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# HIGH TEMPERATURE EFFECT AT TERMINAL STAGE IN MUSTARD GENOTYPES

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## SUMMARY

**Twenty two promising mustard (*Brassica juncea* (L.) Czern & Coss) genotypes were sown in October and November of *rabi* 2005-06. Late sowing was done to allow high temperature exposure on mustard genotypes at seed development stage. Late sowing at terminal stage caused significant and drastic reduction in number of branches, number of siliquae, seed yield, harvest index and test weight. Maximum reduction in dry matter production at 50% flowering (64.3%), at harvest (73.7%) and in seed yield (90.3%) on secondary branches occurred in RGN-48 while number of siliquae on secondary branches in Kranti (77.7%) over normal sown plants. Significant genotypic variations were also observed for these characters. Genotypes PCR-7, SKM-9927, SKM-9928 and NPJ-93 were found tolerant to high temperature at terminal stage as these showed value of heat susceptibility index ≤ 0.5 and yield stability ratio > 70.0%. Dry matter accumulation at harvest (r=0.836) showed positive association with seed yield in mustard genotypes under late sown condition.**

***Key words:*** **Heat susceptibility index, high temperature tolerance, mustard, seed yield, yield stability ratio.**

## INTRODUCTION

In the northern belt, the recommended sowing time of Indian mustard is the middle of October, when the mean daily temperature is about 25°C. Earlier and later sowing results reduction in the potential yield. High temperature during reproduction has been reported to cause a reduction in fertility and seed yield in wheat (Saini *et al.* 1983), cowpea (Ahmed and Hall 1993) and in pea (Guilioni *et al.* 1997). Babu (1985) reported that delay of 20 days beyond October 21 results 40% yield reduction in mustard. Delay in planting resulting in high temperature during flowering caused pod abortion and lower yield in rapeseed (McGregor 1981). Delay in sowing shortens vegetative phase, advances flowering time and reduce dry matter accumulation (Thurling and Das 1980). High temperature and long photoperiods are also detrimental for siliquae and seed development of mustard (Munshi and Kumari 1994).

Growing Indian mustard under late sown condition in northern belt is getting importance under multiple cropping system. Hence, there is need to screen mustard genotypes that can yield better under late sown condition and how does high temperature exposure at terminal stage affects the total performance including biomass production, seed yield and other related traits of mustard cultivars was the main objective of the investigation.

## MATERIALS AND METHODS

Twenty two varieties of mustard [*Brassica juncea* (L.) Czern & Coss)] i.e. Varuna, RGN-48, RGN-81, SKM-9927, SKM-9928, RH-0116, RK02-03, SKM-0125, NPJ-93, SKM-0158, NPJ-92, NDRS-2001, SKM-0149, Kranti, NRCDR-2, PBR-92, PR2002-8, PBR-97, PCR-7, RM-11, RM-15 and RM-101, were sown under normal (28 October 2005) and late (25 November 2005)

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to expose the seed development stage of mustard genotypes to high temperature condition in randomized block design with three replications at Oilseed Research Farm, Kalyanpur of the C.S. Azad University of Agriculture & Technology, Kanpur. The plot size was 11.25 $m^2$ (5.0mx2.25m). The average maximum and minimum temperature during this stage was 23.7, 15.4 under normal and 30.0 and 21.9°C late sown conditions, respectively. The distance between rows and plant to plant within rows were kept at 45cm and 15cm respectively. A basal dose of 60 kg N, 40 kg $P_2O_5$ and 40 kg $K_2O$ per ha was applied in the form of urea, DAP and Muriate of Potash, respectively. The remaining 60 kg N/ha was top dressed after 35 days of sowing. Two irrigations (5 ha. cm) were given on 28 November, 23 December 2005 under normal and 25 December 2005 and 20 January 2006 late sown conditions, respectively. At maturity, three plants were harvested randomly for recording yield and yield attributes. Branches per plant and siliquae from different branches were separated, threshed and the seeds were cleaned and weighed. The harvest index was calculated using the formula of Donald and Hambline (1976). Heat susceptibility index (S) was calculated for seed yield as Fisher and Maurer (1978).

