Physiological Traits Study to Identify Suitable Mustard Genotype for Late Sown Condition of Northern Part of India

Akanksha Singh Yadav, Lallu, Maharaj Singh

ABSTRACT

Background: Indian mustard (Brassica juncea L.) is a prominent seed crop grown in most of the northern part of India. It is also grown in different cropping systems where sowing time differs as per availability of vacant field prior to preceding crop. Being a rabi season (winter) crop its physiological as well as morphological developments are markedly influenced by temperature condition.

Methods: An investigation was carried out during rabi season of 2010-11 and 2011-2012 at oilseeds research farm Kanpur (UP) with 4 sowing dates (30th Sept. 11th Oct, 31st Oct.) and 5 genotypes (Kranti, Maya, PAC-437, PBR-357, Rohini) of mustard on sandy loam soil under irrigated condition to study different physiological and yield attributing characters.

Result: The results shown that among the sowing dates, 11th October registered the highest values of specific leaf weight (SLW), Crop Growth rate (CGR) estimated at 60-90 DAS, seed yield and oil content. The early sowing at 30th Sept. registered significantly lowest seed yield (1880 Kgha⁻¹) and seed oil content (38%). In case of genotypes, PAC-437 registered highest values of SLW (29.60 mg cm⁻²), NAR (113.3 mg dm⁻² day⁻¹), RGR (26.7 mg g⁻¹ day⁻¹), CGR (0.94g plant⁻¹ day) at 60-90 DAS, seed yield (2079 kg ha⁻¹). The interaction effect of sowing date × genotypes was found significant in most of the cases. Thus, the results concluded in Indian condition specially the northern part, 11th October proved to be the optimum sowing time of mustard. As far as the genotype is concerned, Kranti perform well of this date of sowing while PAC-437 proved its superiority over other genotypes as well as different sowings date of October month.

Key words: Genotype, Mustard, Sowing time, Seed quality, Yield.

INTRODUCTION

Indian mustard (Brassica juncea L.) is a prominent oil seed crop grown in most of the northern part of India. It is also grown in different cropping systems where sowing time differs as per availability of vacant field prior to preceding crop. Being a rabi season (winter) crop its physiological as well as morphological developments are markedly influenced by temperature condition. In different cropping systems, sowing of mustard varies from late September and goes up to November. Many times, early sowing of mustard failed due to high temperature while the delay in sowing shortens vegetative phase, advances flowering time, accelerates senescence, reduces seed development duration and dry matter accumulation (Dhaliwal et al. 2007). Sometime the late sowing also exposes vegetative phase to low temperature, resulting in poor and slow vegetative phase. The high temperature during grain developmental phase results poor biomass and seed yield. However, extent of influence of low as well as high atmospheric temperature varies in different genotypes of mustard. Thus, the seed yield of mustard is greatly influenced by prevailing temperature during crop period regardless of genotypes, though extent of influence varies in different genotypes.

Therefore, selection of suitable genotype for different sowing times is necessary to get the satisfactory yields under different sowing. It is why the present investigation was undertaken to study different physiological traits responsible for high temperature tolerance at grain filling stage.

MATERIALS AND METHODS

A field experiment was conducted during winter season of 2010-2011 and 2011-2012 at Oil Seed Experiment Farm, Kalyanpur (26. N, 80. E) of C S Azad University of Agriculture and Technology (26. 28’ North and 80. 24’ East), Kanpur (U.P.), India. Experimental soil was sandy loam and slightly alkaline (pH 7.7) contained 0.44% OC, 268 Kg ha⁻¹ available nitrogen, 18.3 Kg ha⁻¹ available phosphorus and 268 kg ha⁻¹ available potassium. The treatment included five genotypes of mustard viz. Kranti, Maya, PAC-437, PBR-357 and Rohini sown on four different dates viz. 30th Sept, 11th Oct, 21st Oct. and 31st October of year 2010-2011 and 2011-12. A total of 20 treatments were tested in split-plot design with sowing dates in main plots and genotypes in subplots the size of subplot is 4.05x6m which replicated thrice. The crop was
Physiological Traits Study to Identify Suitable Mustard Genotype for Late Sown Condition of Northern Part of India

