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Effect of high temperature on growth and yield parameters of wheat variety

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ABSTRACT : An experiment was conducted during *Rabi*, 2006-2007 and 2007-2008 at Student Instructional Farm of Narendra Deva University of Agriculture and Technology, Narendra Nagar (Kumarganj), Faizabad. The experiment was planned under split plot design with three replications. The treatment consisted of three dates of sowing *viz*., 10th December (NS), 25th December (LS_1) and 10th January (LS_2) and fifteen varieties *viz*., Halna, Raj 3765, NW 1014, PBW 343, HD 2643, HP 1744, NW 2036, DBW 14, NW 1076, Sonalika, HD 2285, HD 2307, K 8962, UP 2425, and HP 1633. Result of the experiment revealed that growth character like plant biomass, RGR of all varieties showed and initial increase (at 30 DAS) due to late sowing, however, at later stage (90 DAS) reduced drastically number of ear plant^{-1}, ear length, number of seed ear^{-1}, test weight and biological yield were reduced drastically due to late sowing, which result is server grain yield reduction.

Key Words : RGR, Biomass, Grain yield

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Late planting of wheat in India is very common due to the wide spread intensive cropping system, which so often delays the sowing of wheat up to the middle of January, particularly in North-West India, where it is generally sown after harvest of paddy, sugarcane, pigeonpea etc. As a result a portion of maturity period of the crop is pushed forward and thus, has to phase higher temperature of the summer as well as hot spells often occurring at that time. This high temperature at the time of grain development limits the yield and quality of wheat (Alkhatib and Paulsen, 1984).

Dispite the long standing evidences for the harmful effects of high temperature on wheat yield, concerted attempts to analyse the parameters contributing yield under normal and late sown condition are meagre (Reynold *et al*., 1994; Porter and Gawith, 1999).

RESEARCH PROCEDURE

The experiment was conducted Student Instructional Farm, NDUA&T, Kumarganj, Faizabad. Three showing dates, 15th December (NS), 25th December (LS_1) and 10th January (LS_2) were used during the two seasons early sowing subjects wheat to heat stress during the early growth stage of the crop, which effect the establishment of the crop and the development of plant biomass, RGR and yield parameters. This permits differentiation of varieties according to their reaction to the early heat stress. The late sowing allows the crop to grow and mature under high temperature and the response of different genotypes to late heat stress can be assessed. Normal cultural practices were followed to raise the experiments. Irrigation was given as per the schedule to avoid any water stress. The experiment was arranged in a split plot design with three replications. Date on growth characters and yield parameters were subjected to stress related parameters *viz.*, plant biomass, RGR (Radford, 1962), number of ear plant^{-1}, ear length, number of seeds ear^{-1}, test weight, biological yield and grain yield. Pooled data were statistical analysed by the method of Fisher and Yates (1963).

RESEARCH ANALYSIS AND REASONING

Data recorded on plant biomass as influenced by late sowing have been presented in Table 1. In general, late sowing resulted in increase in plant biomass of almost all varieties at 30 DAS and 60 DAS. However, at 90 DAS, all the varieties exhibited decrease in plant biomass under both 15 days and 30 days late sowing as compared to normal sowing. At 30 days, under 15 days late sowing significant increase in plant biomass was over normal sowing was observed in PBW 343, Sonalika and K 8962. Rest of the varieties showed non-significant

increase in biomass. Under 30 days delayed sowing, all the varieties exhibited significant increase in plant biomass. At 60 DAS, under 15 days late sowing, all the varieties except K 8962 recorded non-significant increase in plant biomass over normal. However, under 30 days late sowing all the varieties showed significant increase in plant biomass over normal sowing. In contrast to above stage, at 90 DAS, significant reduction in plant biomass was observed under late over to normal sowing and magnitude of reduction was more under 30 days late sowing in comparison to 15 days delayed sowing. Under 15 days late sowing, only two varieties *viz*., Halna and Sonalika had non-significant decrease in plant biomass as compared to normal sowing, however, rest of the varieties had significant decrease. All the varieties resulted in significant decrease in plant biomass over normal sowing in both years. However, maximum plant biomass was observed in Raj 3765 followed by Sonalika and UP 2425.

