 | 90.83 | 14641.72 | 46.47 | 39.43 | 72.53 |
| $G_{10}$-AKAW-4627 | 678.66 | 16.12 | 25.27 | 216.67 | 0.081 | 91.16 | 13597.57 | 47.83 | 42.60 | 74.27 |
| $G_{11}$-LOK-1 | 650.00 | 13.52 | 18.43 | 172.17 | 0.075 | 89.50 | 12981.24 | 45.71 | 37.90 | 70.23 |
| $G_{12}$-MACS-1967 | 614.66 | 10.14 | 26.72 | 92.83 | 0.056 | 77.66 | 14051.92 | 33.74 | 33.01 | 60.21 |
| $G_{13}$-AKAW-3997 | 658.33 | 13.92 | 19.42 | 177.00 | 0.075 | 89.83 | 13743.55 | 45.79 | 38.50 | 71.00 |
| $G_{14}$-AKAW-4073 | 672.16 | 15.67 | 21.43 | 196.50 | 0.079 | 91.16 | 13643.54 | 46.80 | 40.41 | 73.20 |
| $G_{15}$-AKAW-4210-6 | 658.33 | 14.98 | 18.67 | 178.50 | 0.078 | 90.00 | 11229.80 | 46.11 | 39.24 | 72.31 |
| $G_{16}$-AKAW-4493 | 628.00 | 11.72 | 20.22 | 124.83 | 0.067 | 85.00 | 13118.74 | 36.79 | 35.04 | 64.50 |
| $G_{17}$-AKAW-4705 | 646.66 | 13.64 | 20.27 | 171.33 | 0.074 | 89.50 | 13560.40 | 42.80 | 37.64 | 70.03 |
| $G_{18}$-AKAW-4731 | 617.16 | 10.94 | 21.48 | 96.33 | 0.058 | 82.00 | 11772.41 | 33.95 | 34.15 | 60.67 |
| $G_{19}$-AKAW-4636 | 621.5 | 11.46 | 21.42 | 112.17 | 0.060 | 83.66 | 13713.98 | 35.79 | 34.62 | 62.10 |
| $G_{20}$-AKAW-4739 | 642.83 | 13.38 | 22.43 | 166.17 | | 89.33 | 13709.35 | 39.79 | 37.57 | 69.67 |
| S.E. ± | 0.58 | 1.10 | 1.63 | 9.20 | 0.0050 | 1.01 | 775.20 | 1.09 | 1.71 | 2.04 |
| C.D. (P=0.05) | 1.64 | 3.28 | 4.88 | 25.46 | 0.014 | 2.80 | 2182.57 | 3.04 | 4.82 | 5.7 |

MW), this might be the reason for lower number of grain plant$^{-1}$ in $D_2$. Similar results were reported by Nainwal and Singh (2000) and Sardana *et al.* (2005).

Significantly highest number of grains plant$^{-1}$ (216.67) was recorded in genotype $G_{10}$ (AKAW -4627) than rest of the genotypes except genotype $G_{14}$ (AKAW-407) which was found at par with it. Genotype $G_{12}$ recorded significantly lowest number of grains plant$^{-1}$ than all other genotypes excluding genotypes $G_{18}$(AKAW-4731), $G_8$ (HIDW-295) and $G_{19}$(AKAW-4739), which were found at par with each other.

**Yield per day per plant (g) :**

The higher yield per day per plant was 0.072 recorded with $D_1$ (45$^{th}$ MW) which was significantly superior over (0.068) recorded with $D_2$ (48$^{st}$ MW) (Table 2). Lesser time available for expression of various phenophases particularly the process of grain filling in case of $D_2$ (48$^{st}$ MW), this might be the reason for lower number of grain plant$^{-1}$ in $D_2$. Similar results were reported by Nainwal and Singh (2000) and Sardana *et al.* (2005). Significantly highest yield per day per plant (0.081) was recorded in genotype $G_{10}$ (AKAW -4627) that was significantly higher over rest of genotypes except $G_{14}$ (AKAW-4073) which