fertilized @150 Kg N+ 75Kg P₂O₅ + 75Kg K₂O ha⁻¹ uniformly irrespective of treatment. Sowing of seed was done behind country plough in furrows 40 cm a part using 5 kg seed ha⁻¹ for all genotypes and sowing times. The plant spacing with in row was maintained 15 cm by thinning extra plants at the stages of 15 days after sowing. The observations on growth parameters were recorded at successive periods of crop growth. The seed yield was estimated on individual plant basis (5 sample plants) on net plot area basis (kg ha⁻¹). Growth analysis parameters viz. specific leaf weight (SLW), relative growth rate (RGR), crop growth rate (CGR) and net assimilation rate (NAR) were calculated as per formula given below. Finally, the crop was harvested at physiological maturity in different sowings while threshing was done after complete sun drying of crop bundles. The oil content in seeds was estimated with the help of ‘Soxhell’s extraction method’. All data obtained from different observations were statistically analyzed using the method suggested by Fisher (1921).

\[
SLW (mg cm⁻²) = \frac{\text{Leaf dry weight}}{\text{Leaf area}}
\]

\[
RGR (mg g⁻¹day⁻¹) = \frac{(\log_e W_2 - \log_e W_1)}{(t_2 - t_1)}
\]

Where, \( W_2 \) and \( W_1 \) indicated the dry weight plant⁻¹ at time \( t_2 \) and \( t_1 \), \( \log_e \) is the natural logarithm (Fisher, 1921).

\[
CGR (g plant⁻¹ day⁻¹) = \frac{W_2 - W_1}{t_2 - t_1}
\]

Where, \( W_2 \) and \( W_1 \) are dry weight of plants at time \( t_2 \) and \( t_1 \), respectively (Watson, 1952).

\[
NAR (mg dm⁻²day⁻¹) = \frac{(W_2 - W_1)(\log_e L_2 - \log_e L_1)}{(t_2 - t_1)(L_2 - L_1)}
\]

Where, \( W_2 \) and \( W_1 \) indicate the values of dry weight per plant at time \( t_2 \) and \( t_1 \), respectively. \( L_2 \) and \( L_1 \) indicate the leaf area per plant at their respective time. \( \log_e \) is the natural logarithm. (Gregory, 1921).

**RESULTS AND DISCUSSION**

**Growth character**

The early sown (30th Sept.) mustard varieties recorded significantly higher plant height while the other sowing date showed no significant effect on plant height as shown in (Table1). While on the other hand 30th Sept. sowing gave significantly lower values of branches plant⁻¹, leaf area and dry matter accumulation. On mean basis of both years, 11th Oct. sowing produced 5.3, 14.2 and 24.8% more branches plant⁻¹, 7.9, 17.9 and 41.1% higher leaf area plant⁻¹ and 6.3, 36.8 and 81.3% more dry matter plant⁻¹ over 21st, 31st Oct. and 30th Sept. sowings. The higher plant height attributed to higher temperature caused rapid cell division in meristematic tissues and led to taller plants (Ramesh, 2012). Maximum branches and other growth characters under 11th Oct. sowing might be attributed to the prevalence of optimum temperature during growth period. Reduced growth in later sowings beyond 11th October, might be subjected to relatively lesser time span available for plant growth. These results confirm the findings of Lallu and Dixit (2008). Among genotypes, Kranti produced significantly taller plants while other growth characters were higher in PAC-437. These are as per their genetic makeup and susceptibility to temperature adversities. These results may be supported by the findings of Awasthi et al. (2007).

**Specific leaf weight (SLW)**

The significant differences in specific leaf weight was recorded with date of sowing and genotypes (Fig 4.) Among sowing dates, significantly higher SLW was measured with 11th October followed by 21st October sowing whereas 30th September sowing registered lowest SLW at all stages of crop growth. However, the SLW increased with advancement of plant age, thus it maximized at last stage of 90 DAS during both years. At this stage, 11th October sowing registered 8.3, 17.7 and 18.9% higher SLW over 21st October, 31st October and 30th September sowings, respectively on mean basis of two years data. The maximum SLW at 11th October sowing could probably due to enhanced photosynthetic efficiency per unit leaf area under optimum sowing time. Prasad et al. (2009) also observed similar results.

Genotype PAC-437 closely followed by Kranti, recorded significantly higher SLW than all other genotypes which remained almost at par with each other. The genotype PAC-437 recorded 3.7, 6.5, 7.4 and 8.0% higher SLW than Kranti, Maya, PBR-357 and Rohini genotypes, respectively at 90 DAS in mean data of 2 years.

These results corroborate with the findings of Kalubarne and Pandey (1979). The interaction effect of sowing date × genotypes was not found significant on SLW at any stage.