$$S = (1-Y/Yp) / (1-X/Xp)$$

Where Y = mean seed weight of a genotype in a stress environment ($D_2$), Yp = mean seed weight of a genotype in a stress free environment ($D_1$), X = mean Y of all genotype, Xp = mean Yp of all genotypes. S is the relative heat stress tolerance ($S \leq 0.5$ stress tolerant, $S>0.5$ - 1.0 moderately stress tolerant and $S > 1.0$ susceptible). Yield stability ratio (YS) was calculated by taking the ratio of seed yield under $D_2$ (late) and $D_1$ (normal) conditions as per Lewis (1954).

$$YS = (\text{Seed yield under } D_2 / \text{Seed yield under } D_1) \times 100$$

## RESULTS AND DISCUSSION

Significant reduction in dry matter accumulation at different stages, number of branches and siliqua length were recorded under late sown ($D_2$) compared to normal sown ($D_1$) sown plants (Table 1). Maximum reduction in dry matter production at 50% flowering, harvest stage and number of branches occurred in RGN-48 to the tune of 64.3, 73.7 and 71.6%, respectively while minimum reduction in these characters were recorded in SKM-9927 (7.4%), NPJ-93 (7.3%) and in SKM-9928 (8.2%) under late sown over normal sown plants. This may be because of an increasing proportion of available solar radiation is not intercepted by the reduced crop canopy (reduced green area) due to late sowing. Results of the present study are in agreement with the earlier findings of Panda *et al.* (2004) in mustard.

Among different mustard genotypes dry matter production per plant at 50% flowering and at harvest, ranged between 14.8 (SKM-9927) to 20.7g (RGN-48) and 66.7 (SKM-9928) to 133.3g (RGN-48) respectively. Likewise number of branches and siliqua length ranged from 19.0 (Varuna) to 37.3 (RGN-48) and 5.2 (RGN-48) to 7.3cm (RH-0116), respectively under $D_1$ condition. Under $D_2$ condition genotypic variation in above recorded characters varied between 7.4 (RGN-48) to 13.8g (NPJ-93), 35.0 (RGN-48, Kranti) to 85.0g (NPJ-93), 10.6 (RGN-48) to 22.4 (NPJ-93) and 4.0 (RGN-81, RM-11) to 7.0 cm (NPJ-93) respectively (Table 1). The significant variations in these characters were obviously due to their genetic potential and the environmental response under normal and late sown conditions.

Amongst the mustard genotypes number of siliquae borne on main branch, primary branches, secondary and tertiary branches and total per plant ranged between 27.0 (Kranti) to 58.7 (RGN-81), 104.3 (PBR-92) to 220.3 (SKM-0125), 151.3 (RGN-81) to 492.4 (NDRS-2001) and 328.6 (Varuna) to 692.7 (NDRS-2001) respectively under $D_1$ condition (Table 2). The number of siliquae on different branches stated above among different genotypes varied between 24.7 (PBR-97) to 41.7 (RGN-81), 82.3 (RGN-48) to 183.3 (NPJ-92), 74.7 (Kranti) to 289.0 (NPJ-93) and 197.6 (RGN-48) to 487.9 (NPJ-93) respectively under $D_2$ condition. Genotypic variations in siliquae production were also observed earlier among mustard genotypes (Kurmi 2002).

Furthermore, the adverse effect of high temperature due to late sowing was reflected in less number of siliquae on different branches among mustard genotypes (Table 2), which was also associated with reduction in the number of branches as such. Maximum reduction in siliquae production occurred on secondary and tertiary branches which varied

**Table 1.** Dry matter accumulation, number of branches and siliqua length among mustard genotypes under normal ($D_1$) and late ($D_2$) sown conditions.