The plant biomass of all varieties increased due to late sowing at 30 and 60 DAS, however, at, 90 DAS, all the varieties showed significant decrease and the magnitude of decrease was higher under 30 days late sowing in comparison to 15 days late sowing. At 90 DAS, the average plant biomass under normal sowing was 24.4 g per plant which was reduced to the tune of 15.9 and 19.5 g, 15 and 30 days late sowing, respectively. Longer growth duration of wheat plants under normal sowing provided an opportunity to accumulate more biomass as compared to late sown plant and henceforth manifested higher plant biomass. The varieties like Raj 3765, Sonalika, HD 2285 and K 8962 which had less reduction in plant biomass under late sowing also showed less reduction in maturity duration than other varieties.

RGR of all the varieties was higher between 30-60 DAS than 60-90 DAS under both normal and late sown condition. Between 30-60 DAS, RGR of all varieties was higher under both 15 and 30 days late sowing than normal sowing. In contrast to this, between 60-90 DAS all the varieties showed reduced RGR under late sowing as compared to normal sowing. 30 days late sowing caused more decrease in RGR than 15 days late sowing. Between 60-90 DAS, highest RGR was observed in Raj 3765 followed by Halna and HP 1744 under 30 days late sowing, however, HP 1633, UP 2425, HD 2307 and PBW 343 showed less RGR than other varieties. The RGR of wheat varieties was computed by using the plant biomass values observed at 30, 60 and 90 DAS. Since, the plant biomass of almost all the varieties was higher at 30 and 60 DAS and less at 90 DAS under late sowing as compared to normal sowing as a result higher RGR value of wheat varieties was higher between 30-60 DAS and less between 60-90 DAS under late sowing in comparison to normal sowing. RGR in wheat varieties under normal and late sowing has been presented in Table 2. In general, RGR of all varieties between 30-60 DAS was higher than 60-90 DAS under normal as well as late sowing conditions. Between 30-60 DAS, 15 days late sowing caused significant increase in RGR over normal sowing in variety. Significant increase was observed in varieties NW 1014, Raj 3765, NW 2036, HD 2285 and HD 2307. However, under 30 days late sowing, significant increase in RGR over normal sowing was found in HD 2643, HP 1744, NW 2036, Sonalika, HD 2285 and HD 2307. Between 60-90 DAS, in comparison to normal sowing, the late sowing for both 15 and 30 days decreased significantly the RGR of all

Table 1 : Effect of late sowing on plant biomass (g/plant) in wheat varieties at different growth intervals (2006-07 and 2007-08)

Varieties	30 DAS				60 DAS				90 DAS			
	NS	LS_1	LS_2	Mean	NS	LS_1	LS_2	Mean	NS	LS_1	LS_2	Mean
Halna	0.15	0.16	0.29	0.20	2.69	3.65	5.71	4.02	23.46	22.05	17.36	20.96
Raj 3765	0.10	0.12	0.39	0.20	2.70	3.17	5.68	3.85	27.07	22.46	18.13	22.55
NW 1014	0.11	0.12	0.21	0.15	2.16	4.77	6.38	4.44	25.17	20.13	15.10	20.13
PBW 343	0.10	0.18	0.30	0.19	2.95	3.26	6.95	4.39	22.60	16.95	13.33	17.63
HD 2643	0.13	0.17	0.30	0.20	2.96	2.52	5.33	3.60	25.88	18.90	14.23	19.67
HP 1744	0.13	0.16	0.30	0.20	2.39	3.64	4.64	3.56	22.68	16.33	13.60	17.54
NW 2036	0.11	0.13	0.20	0.15	2.99	3.66	6.55	4.40	21.14	17.96	15.22	18.11
DBW 14	0.12	0.14	0.31	0.19	2.73	3.52	6.44	4.23	18.35	15.41	12.47	15.41
NW 1076	0.14	0.15	0.30	0.20	2.40	3.77	6.50	4.22	23.91	17.15	14.58	18.55
Sonalika	0.11	0.18	0.27	0.19	2.06	3.64	9.57	5.09	23.83	21.43	18.08	21.11
HD 2285	0.18	0.18	0.27	0.21	2.86	3.74	8.06	4.89	26.36	21.08	17.39	21.61
HD 2307	0.11	0.13	0.29	0.18	2.19	3.31	7.57	4.36	22.53	17.34	13.51	17.79
K 8962	0.11	0.20	0.31	0.21	2.92	5.10	8.02	5.35	24.62	20.43	16.49	20.51
UP 2425	0.14	0.17	0.29	0.20	3.08	3.69	8.60	5.12	29.11	20.37	15.71	21.73
HP 1633	0.14	0.16	0.29	0.19	2.74	3.34	8.46	4.85	25.75	17.51	14.16	19.14
Mean	0.13	0.16	0.29		2.65	3.65	6.96		24.16	19.03	15.29	
C.D. (P=0.05)	V=0.02, S=0.02,V at S=0.05, S at V=0.05				V=0.83, S=0.69, V at S = 1.44, S at V=1.51				V=1.43, S=1.17, V at S=2.48, S at V=2.59			