**Table 3 : Effect of sowing dates and genotypes on cumulative growing degree days (GDD)**

| Treatments | Effect of sowing dates and genotypes on cumulative growing degree days (GDD) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | CRI | Tillering | Late jointing | Panical initiation | 50 per cent flowering | Dough stage | 50 per cent maturity | Harvesting |
| **Factor 'A' - Sowing dates** | | | | | | | | |
| $D_1$- 45$^{th}$ MW | 350.25 | 531.10 | 618.64 | 707.70 | 906.04 | 1360.90 | 1507.10 | 1920.40 |
| $D_2$- 48$^{th}$ MW | 277.07 | 417.03 | 508.01 | 644.19 | 843.29 | 1203.40 | 1448.70 | 1632.60 |
| S.E. ± | 5.61 | 3.28 | 4.65 | 5.46 | 5.94 | 23.03 | 8.71 | 4.34 |
| C.D. (P=0.05) | 15.82 | 9.24 | 130.9 | 15.38 | 16.73 | 64.84 | 25.54 | 12.24 |
| **Factor 'B'- Genotypes** | | | | | | | | |
| $G_1$-AKDW-4021 | 298.10 | 467.13 | 561.97 | 656.45 | 866.85 | 1287.17 | 1470.02 | 1767.07 |
| $G_2$-AKDW-2977-16 | 309.88 | 472.62 | 567.90 | 674.18 | 868.62 | 1299.88 | 1480.07 | 1777.57 |
| $G_3$-AKDW-4749 | 306.03 | 469.70 | 565.90 | 669.83 | 867.83 | 1296.60 | 1477.30 | 1774.55 |
| $G_4$-AKDW-4750 | 302.77 | 469.70 | 565.90 | 662.43 | 867.20 | 1290.28 | 1476.77 | 1773.58 |
| $G_5$-AKDW-4132-2 | 311.22 | 474.87 | 568.98 | 680.57 | 872.85 | 1305.07 | 1485.32 | 1777.72 |
| $G_6$-AKDW-3931-2 | 296.80 | 451.32 | 535.85 | 654.30 | 854.05 | 1263.53 | 1439.52 | 1754.90 |
| $G_7$-HD-2189 | 297.85 | 462.93 | 546.42 | 655.75 | 866.68 | 1270.12 | 1463.25 | 1758.92 |
| $G_8$-HIDW-295 | 288.37 | 439.30 | 517.13 | 648.20 | 844.30 | 1233.27 | 1431.87 | 1739.45 |
| $G_9$-NIAW-34 | 242.25 | 430.07 | 506.00 | 636.43 | 840.20 | 971.75 | 1403.73 | 1714.23 |
| $G_{10}$-AKAW-4627 | 343.08 | 498.48 | 592.52 | 704.65 | 899.73 | 1356.27 | 1514.20 | 1809.67 |
| $G_{11}$-LOK-1 | 338.90 | 493.67 | 585.98 | 691.83 | 879.13 | 1319.05 | 1512.55 | 1798.35 |
| $G_{12}$-MACS-1967 | 351.30 | 505.70 | 596.82 | 705.78 | 900.85 | 1360.48 | 1525.48 | 1813.60 |
| $G_{13}$-AKAW-3997 | 342.50 | 498.25 | 588.92 | 698.52 | 891.72 | 1348.83 | 1513.78 | 1805.40 |
| $G_{14}$-AKAW-4073 | 342.57 | 525.62 | 617.43 | 738.18 | 966.13 | 1443.32 | 1523.38 | 1822.33 |
| $G_{15}$-AKAW-4210-6 | 296.92 | 458.93 | 538.95 | 655.27 | 858.52 | 1264.15 | 1459.58 | 1755.47 |
| $G_{16}$-AKAW-4493 | 287.58 | 437.57 | 515.58 | 642.32 | 843.30 | 1064.50 | 1428.07 | 1733.13 |
| $G_{17}$-AKAW-4705 | 334.20 | 483.32 | 580.42 | 690.67 | 878.07 | 1318.07 | 1489.48 | 1798.03 |
| $G_{18}$-AKAW-4731 | 329.62 | 483.22 | 576.85 | 684.55 | 877.73 | 1308.32 | 1489.10 | 1797.37 |
| $G_{19}$-AKAW-4636 | 361.10 | 517.40 | 608.15 | 718.83 | 904.50 | 1379.83 | 1538.20 | 1817.05 |
| $G_{20}$-AKAW-4739 | 292.17 | 441.48 | 528.82 | 650.13 | 845.03 | 1262.62 | 1436.55 | 1743.30 |
| S.E. ± | 17.77 | 10.38 | 14.71 | 17.28 | 18.80 | 72.82 | 27.56 | 13.75 |
| C.D. (P=0.05) | 50.03 | 29.23 | 41.42 | 48.66 | 52.93 | 205.04 | 77.61 | 38.72 |
| **Interaction (DxG)** | | | | | | | | |
| S.E. ± | 25.13 | 14.68 | 20.80 | 24.44 | 26.58 | 102.99 | 38.98 | 19.44 |
| C.D. (P=0.05) | - | - | - | - | - | - | - | - |
| GM | 316.29 | 474.06 | 563.32 | 675.94 | 874.67 | 1282.20 | 1477.90 | 1776.60 |