| Genotypes | Dry matter (g/plant) at 50% flowering | | Dry matter (g/plant) at harvest | | No. of branches /plant | | Siliqua length (cm) | |
|---|---|---|---|---|---|---|---|---|
| | $D_1$ | $D_2$ | $D_1$ | $D_2$ | $D_1$ | $D_2$ | $D_1$ | $D_2$ |
| RGN-48 | 20.7 | 7.4 | 133.3 | 35.0 | 37.3 | 10.6 | 5.2 | 4.6 |
| RGN-81 | 15.3 | 8.4 | 125.0 | 51.7 | 26.2 | 15.0 | 6.8 | 4.0 |
| SKM-9927 | 14.8 | 13.7 | 75.0 | 60.0 | 25.0 | 21.7 | 6.3 | 6.2 |
| SKM-9928 | 15.7 | 13.0 | 66.7 | 51.7 | 22.0 | 20.2 | 6.3 | 6.3 |
| Varuna | 15.5 | 8.5 | 75.0 | 51.7 | 19.0 | 15.0 | 6.4 | 4.8 |
| RH-0116 | 20.2 | 8.8 | 116.7 | 51.7 | 28.4 | 15.6 | 7.3 | 6.6 |
| RK02-03 | 17.4 | 8.5 | 126.7 | 60.0 | 33.6 | 13.0 | 7.0 | 6.8 |
| SKM-0125 | 18.7 | 8.3 | 125.0 | 51.7 | 32.0 | 15.3 | 6.0 | 5.6 |
| NPJ-93 | 16.7 | 13.8 | 91.7 | 85.0 | 27.4 | 22.4 | 7.1 | 7.0 |
| SKM-0158 | 16.5 | 8.5 | 83.3 | 51.7 | 30.7 | 16.0 | 6.5 | 5.8 |
| NPJ-92 | 17.0 | 10.3 | 83.3 | 68.3 | 27.4 | 18.6 | 6.6 | 6.0 |
| NDRS-2001 | 19.5 | 8.3 | 126.7 | 51.7 | 32.0 | 15.7 | 6.7 | 5.4 |
| SKM-0149 | 15.7 | 10.4 | 81.7 | 60.0 | 26.0 | 15.0 | 6.4 | 6.0 |
| Kranti | 16.9 | 7.6 | 108.3 | 35.0 | 27.6 | 11.3 | 6.2 | 6.0 |
| NRCDR-2 | 18.8 | 8.6 | 125.0 | 60.0 | 34.0 | 12.0 | 6.0 | 5.7 |
| PBR-92 | 16.2 | 8.5 | 125.0 | 75.0 | 22.0 | 17.0 | 7.2 | 6.8 |
| PR2002-8 | 16.8 | 9.6 | 116.7 | 76.7 | 30.0 | 14.7 | 5.8 | 5.2 |
| PBR-97 | 16.5 | 9.7 | 100.0 | 68.3 | 28.3 | 17.0 | 7.0 | 6.0 |
| PCR-7 | 15.5 | 13.3 | 116.7 | 70.0 | 20.4 | 18.9 | 6.6 | 6.5 |
| RM-11 | 16.3 | 9.3 | 83.3 | 76.7 | 21.6 | 18.7 | 6.4 | 4.0 |
| RM-15 | 17.0 | 7.9 | 83.3 | 51.7 | 27.0 | 16.3 | 6.6 | 6.0 |
| RM-101 | 17.6 | 8.9 | 100.0 | 68.3 | 26.9 | 18.3 | 7.0 | 6.0 |
| Mean | 17.1 | 9.6 | 103.1 | 59.6 | 27.5 | 16.4 | 6.5 | 5.8 |
| CD (0.05) | G. D.<br>0.9 0.3 | G x D<br>1.3 | G. D.<br>3.7 1.1 | G x D<br>5.3 | G. D.<br>1.4 0.4 | G x D<br>2.0 | G. D.<br>0.2 0.1 | G x D<br>0.3 |

between 5.5 (SKM-9927) to 77.7% (Kranti) while on per plant basis reduction varied between 3.6 (SKM-9927) to 67.3% (RGN-48). Maximum per cent reduction in siliquae number on main branch was observed in PBR-92 and PBR-97 (42.6%), while the RGN-48 showed the highest reduction (55.1%) in siliquae number on primary branches. Interestingly PBR-92 and PBR-97 did not show any reduction in siliquae number on the primary branches. The reduction in siliquae production may be due to floral stertility caused due to high temperature exposure as this was indicated in *B. napus* by Morrison and Stewert (2002).