**Net assimilation rate (NAR)**

The net assimilation rate recorded at two stages i.e. 30-60 DAS and 60-90 DAS showed significant differences among the genotypes and with different date of sowing (Fig 3). The genotype PBR-357 and Rohini were at par and recorded significantly higher NAR values than other genotypes at 30-60 DAS at first two sowings dates i.e. 30th Sept. and 11th Oct. While at late sowing on 31st October, difference between genotypes were non-significant. The genotype Rohini registered maximum and Kranti registered minimum NAR at 21st October sowing. At early sown (30th September) condition, genotype PAC-437 registered significantly higher NAR followed by Maya at 60-90 DAS stage. The sowings at 11th and 21st October, genotype PAC-437 recorded significantly higher NAR followed by Maya, while PBR-357 registered significantly lower NAR. These results may be explained as the resistance or susceptibility of genotypes to temperature exposure (Gregory, 1926). These results were supported by the findings of Pandey and Bose (2006).
Relative growth rate
Crop sown on 30th September recorded significantly higher RGR (Fig 2) while other sowing dates remained at par. At later stage of crop growth i.e. 60-90 DAS, treatment and their interaction influenced RGR significantly. In first and last sowings on 30th Sept. and 31st October, genotype PAC-437 registered significantly higher RGR while at 21st October sowing, Kranti recorded highest RGR. October, 11th sowing showed non-significant difference in RGR between genotypes. Almost similar trend in results was observed during both years of study. On mean basis, PAC-437 recorded highest RGR closely followed by Maya and Kranti.

Table 1: Effect of sowing dates and genotypes of mustard on growth characters.

| Sowing date | Treatments | Plant height (cm) | No. of branches plant⁻¹ | Leaf area per plant (cm) | Dry matter plant⁻¹ (g) |
|-------------|------------|-------------------|--------------------------|--------------------------|------------------------|
| 30th Sept.  | 2010-11    | 187.6             | 16.86                    | 702.5                    | 33.4                   |
|             | 2011-12    | 189.5             | 18.23                    | 711.40                   | 34.1                   |
| 11th Oct.   | 2010-11    | 183.1             | 21.17                    | 993.7                    | 61.4                   |
|             | 2011-12    | 184.0             | 22.63                    | 1001.4                   | 61.00                  |
| 21st Oct.   | 2010-11    | 182.9             | 19.78                    | 921.7                    | 57.8                   |
|             | 2011-12    | 186.8             | 21.83                    | 926.82                   | 57.32                  |
| 31st Oct.   | 2010-11    | 183.0             | 18.33                    | 842.0                    | 44.5                   |
|             | 2011-12    | 184.8             | 20.02                    | 850.94                   | 45.02                  |
| S.Ed ±      |            | 0.3               | 0.37                     | 4.9                      | 0.3                    |
| C.D. (P=0.05)|           | 0.8               | 0.91                     | 11.9                     | 0.8                    |

Genotype
Kranti       | 189.4      | 192.02           | 20.28                    | 871.5                    | 48.95                  |
Maya         | 181.2      | 182.5            | 19.87                    | 862.20                   | 49.55                  |
PAC-437      | 187.6      | 188.5            | 21.86                    | 907.55                   | 52.83                  |
PBR-357      | 183.2      | 185.6            | 18.08                    | 845.70                   | 47.48                  |
Rohini       | 179.5      | 182.6            | 17.68                    | 837.72                   | 47.73                  |
S.Ed ±       | 0.6        | 0.7              | 0.36                     | 4.9                      | 0.3                    |
C.D. (P=0.05)| 1.2        | 1.4              | 0.74                     | 10.1                     | 0.6                    |

Fig 1: Effect of sowing dates on Crop growth rate (g m⁻² day⁻¹) of mustard genotypes at successive periods of crop growth stages.
Physiological Traits Study to Identify Suitable Mustard Genotype for Late Sown Condition of Northern Part of India

Fig 2: Effect of sowing dates on Relative growth rate (mg g⁻¹ day⁻¹) of mustard genotypes at successive periods of crop growth stages.