Table 2 : Effect of late sowing on RGR (mg g^{-1} day^{-1}) in wheat varieties at different growth intervals (2006-07 and 2007-08)

Varieties	30-60 DAS				60-90 DAS			
	NS	LS_1	LS_2	Mean	NS	LS_1	LS_2	Mean
Halna	92.74	101.12	93.27	95.71	74.95	63.13	38.71	58.93
Raj 3765	90.26	103.10	92.11	95.16	86.76	62.06	36.88	61.90
NW 1014	90.02	106.27	97.32	97.87	84.45	48.21	29.81	54.16
PBW 343	84.57	93.30	106.75	94.87	79.38	51.52	16.22	49.04
HD 2643	79.10	90.85	102.97	90.97	98.02	65.73	30.86	64.87
HP 1744	89.48	97.23	104.28	97.00	80.71	52.09	30.53	54.44
NW 2036	80.09	93.46	104.72	92.76	77.56	53.32	27.75	52.88
DBW 14	88.19	94.14	99.85	94.06	75.42	50.44	22.51	49.46
NW 1076	91.14	93.10	94.92	93.05	79.50	53.35	25.21	52.69
Sonalika	91.66	96.54	107.63	98.61	71.59	53.97	20.58	48.71
HD 2285	90.08	105.51	105.16	100.25	90.41	56.78	22.12	56.44
HD 2307	88.54	101.09	100.46	96.70	75.36	49.89	13.66	46.30
K 8962	98.20	106.76	93.80	99.59	73.73	49.49	26.58	49.93
UP 2425	96.23	99.20	106.15	100.53	80.52	50.98	18.80	50.10
HP 1633	104.79	94.63	111.29	103.57	75.52	58.89	15.55	49.99
Mean	90.34	98.42	101.38		80.26	54.66	25.05	
C.D. (P=0.05)	V = 6.62, S=7.33, V at S = 11.46, S at V = 12.58				V = 5.47, S=4.91, V at S = 9.47, S at V = 10.02			

varieties ,highest RGR under 15 days and 30 days, late sowing was found in Raj 3765 followed by Halna, Sonalika and HP 1744.Under 30 day late sowing, decrease in RGR was higher in almost all varieties was higher.

The data regarding number of ears per plant have been presented in Table 3. The data revealed tremendous decrease in number of ears per plant due to late sowing decrease and maximum decrease was observed under 30 days late sowing in all varieties. Under 15 days late sowing, the varieties, Raj 3765, Sonalika, HD 2285 and K 8962 showed non-significant decrease in number of ears per plant over normal sowing, however, rest of the varieties had significant decrease. The per cent decrease in number of ears with respect to normal sowing ranged between 7.0-8.5 per cent in Raj 3765, 8.2-9.5 per cent in Sonalika, 6.4 per cent in HD 2285 and 6.5-9.0 per cent in K 8962. Under 30 days late sowing, the decrease in number of ears in above varieties was in order of 24.5-27.0 per cent, 24.4-24.6 per cent, 17.3-32.2 per cent and 19.7-22.1 per cent, respectively. The varieties, HP 1744, NW 1014, HP 1633, PBW 343, UP 2425, HD 2663 and NW 1076 showed greater reduction in number of ears and per cent reduction in these varieties in both years ranged from 13.5-25.6 per cent and 38.5-47.5 per cent under 15 days and 30 days late sowing, respectively.