Seed yield significantly declined in all genotypes of mustard under late sowing (Table 3). The maximum reduction in seed yield of main branch, primary branches and secondary & tertiary branches was occurred to the tune of 70.6, 76.0 and 90.3% respectively in RGN-48. The highest reduction in seed yield/plant (More than 70%) was

**Table 2.** Number of siliquae on different branches and total per plant among mustard genotypes under normal ($D_1$) and late ($D_2$) sown conditions.

| Genotypes | Main branch | | Primary branches | | Secondary and teritary branches | | Total/plant | |
|---|---|---|---|---|---|---|---|---|
| | $D_1$ | $D_2$ | $D_1$ | $D_2$ | $D_1$ | $D_2$ | $D_1$ | $D_2$ |
| RGN-48 | 52.0 | 31.3 | 183.0 | 82.3 | 368.3 | 84.0 | 603.6 | 197.6 |
| RGN-81 | 58.7 | 41.7 | 121.6 | 94.7 | 151.3 | 83.7 | 331.6 | 220.1 |
| SKM-9927 | 33.3 | 38.7 | 138.3 | 130.7 | 204.3 | 193.0 | 375.9 | 362.4 |
| SKM-9928 | 37.5 | 41.3 | 145.7 | 129.0 | 204.3 | 187.3 | 387.5 | 357.6 |
| Varuna | 28.0 | 25.7 | 126.3 | 109.7 | 174.3 | 107.0 | 328.6 | 242.4 |
| RH-0116 | 43.0 | 39.3 | 163.0 | 129.7 | 392.3 | 121.0 | 598.3 | 290.0 |
| RK02-03 | 47.3 | 31.7 | 170.0 | 127.7 | 461.7 | 110.0 | 679.0 | 269.4 |
| SKM-0125 | 43.3 | 33.3 | 220.3 | 127.7 | 398.3 | 100.0 | 661.9 | 261.0 |
| NPJ-93 | 38.7 | 41.3 | 199.7 | 167.6 | 388.0 | 289.0 | 626.4 | 487.9 |
| SKM-0158 | 36.7 | 34.0 | 139.7 | 103.7 | 271.7 | 108.3 | 448.1 | 246.0 |
| NPJ-92 | 39.0 | 28.7 | 188.7 | 183.3 | 296.7 | 136.0 | 524.4 | 308.0 |
| NDRS-2001 | 40.3 | 36.7 | 160.0 | 120.7 | 492.4 | 117.3 | 692.7 | 274.7 |
| SKM-0149 | 38.7 | 28.7 | 157.3 | 153.3 | 260.0 | 130.0 | 436.0 | 292.0 |
| Kranti | 27.0 | 25.7 | 148.0 | 107.7 | 335.7 | 74.7 | 510.7 | 208.1 |
| NRCDR-2 | 44.7 | 33.0 | 148.0 | 117.7 | 390.0 | 102.7 | 582.7 | 253.4 |
| PBR-92 | 43.0 | 24.7 | 104.3 | 113.0 | 244.7 | 138.3 | 392.0 | 276.0 |
| PR2002-8 | 32.0 | 29.3 | 159.7 | 157.6 | 340.0 | 157.3 | 531.7 | 344.2 |
| PBR-97 | 43.0 | 24.7 | 159.7 | 160.1 | 247.0 | 122.0 | 449.7 | 306.7 |
| PCR-7 | 31.3 | 39.3 | 158.1 | 134.1 | 240.0 | 185.0 | 429.4 | 358.4 |
| RM-11 | 37.0 | 26.7 | 158.3 | 138.3 | 246.0 | 136.3 | 441.3 | 301.3 |
| RM-15 | 50.7 | 35.0 | 165.7 | 117.3 | 232.7 | 117.3 | 449.1 | 269.6 |
| RM-101 | 43.7 | 33.3 | 158.2 | 138.7 | 273.0 | 128.3 | 474.9 | 300.3 |
| Mean | 40.4 | 32.9 | 157.9 | 129.3 | 300.6 | 133.1 | 498.0 | 292.1 |
| CD (0.05) | G. D.<br>2.7 0.8 | G x D<br>3.8 | G. D.<br>8.0 2.4 | G x D<br>11.3 | G. D.<br>14.1 4.3 | G x D<br>19.9 | G. D.<br>28.0 8.4 | G x D<br>39.6 |