Fig 3: Effect of sowing dates on net assimilation rate (mg dm⁻² day⁻¹) of mustard genotypes at successive periods of crop growth stage.
Physiological Traits Study to Identify Suitable Mustard Genotype for Late Sown Condition of Northern Part of India

Among sowing dates, 21st Oct. sowing closely followed by 11th Oct. registered highest RGR value. It might be the effect of soil and atmospheric temperatures experienced by crop during different growth phases under varied sowing dates. The higher RGR of PAC-437 might be associated with higher rate of photosynthesis particularly at the late stage beyond 60 DAS. The results confirm the findings of Gavit et al. (2008).

**Crop growth rate**

Sowing dates and genotypes significantly influenced the crop growth rate (CGR) at both stages but their interaction effect was found significant only at later stage of 60-90 DAS (Fig 1). Among different sowing dates, 11th Oct. recorded significantly higher CGR followed by 21st Oct sowing while 30th Sept. sowing registered significantly lowest CGR value during both the years at both stages. It might be attributed to favorable environment particularly temperature experienced at 11th Oct. Sowing which could utilize the available resources efficiently. In case of genotypes, PAC-437 registered significantly highest CGR at both stages during each year. It might be because of genetic makeup of genotype which differs in each other. These results are in agreement with the findings of Pradhan et al. (1997). The data regarding interaction effect indicated that first and last

![Image](specific_leaf_weight.png)

**Fig 4:** Effect of sowing dates on specific leaf weight (mg cm\(^{-2}\)) of mustard genotypes at successive periods of crop growth stage.

**Table 2:** Effect of sowing date on seed yield of mustard genotypes.

| Treatment | 2010-2011 | 2011-2012 |
|-----------|-----------|-----------|
|           | 30th Sept | 11th Oct  | 21st Oct | 31st Oct | Mean | 30th Sept | 11th Oct | 21st Oct | 31st Oct | Mean |
| Kranti    | 1959      | 2183      | 2093     | 1904     | 2034  | 1960      | 2185      | 2093     | 1908     | 2036  |
| Maya      | 1958      | 2130      | 2090     | 1905     | 2020  | 1854      | 2134      | 2107     | 1909     | 2001  |
| PAC-437   | 1852      | 2275      | 2103     | 2024     | 2063  | 1855      | 2278      | 2211     | 2027     | 2093  |
| PBR-357   | 1852      | 2183      | 2209     | 1971     | 2053  | 1853      | 2185      | 2132     | 1973     | 2036  |
| Rohini    | 1825      | 2077      | 2130     | 1969     | 2000  | 1829      | 2079      | 2053     | 1972     | 1983  |
| Mean      | 1889      | 2170      | 2125     | 1955     | 2000  | 1870      | 2172      | 2119     | 1957     |       |
| Factors   | D         | G         | G x (D)  | D         | G     | G x (D)   |           |          |          |       |
| S.Ed±     | 12        | 14        | 29       | 10        | 13    | 26        |           |          |          |       |
| C.D(P=0.05) | 30    | 29        | 59       | 25        | 27    | 24        |           |          |          |       |
sowings on 30th Sept. and 31st Oct with genotype PAC-437 recorded highest CGR but in other sowings, difference in CGR between genotypes were non-significant. It showed that under favorable environment with timely sown, crop genotypes made no difference in CGR, while in adverse environment of earliest and last sowings, PAC-437 proved its superiority by showing resistance to adverse environment in respect to CGR. It may be supported by NAR and RGR values also.

Yield attributes

Yield attributes were significantly influenced by sowing dates and genotypes (Table 4). Number of siliquae plant\(^{-1}\), siliqua length, seeds siliqua\(^{-1}\), 1000-seed wt. and seed wt. plant\(^{-1}\) were comparatively higher in 11th October sowing and significantly lower in 30th Sept. sowing. The delay in sowing beyond 11th Oct. reduced all yield attributes significantly, might be because of less number of branches and lower leaf area plant\(^{-1}\). More number of branches and larger leaf area might have increased the photosynthetic area which resulted in the accumulation of more photosynthates in different plant parts and their translocation from source to sink, thus yield attributes attained highest values under optimum time of sowing i.e. 11th October. These results corroborate with the findings of Archana Kumari et al. (2012). However, harvest index was not influenced by sowing dates. All sowings registered harvest index at par except 31st Oct. sowing which recorded significantly lowest harvest index. It might be because of lesser fruiting due to shortened reproductive phase of crop.