was at par with $G_{12}$ (MACS-1967). $G_{12}$ (MACS-1967) recorded significantly lowest yield (0.056) which was found statistically at par with genotypes $G_{18}$ (AKAW-473), $G_{19}$ (AKAW-636), $G_6$ (AKDW-3931-2), $G_{16}$ (AKAW-4493) and $G_1$ (AKDW-4021).

**Rate of grain filling (%) :**

The higher rate of grain filling was 88.01 recorded with $D_1$ (45$^{th}$ MW) which was significantly superior over 85.83 recorded with $D_2$ (48$^{st}$ MW) (Table 2). The rate of grain filling in timely sowing was highest which progressively lowest in late sowing. Wheat varieties differed in rate of grain filling. The average rate of grain filling was highest in timely sowing and lowest in late sowing. Particularly the process of rate of grain filling in case of $D_2$ (48$^{st}$ MW) might be the reason for lower number of grain panicalst$^{-1}$ in late sown condition. Similar results were reported by Randhawa *et al.* (1981). Significantly highest rate of grain filling was recorded in genotype $G_{10}$ (AKAW-4627) than rest of the genotypes except genotype $G_{14}$ (AKAW-4073), where was found at par with it. Genotype $G_{12}$ recorded significantly lowest rate of grain filling than all other genotypes excluding genotypes $G_{18}$(AKAW-473), $G_8$ (HIDW-295) and $G_{19}$ (AKAW-4739), which were found at par with each other.

**Helio thermal unit ($^0$C day hr$^{-1}$) :**

There was significant difference in helio thermal units at harvesting stage. Sowing on $D_1$ (45$^{th}$ MW) had recorded 15784.51 helio thermal units significantly more over $D_2$ (48$^{th}$ MW) (Table 2). This could be explained by the fact that delayed sowing resulted in forced maturity of wheat because of high temperature prevailed during reproductive phase of late sown crop. Similar findings were also reported by Jat *et al.* (2003), Khichar and Niwas (2007) and Gill (2009).

Genotype $G_1$ (AKDW-4021) recorded more helio thermal units 14764.34 at harvesting stage. Genotype $G_{15}$ (AKAW-4210-6) recorded significantly lower 11229.80 helio thermal units which was statistically at par with genotype $G_5$ (AKDW-4132-3), $G_{18}$ (AKAW-473) $G_3$ (AKDW-4749), $G_{11}$ (LOK-1) and $G_{16}$ (AKAW-4493).

**Test weight (g) :**

The highest test weight 41.67 g was obtained in D1 (45$^{th}$ MW) sowing which was significantly superior over 38.30 g when sowing was done at $D_2$ (48$^{th}$ MW) sowing (Table 2).

Delayed emergence of seedlings owing to lower temperature at sowing time and forced early maturity of crop due to terminal heat stress caused by high temperature at reproductive phase might have reduced the growth period of crop and thus resulted in lower test weight in $D_2$ (48$^{th}$ MW) sowing. Similar results were reported by Nainwal and Singh (2000); Sardana *et al.* (2003) and Shirpurkar *et al.* (2008). Genotype $G_{10}$ (AKAW -4627) recorded significantly highest test weight (47.83 g) than rest of genotypes excluding $G_{14}$ (AKAW-4073), $G_9$ (NIAW-34), $G_{15}$(AKAW-4210-6) and $G_{13}$ (AKAW-3997) while later four genotypes were found statistically at par with $G_{10}$ (AKAW-4627). Genotype $G_{12}$ (MACS-1967) recorded significantly lowest test weight (33.74 g) than other genotypes whereas it was statistically at par with genotypes $G_{18}$ (AKAW-4731) and $G_8$ (HIDW-295), $G_{19}$ (AKAW-4636**)** and $G_7$ (HD-2189).