recorded in RGN-48, Kranti, SKM-0125, RK-02-03 and NDRS-2001 while minimum (less than 30%) was recorded in SKM-9927, SKM-9928, NPJ-93 and PCR-7 under high temperature experienced at terminal stage in late sown as compared to normal sown plants (Table 3). Earlier reports of Singh *et al.* (2001) and Srivastava and Balkrishna (2003) support finding of present study.

Genotypic differences in seed yield of main branch, primary branches, secondary & tertiary branches and total yield per plant ranged between 1.2 (Kranti) to 3.6g (RGN-81), 4.0 (PBR-92) to 9.7g (NPJ-93), 5.7 (RGN-81) to 19.4g (NDRS-2001) and 13.2 (SKM-9928) to 30.2g (RGN-48) respectively under $D_1$ condition, whereas under $D_2$ condition it varied between 0.9 (RGN-48) to 2.6g (NPJ-93), 2.3

**Table 3.** Seed yield (g) of different branches and total seed weight per plant among mustard genotypes grown under normal ($D_1$) and late ($D_2$) sown conditions.

| Genotypes | Main branch | | Primary branches | | Secondary and teritary branches | | Yield (g)/plant | |
|---|---|---|---|---|---|---|---|---|
| | $D_1$ | $D_2$ | $D_1$ | $D_2$ | $D_1$ | $D_2$ | $D_1$ | $D_2$ |
| RGN-48 | 3.0 | 0.9 | 9.6 | 2.3 | 17.6 | 1.7 | 30.2 | 4.8 |
| RGN-81 | 3.6 | 1.8 | 5.0 | 2.5 | 5.7 | 1.7 | 14.3 | 6.0 |
| SKM-9927 | 1.4 | 1.7 | 5.1 | 4.2 | 7.6 | 4.6 | 14.1 | 10.5 |
| SKM-9928 | 1.7 | 2.1 | 4.7 | 3.0 | 6.8 | 4.4 | 13.2 | 9.5 |
| Varuna | 1.6 | 1.4 | 5.1 | 3.1 | 7.0 | 2.1 | 13.7 | 6.6 |
| RH-0116 | 2.0 | 2.0 | 7.5 | 3.3 | 16.1 | 3.2 | 25.6 | 8.5 |
| RK02-03 | 2.6 | 1.7 | 8.1 | 3..0 | 17.9 | 2.9 | 28.6 | 7.6 |
| SKM-0125 | 2.5 | 1.9 | 9.5 | 2.7 | 16.8 | 2.4 | 28.8 | 7.0 |
| NPJ-93 | 2.1 | 2.6 | 9.7 | 7.0 | 13.7 | 9.1 | 25.5 | 18.7 |
| SKM-0158 | 1.6 | 1.6 | 6.1 | 2.8 | 9.8 | 2.1 | 17.5 | 6.5 |
| NPJ-92 | 1.7 | 1.7 | 9.2 | 8.1 | 9.2 | 4.0 | 20.1 | 13.8 |
| NDRS-2001 | 2.4 | 1.4 | 7.0 | 3.9 | 19.4 | 2.7 | 28.8 | 8.0 |
| SKM-0149 | 1.6 | 1.4 | 6.3 | 6.1 | 8.6 | 4.0 | 16.5 | 11.5 |
| Kranti | 1.2 | 0.9 | 6.2 | 2.8 | 13.3 | 1.2 | 20.7 | 4.9 |
| NRCDR-2 | 2.4 | 1.7 | 6.3 | 4.8 | 15.5 | 2.4 | 24.1 | 8.9 |
| PBR-92 | 2.3 | 1.9 | 4.0 | 4.5 | 9.0 | 3.8 | 15.3 | 10.2 |
| PR2002-8 | 1.8 | 1.6 | 5.2 | 5.2 | 10.5 | 4.0 | 17.5 | 10.8 |
| PBR-97 | 2.2 | 1.5 | 5.7 | 5.7 | 9.2 | 4.0 | 17.1 | 11.2 |
| PCR-7 | 1.6 | 2.5 | 5.0 | 3.8 | 7.0 | 4.3 | 13.6 | 10.6 |
| RM-11 | 1.7 | 1.3 | 5.7 | 5.4 | 8.2 | 3.8 | 15.6 | 10.5 |
| RM-15 | 2.7 | 1.7 | 7.7 | 3.9 | 8.3 | 3.0 | 18.7 | 8.6 |
| RM-101 | 2.2 | 1.4 | 6.6 | 5.2 | 9.8 | 4.0 | 18.6 | 10.6 |
| Mean | 2.1 | 1.7 | 6.6 | 4.2 | 11.2 | 3.4 | 19.9 | 9.3 |
| CD (0.05) | G. D.<br>0.2 0.1 | G x D<br>0.3 | G. D.<br>0.5 0.2 | G x D<br>0.8 | G. D.<br>0.7 0.2 | G x D<br>0.9 | G. D.<br>1.3 0.4 | G x D<br>1.8 |