Table 3 : Effect of late sowing on number of ears $plant^{-1}$ in wheat varieties

Varieties	2006-07 and 2007-08			
	NS	LS_1	LS_2	Mean
Halna	9.84	8.22 (16.46)	6.35 (35.46)	8.14
Raj 3765	11.09	10.30 (7.12)	8.37 (24.52)	9.92
NW 1014	11.65	9.33 (19.91)	7.17 (38.45)	9.38
PBW 343	9.88	8.54 (13.56)	5.50 (44.33)	7.97
HD 2643	10.33	8.96 (13.26)	6.29 (39.10)	8.53
HP 1744	10.36	7.89 (23.84)	6.40 (38.22)	8.22
NW 2036	10.89	9.63 (11.57)	7.84 (28.00)	9.45
DBW 14	9.48	8.05 (14.53)	5.11 (44.41)	7.55
NW 1076	7.08	5.58 (21.18)	4.90 (30.79)	6.35
Sonalika	8.18	7.51 (8.19)	6.17 (24.57)	7.29
HD 2285	10.94	10.24 (6.39)	9.05 (17.27)	10.08
HD 2307	9.47	8.08 (14.67)	6.01 (36.53)	7.85
K 8962	9.44	8.83 (6.46)	7.58 (19.70)	8.62
UP 2425	8.57	7.25 (15.40)	4.50 (47.49)	6.77
HP 1633	10.48	8.84 (15.64)	5.64 (46.18)	8.32
Mean	9.85	8.48 (13.90)	6.46 (34.41)	
C.D. (P=0.05)	V = 0.63, S=0.58, V at S = 1.10, S at V = 1.17			

Under 15 days late sowing, significant decrease in ear length over normal sowing was found in Halna, HD 2307 and UP 2425. However, under 30 days late sowing, all the varieties recorded significant decrease in ear length in both years. The reduction percentage in ear length in different varieties ranged from 1.5-24.5 and 11.3-30.4 under 15 days and 30 days late sowing, respectively. The varieties which exhibited comparatively less reduction in ear length than other varieties in both years were identified as NW 1014, Raj 3765, NW 2036, Sonalika, K 8962, HD 2285 and DBW 14. In these varieties, reduction percentage ranged from 1.5-9.7 and 10.8-21.9 under 15 and 30 days late sowing, respectively. UP 2425, HP 1633, PBW 343 and HP 1744 showed higher reduction in ear length and per cent decrease in these verities ranged between of 36 to

40.5 per cent under 30 day late sowing. Number of seeds per ear in wheat varieties under normal and late sowing has been presented in Table 4. Late sowing decreased the number of seeds per ear in all varieties and extent of decrease was more under 30 days late sowing (Table 5). Under 15 days late sowing, Raj 3765, NW 2036, HD 2285, K 8962 showed non-significant decrease in number of seeds per ear, however, rest of the varieties had significant decrease. The per cent reduction in grain number in above varieties ranged from 6.9 to 10.6 per cent under 15 days late sowing which increased to the level of 18.6 to 3 0 per cent under 30days late sowing.

Under 30days late sowing, all the varieties recorded significant decrease in number of grains per year over normal sowing and higher reduction percentage was observed in varieties, UP 2425, HP 1633, HD 2307, HP 1744, PBW 343, HD 2643 and NW 1014. These varieties exhibited reduction of about 17.0 to 26.0 per cent and 39.0 to 47.0 per cent under 15 and 30 days late sowing, respectively.

Grain yield recorded in wheat varieties under normal and late sowing have been presented in Table 6. Under normal condition, highest grain yield was observed in PBW 343 followed by NW 2036 and DBW 14, however, HD 2307 had lowest yield followed by K 8962 and HP 1633. Late sowing reduced the grain yield drastically and per cent reduction in different varieties ranged from 13.3 to 35 per cent and 32 to 59 per cent under 15 and 30 DAS. Under late sowing, increase in temperature results into forced maturity of crop which causes lesser number of tillers per plant. Similar to our findings several workers have reported reduced number of tillers in different wheat varieties on varying extent under late sown condition (Singh *et al.*, 2001; Kumar and Sharma, 2003; Negi *et al.*, 2003).