**Growing degree days :**

When wheat crop was sown in $D_1$ (45$^{th}$ MW) accumulated significantly higher GDD in crop than sown at $D_2$ (48$^{th}$ MW) as shown in Table 3, for all crop phenophases studied during the experimentation. This could be explained by the fact that delayed sowing resulted in forced maturity of wheat because of high temperature prevailed during reproductive phase of late sown crop. Similar findings were also reported by Jat *et al.* (2003); Khichar and Niwas (2007) and Gill (2009). Genotype $G_{14}$ (AKAW-4073) accumulated significantly higher GDD whereas genotype $G_9$ (NIAW-34) accumulated significantly lowest GDD for all crop phenophases like CRI, tillering, late jointing, panicle initiation, 50 per cent flowering, dough stage, 50 per cent maturity and harvesting.

**Grain yield (q ha$^{-1}$) :**

Grain yield due to sowing dates was not significantly influenced whereas numerically higher grain yield (38.49 q ha$^{-1}$) was recorded with $D_1$ (45$^{th}$ MW) sowing (Table 2). This could be explained by the fact that delayed sowing resulted in forced maturity of wheat because of high temperature that prevailed during reproductive phase of the late sown crop $D_2$ (48$^{th}$ MW). Significantly higher grain yield was obtained from timely sown $D_1$ (45$^{th}$ MW).It may be due to more contribution tendered by number of grains plant$^{-1}$, weight of grains plant$^{-1}$. Similar results were reported by Patil (2000); Sardana *et al.* (2003); Sardana *et al.* (2005) and Malik *et al.* (2007).

Genotype $G_{10}$ (AKAW-4627) recorded significantly highest grain yield (42.60 q $ha^{-1}$) which was statistically at par with $G_9$ (NIAW-34), $G_{15}$ (AKAW-4210-6) and $G_{13}$ (AKAW-4073). Genotype $G_{12}$ (MACS-1967) recorded significantly lower grain yield 33.01 q $ha^{-1}$ which was statistically at par with $G_{17}$ (AKAW-4705), $G_{19}$ (AKAW-4636) and $G_7$(HD-2189).

**Straw yield (q $ha^{-1}$) :**

The straw yield (q $ha^{-1}$) was significantly affected by different sowing dates. $D_1$ (45th MW) sowing gave the significantly higher straw yield of 71.39 q $ha^{-1}$ over 63.82 q $ha^{-1}$ when sowing was done at $D_2$ (48th MW) (Table 2). This might be due to considerable increment in tillers $m^{-1}$, chlorophyll content, leaf area, dry matter accumulation in wheat genotype was occurred when sown in $D_1$ (45th MW), which have been reported by several workers (Singh *et al.*, 1974; Pal *et al.*, 1996; Kumar *et al.*, 1998; Kumar *et al.*, 2000 and Negi *et al.*, 2003).

**Effect of genotype :**

Wheat genotype $G_{10}$ (AKAW-4627) recorded significantly highest straw yield 74.27 q $ha^{-1}$ than rest of the genotypes except $G_{14}$ (AKAW 4073) which found at par with it (Table 2). Genotype $G_{12}$ (MACS) recorded significantly lower straw yield 20.21 q $ha^{-1}$ among rest of genotypes.

**Correlation of cumulative growing degree days (GDD) with grain and straw yield:**

Data regarding correlation of cumulative growing degree days (GDD). With grain and straw yield are presented in Table 1. GDD accumulated at different phenophases did not reflected in association with grain and straw yield. Similar results were reported by Saradana *et al.* (2003).

Correlation studies reveal that correlation between GDD with grain yield and straw yield were found to be significant showing the positive correlation at all phonological stages during experiment. It was also reported earlier by Saradana *et al.* (2003).

**Conclusion :**

– Sowing during 45th meteorological week (Timely sowing) with genotype (AKAW-4627), (AKAW-4073), (NIAW-34), (AKAW-4493) and (AKAW-3997) registered significantly higher grain yield. Similarly genotype AKAW- 3997 and NIDW 295 were more suitable for sowing in 48th (Late sowing) MW.

– Correlation of growing degree days (GDD) showed significant positive correlation with grain yield and straw yield during experiment.

– Sowing of wheat during 45th meteorological week recorded higher grain and straw yield.

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