Table 3: Effect of sowing dates on seed oil content (%) of mustard genotypes.

| Treatment | Genotypes | Sowing dates | 2010-11 | | | | Significance |
|-----------|------------|--------------|---------|---|---|---|---|
| | | | | | | | |
| | | 30th Sept | 11th Oct | 21st Oct | 31st Oct | Mean | Genotypes | S.Ed± | C.D.(p=0.05) |
| Kranti | 39.0 | 42.9 | 41.3 | 40.7 | 41.0 | | | | |
| Maya | 35.3 | 41.3 | 40.7 | 39.9 | 39.3 | D | 0.2 | 0.5 |
| PAC-437 | 37.20 | 43.8 | 43.5 | 41.7 | 41.6 | G | 0.2 | 0.5 |
| PBR-357 | 36.4 | 42.9 | 42.8 | 39.9 | 40.5 | G x D | 0.5 | 1.0 |
| Rohini | 38.9 | 41.9 | 41.4 | 38.0 | 40.3 | | | | |
| Mean | 37.4 | 42.6 | 41.9 | 40.2 | | | | | |

Table 4: Effect of sowing dates and genotypes on yield attributes of mustard.

| Yield attributes of mustard | Treatments | No. of siliquae plant\(^{-1}\) | Siliqua length (cm) | Seeds siliqua\(^{-1}\) | 1000 seed weight (g) | Seed wt plant\(^{-1}\) (g) | Harvest index |
|----------------------------|-------------|-----------------------------|---------------------|---------------------|----------------------|-----------------------|----------------|
| Sowing dates | 2010-11 | 2011-12 | 2010-11 | 2011-12 | 2010-11 | 2011-12 | 2010-11 | 2011-12 | 2010-11 | 2011-12 | 2010-11 | 2011-12 | 2010-11 | 2011-12 | 2010-11 | 2011-12 | 2010-11 | 2011-12 | 2010-11 | 2011-12 | 2010-11 | 2011-12 | 2010-11 | 2011-12 | 2010-11 | 2011-12 |
| 30th Sept. | 716.3 | 709.8 | 5.7 | 5.9 | 10.5 | 10.3 | 4.7 | 4.5 | 18.2 | 18.4 | 23.2 | 24.1 | | | | |
| 11th Oct. | 882.7 | 884.7 | 7.2 | 7.4 | 12.0 | 11.8 | 5.1 | 5.1 | 25.7 | 26.2 | 23.5 | 24.9 | | | | | |
| 21st Oct. | 839.8 | 833.0 | 6.6 | 6.8 | 11.4 | 11.3 | 4.9 | 4.7 | 24.7 | 25.0 | 23.4 | 24.3 | | | | | |
| 31st Oct. | 783.5 | 786.0 | 6.2 | 6.4 | 11.5 | 11.4 | 4.9 | 4.7 | 21.0 | 21.4 | 21.1 | 21.9 | | | | | |
| S.Ed± | 4.6 | 6.4 | 0.07 | 0.12 | 0.02 | 0.06 | 0.03 | 0.02 | 0.23 | 0.44 | 0.22 | 0.42 | | | | | |
| C.D.(P=0.05) | 11.3 | 15.6 | 0.18 | 0.28 | 0.06 | 0.16 | 0.08 | 0.05 | 0.56 | 1.09 | 0.53 | 1.02 | | | | | |

Physiological Traits Study to Identify Suitable Mustard Genotype for Late Sown Condition of Northern Part of India
Among the genotypes, PAC-437 registered highest values of all yield attributes except 1000-seed weight and harvest index. Harvest index and 1000-seed weight were found significantly higher in genotype PBR-357 which is purely a genetic character. These results are in agreement with those of Archana Kumari et al. (2012).

### Yield

Sowing date and genotypes were significantly influenced seed yield (Table 2). The 11th Oct. sown crop produced significantly higher seed yield which reduced with delay in sowing. However, the earliest sown crop (30th Sept.) yielded significantly lowest biomass and seed yield. The similar situation was observed during both the years. On mean basis of 2-years data, 11th Oct. Sowing produced 2.3, 11.0 and 15.5% higher seed yield over 21st Oct., 31st Oct and 30th Sept. sowing respectively. Thus, the early sowing reduced mustard yields by greater margins over the optimum sowing date of 11th October. Such yield trends might be because of various growth and yield attributes which also behaved almost in the similar way. These results are in agreement to the findings of Pronay Bala et al. (2011).