(RGN-48) to 7.0g (NPJ-93), 1.2 (Kranti) to 9.1g (NPJ-93) and 4.0 (RGN-48, Kranti) to 18.7g (NPJ-93), respectively (Table 3). Genotypic differences in seed yield were also reported among mustard genotypes (Kurmi 2002).

In general, significant reduction in harvest index (HI) and test weight occurred irrespective of genotypes under $D_2$ over $D_1$ condition (Table 4). Amongst the mustard genotypes HI and test weight ranged between 11.4 (RGN-81) to 27.8% (NPJ-93), 4.0 (PCR-7) to 5.5g (NPJ-93, NDRS-2001), respectively under $D_1$ whereas above both characters varied between 10.2 (SKM-0149) to 22.0% (NPJ-93), 2.8 (RGN-48, RGN-81) to 4.2g (NPJ-93, NPJ-92) respectively under $D_2$ condition. This finding corroborate the results of Singh *et al.* (2002) in mustard.

**Table 4.** Harvest index, test weight, heat susceptibility index and yield stability ratio among mustard genotypes under normal ($D_1$) and late ($D_2$) sown conditions.

| Genotypes | Harvest index (%) | | Test weight (g) | | Heat susceptibility index | Yield stability ratio |
|---|---|---|---|---|---|---|
| | $D_1$ | $D_2$ | $D_1$ | $D_2$ | (S) | (YS) |
| RGN-48 | 22.7 | 14.0 | 5.3 | 2.8 | 1.572* | 16.2 |
| RGN-81 | 11.4 | 11.6 | 4.1 | 2.8 | 1.090* | 42.0 |
| SKM-9927 | 18.8 | 17.5 | 4.2 | 3.9 | 0.478*** | 74.5*** |
| SKM-9928 | 19.8 | 18.4 | 4.9 | 3.7 | 0.525*** | 72.0*** |
| Varuna | 18.3 | 12.8 | 5.3 | 3.9 | 0.972** | 48.2 |
| RH-0116 | 21.9 | 16.4 | 5.2 | 4.0 | 1.253* | 33.2 |
| RK02-03 | 22.6 | 12.7 | 5.3 | 3.2 | 1.377* | 26.6 |
| SKM-0125 | 23.3 | 13.5 | 5.3 | 3.7 | 1.420* | 24.3 |
| NPJ-93 | 27.8 | 22.0 | 5.5 | 4.2 | 0.501*** | 73.3*** |
| SKM-0158 | 21.0 | 12.6 | 5.1 | 3.4 | 1.180* | 37.1 |
| NPJ-92 | 24.1 | 20.2 | 4.8 | 4.2 | 0.587** | 68.7 |
| NDRS-2001 | 22.7 | 15.5 | 5.5 | 4.0 | 1.355* | 27.8 |
| SKM-0149 | 20.2 | 10.2 | 4.9 | 4.0 | 0.568** | 69.7 |
| Kranti | 19.1 | 14.0 | 3.7 | 3.3 | 1.432* | 23.7 |
| NRCDR-2 | 19.4 | 14.8 | 4.1 | 3.2 | 1.186* | 36.8 |
| PBR-92 | 12.2 | 13.6 | 4.9 | 3.8 | 0.625** | 66.7 |
| PR2002-8 | 15.0 | 14.1 | 4.4 | 4.0 | 0.719** | 61.7 |
| PBR-97 | 17.1 | 16.4 | 4.9 | 4.0 | 0.647** | 65.5 |
| PCR-7 | 11.7 | 15.1 | 4.0 | 3.6 | 0.413*** | 77.9*** |
| RM-11 | 18.7 | 13.7 | 4.5 | 3.8 | 0.614** | 67.3 |
| RM-15 | 22.4 | 16.6 | 4.4 | 3.2 | 1.013* | 46.0 |
| RM-101 | 18.6 | 15.5 | 4.8 | 4.0 | 0.806** | 57.0 |