The effect of late sowing was clearly reflected in the great reduction in almost all the yield traits measured. Number of ears plant^{-1}, test weight (Table 8), ear length, number of seeds ear^{-1}, grain yield, biological yield (Table 7) and harvest index reduced significantly under late sowing and maximum reduction

Table 4 : Effect of late sowing on ear length (cm) in wheat varieties

Varieties	2006-07 and 2007-08			
	NS	LS_1	LS_2	Mean
Halna	8.30	7.16 (13.73)	6.00 (27.71)	7.15
Raj 3765	9.76	9.50 (2.66)	8.00 (18.03)	9.09
NW 1014	9.30	9.16 (1.50)	8.25 (11.29)	8.90
PBW 343	9.50	8.66 (8.84)	7.83 (17.57)	8.66
HD 2643	9.00	8.16 (9.33)	7.66 (14.88)	8.27
HP 1744	9.16	8.76 (4.36)	7.00 (23.68)	8.64
NW 2036	9.16	9.00 (1.47)	7.50 (18.12)	8.55
DBW 14	9.16	8.66 (5.45)	7.83 (14.51)	8.55
NW 1076	9.66	9.00 (6.38)	8.00 (17.18)	8.89
Sonalika	10.00	9.33 (6.70)	8.83 (11.70)	9.39
HD 2285	8.50	8.00 (5.88)	7.33 (13.76)	7.94
HD 2307	11.50	8.66 (24.69)	8.00 (30.43)	9.39
K 8962	10.33	9.33 (9.67)	8.66 (16.16)	9.44
UP 2425	13.00	10.33 (20.53)	9.50 (26.92)	10.94
HP 1633	9.83	9.33 (5.08)	7.83 (20.34)	9.33
Mean	9.74	8.87 (20.34)	8.01 (19.09)	
C.D. (P=0.05)	V = 0.55, S=0.46, V at S = 0.96, S at V = 1.00			

Table 5 : Effect of late sowing on number of seeds ear^{-1} in wheat varieties

Varieties	2006-07 and 2007-08			
	NS	LS_1	LS_2	Mean
Halna	54.66	47.66 (12.8)	29.00 (46.9)	43.77
Raj 3765	47.33	42.33 (10.6)	36.80 (22.2)	42.15
NW 1014	51.00	44.34 (13.1)	29.66 (41.8)	41.67
PBW 343	58.66	50.49 (13.9)	34.00 (42.0)	47.72
HD 2643	41.66	35.00 (15.9)	25.33 (39.1)	34.00
HP 1744	45.33	37.70 (16.8)	28.46 (37.2)	37.16
NW 2036	53.66	49.00 (8.7)	40.66 (24.2)	47.77
DBW 14	48.66	40.00 (17.8)	32.68 (32.8)	40.45
NW 1076	58.33	49.66 (14.9)	38.16 (34.6)	48.72
Sonalika	38.33	35.00 (8.7)	29.83 (22.2)	34.39
HD 2285	40.66	36.66 (9.8)	28.29 (30.4)	35.20
HD 2307	51.33	40.95 (20.2)	31.33 (38.9)	41.20
K 8962	57.33	51.44 (10.3)	45.66 (20.4)	51.48
UP 2425	51.00	37.37 (26.7)	30.66 (39.9)	39.68
HP 1633	37.66	27.89 (25.9)	23.10 (38.7)	29.55
Mean	49.04	41.70(14.96)	32.24(34.25)	
C.D. (P=0.05)	V = 3.24, S=2.76, V at S = 5.61, S at V = 5.81			

Table 6 : Effect of late sowing on grain yield plant^{-1} (q/ha) in wheat varieties