It might be attributed to growth characters. Seed yield was also highest in genotype PAC-437 but it was significantly higher only over the seed yield of Rohini during 2010-11. However, the interaction of genotype with date of sowing showed that Kranti and Maya are good for early sowing (30th Sept) while PBR-357 is suitable for sowing at 21st while Oct 11th and 31st Oct. sowings are suitable for genotype PAC-437 and produced significantly higher seed yield. The similar results have also been observed by Archana Kumari et al. (2012). Most of the growth and yield characters were also influenced by significant interaction effect between sowing dates and genotypes. In such interactions, genotype Kranti performed better than others in 30th Sept. sowing while PAC-437on par with better performer in almost all sowing dates.

### Oil content

The crop sown on 11th Oct. contained significantly higher seed oil content over the 30th Sept. sown crop. Seed oil content also reduced significantly with delay in sowing beyond 11th Oct. during both years. The 2 years mean data showed that seeds obtained from 11th October sowing contained 0.8, 2.4 and 5.2% higher oil content than those obtained from sowings. Yadav et al. (1996) also reported similar results. Among genotypes, seeds of PAC-437 contained 0.60, 1.05, 1.25 and 2.25% more oil than the seeds of Kranti, PBR-357, Rohini and Maya genotypes, respectively. The finding was supported by Bisht (2004). These results have clearly indicated the influenced of sowing dates on oil content irrespective of the genotypes. Seed oil content was also significantly affected by sowing dates × genotypes interaction (Table 3). It showed that in earlier sowing of 30th Sept. genotype Kranti has registered significantly maximum seed oil content while in other sowings, the highest seed oil content was estimated in PAC-437 genotype. It might be attributed to better seed development of Kranti than PAC-437 in earlier sown crop on 30th Sept. as it is proved from 1000-seed weight. It is also associated with lesser heat susceptibility of Kranti genotype. These results are in agreement with the findings of Rajput et al. (1991).

### Table 5: Weather conditions of Kanpur during Rabi 2010-11 and 2011-12 seasons.

| Months          | Total rainfall (mm) | Atmospheric temperature (°C) | Relative humidity (%) | Evaporation rate monthly mean Av. (mm/day) |
|-----------------|---------------------|-------------------------------|-----------------------|--------------------------------------------|
|                 | Max.                | Min.                          | Ave.                  | Max.                                       |
|                 |                     |                               |                       | Min.                                       |
|                 |                     |                               |                       | Avg.                                       |
| **2010-2011**   |                     |                               |                       |                                            |
| September       | 204.70              | 34.40                         | 25.40                 | 29.9                                       | 92.3                                       |
| October         | 18.0                | 32.30                         | 20.70                 | 26.5                                       | 88.2                                       |
| November        | 41.90               | 27.50                         | 16.20                 | 21.85                                      | 83.7                                       |
| December        | 01.20               | 0.00                          | 0.890                 | 0.24                                       | 91.9                                       |
| January         | 00.00               | 19.40                         | 06.70                 | 0.30                                       | 89.4                                       |
| February        | 8.80                | 25.10                         | 11.30                 | 18.2                                       | 88.7                                       |
| March           | 00.00               | 31.90                         | 16.10                 | 24                                         | 75.7                                       |
| **Total**       | 274.6               | 186.7                         | 91.8                  | 149.95                                     | 609.9                                      |
| **2011-2012**   |                     |                               |                       |                                            |
| September       | 93.6                | 32.3                          | 24.5                  | 28.4                                       | 88.4                                       |
| October         | 0.0                 | 33.7                          | 17.7                  | 25.7                                       | 82.9                                       |
| November        | 0.0                 | 29.1                          | 13.0                  | 21.05                                      | 89.4                                       |
| December        | 0.0                 | 22.9                          | 6.9                   | 14.9                                       | 71.3                                       |
| January         | 56.8                | 13.5                          | 7.6                   | 10.55                                      | 92.2                                       |
| February        | 10.8                | 24.3                          | 9.1                   | 16.7                                       | 84.4                                       |
| March           | 0.0                 | 30.9                          | 13.0                  | 21.95                                      | 70.8                                       |
| **Total**       | 67.6                | 186.7                         | 91.8                  | 139.25                                     | 579.4                                      |
CONCLUSION
The above study concluded that the early down mustard crop faced high temperature resulted in poor growth due to reduced growth parameters. The reduced vegetative growth affects yield attributes and seed yield. Similarly, the late sown crop faced high temperature at grain filling and seed yield. However, the genotype Kranti performed well under late sown condition. Thus, the sowing on 11th October observed as the optimum date for sowing in the northern part of India.

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