| Mean | 19.5 | 15.1 | 4.8 | 3.7 | 0.924** | 50.7 |
| CD (0.05) | G. D.<br>0.4 0.1 | G x D<br>0.6 | G. D.<br>0.3 0.1 | G x D<br>0.5 | 0.132 | 3.6 |

* Temperature sensitive genotypes having high (S) low (YS) ** Moderately temperature tolerant
*** Temperature tolerant genotypes having low (S) high (YS)

Heat susceptibility index (S) and yield stability ratio (YS) among different mustard genotypes ranged from 0.413 (PCR-7) to 1.572 (RGN-48) and 16.2 (RGN-48) to 77.9% (PCR-7) respectively (Table 4). Genotypes SKM-9927, SKM-9928, NPJ-93 and PCR-7 showed their high temperature tolerance at terminal stage as these genotypes showed value of heat susceptibility index $\leq$ 0.5 and yield stability ratio >70.0%.

Correlation analysis (Table 5) revealed that dry matter accumulation at harvest (r=0.836), test weight (r=0.695) and number of siliquae on primary branches

**Table 5.** Relationship between seed yield and following characters in mustard sown under normal ($D_1$) and late ($D_2$) sown conditions.

| Characters | Correlation coefficient (r) with seed yield | |
|---|---|---|
| | Normal sown ($D_1$) | Late sown ($D_2$) |
| Yield vs dry matter at 50% flowering | 0.864** | 0.689** |
| Yield vs dry matter at harvest | 0.589** | 0.836** |
| Yield vs test weight | 0.507* | 0.695** |
| Yield vs number of siliquae on main shoot | – 0.348 | – 0.129 |
| Yield vs number of siliquae on primary branches | 0.660** | 0.847** |
| Yield vs number of siliquae on secondary branches | 0.838** | 0.838** |
| Yield vs number of siliquae per plant | 0.946** | 0.82** |
| Yield vs number of branches/plant | 0.824** | 0.707** |
| Yield vs harvest index | 0.669** | 0.660** |

* significant at p = 0.05 (r = > 0.422), **significant at p = 0.01 (r = > 0.536).

(r=0.847) under $D_2$ condition while dry matter production at 50% flowering (r=0.864), number of siliquae per plant (r=0.946) and number of branches per plant (r=0.824) showed positive association with seed yield under $D_1$ condition. HI and number of siliquae borne on secondary branches exhibited positive while number of siliquae on main branch showed negative association with seed yield under both the conditions. Our results are more close to Chauhan and Singh (1980).

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