Varieties	2006-07 and 2007-08			
	NS	LS_1	LS_2	Mean
Halna	32.40	25.98 (19.8)	18.24 (40.6)	25.87
Raj 3765	37.59	31.47 (16.3)	25.56 (32.0)	31.54
NW 1014	37.52	28.06 (25.2)	20.22 (46.1)	28.60
PBW 343	41.73	29.01 (30.5)	19.63 (52.9)	30.12
HD 2643	37.23	27.57 (25.9)	18.17 (51.2)	27.65
HP 1744	35.84	23.71 (33.8)	18.06 (49.6)	25.87
NW 2036	40.12	32.29 (19.5)	27.72 (38.4)	33.37
DBW 14	39.73	29.31 (26.2)	22.20 (44.1)	30.41
NW 1076	35.20	27.32 (22.4)	17.61 (49.9)	26.71
Sonalika	36.84	31.93 (13.3)	23.89 (35.1)	30.88
HD 2285	35.97	31.20 (13.3)	23.77 (33.9)	30.31
HD 2307	27.14	21.47 (20.8)	14.52 (46.5)	21.03
K 8962	28.11	24.06 (14.4)	18.83 (33.0)	23.66
UP 2425	35.47	24.85 (29.9)	17.13 (51.7)	25.81
HP 1633	32.17	22.19 (31.0)	14.83 (53.9)	23.06
Mean	35.53	27.36 (22.99)	20.09 (43.45)	
C.D. (P=0.05)	V = 2.71, S=2.81, V at S = 4.69, S at V = 5.09			

in all traits was observed under 30 days late sowing. Mean number of ear plant^{-1} reduced by about 13 and 33 per cent due to 15 and 30 days late sowing, respectively. Under 30 days late sowing, Raj 3765, Sonalika, HD 2285 and K 8962 showed less decrease (17-27%) in no. of ears plant^{-1}, however, higher reduction (39 to 48%) was observed in HP 1744, NW 1014, HP 1633, PBW 343, UP 2425 and HD 2643. The mean reduction in ear length due to 15 days late sowing was less (90%) as compared to 30 days late sowing (23%). NW 1014, Raj 3765, NW 2036, Sonalika, K 8962 and HD 2285 showed lesser reduction in ear length as compared to other varieties under 30 days late sowing. Similar to our results reduction in no. of ears plant^{-1} and ear length has been reported by Singh *et al.* (2007). Under normal condition, the mean test weight (1000 seed weight) was about 42 g, which reduced to 36 and 32 g under 15 and 30 days late sowing, respectively. The detrimental effect of late sowing on test weight has been also observed by several workers (Shukla *et al.*, 1997 and Singh and Pal, 2003). The delay in sowing for 15 and 30 days reduced the mean biological yield by 26 and 41 per cent, respectively. Higher reduction (47 to 55%) in biological yield was found in PBW 343, HD 2643, NW 1014, HP 1744 and HD 2307, while less reduction (29 to 37%) was observed in Halna, Sonalika, HD 2285, K 8962 and Raj 3765 under 30 days late sowing. Decrease in biological yield under hyper thermal stress has been also advocated by Singh *et al.* (2001) and Singh *et al.* (2007).

Table 8 : Effect of late sowing on test weight (1000 grain) in wheat varieties

Varieties	2006-07 and 2007-08			
	NS	LS_1	LS_2	Mean
Halna	36.37	34.47 (5.2)	28.38 (21.9)	33.07
Raj 3765	39.42	34.64 (12.1)	29.94 (24.0)	34.67
NW 1014	37.35	31.40 (15.9)	26.73 (28.4)	31.83
PBW 343	43.71	36.51 (16.5)	30.60 (29.9)	36.94
HD 2643	45.10	37.79 (16.2)	31.30 (30.6)	38.06
HP 1744	39.31	31.95 (18.7)	25.72 (34.6)	32.33
NW 2036	35.75	30.40 (14.9)	27.22 (23.9)	31.12
DBW 14	40.45	33.20 (17.9)	25.36 (37.3)	33.00
NW 1076	44.65	36.29 (18.7)	31.24 (30.0)	37.39
Sonalika	48.53	43.65 (10.0)	38.37 (20.9)	43.52
HD 2285	41.32	37.25 (9.8)	33.41 (19.1)	37.33
HD 2307	41.90	34.20 (18.4)	29.14 (30.5)	35.08
K 8962	42.40	37.40 (11.8)	32.90 (22.4)	37.57
UP 2425	50.55	40.28 (20.3)	32.22 (36.3)	41.02
HP 1633	39.52	32.27 (18.3)	25.79 (34.7)	32.53
Mean	41.76	35.45	29.89	
C.D. (P=0.05)	V = 2.30, S=2.04, V at S = 3.98, S at V = 4.20			

Table 7 : Effect of late sowing on biological yield (g) in wheat varieties

Varieties	2006-07 and 2007-08			
	NS	LS_1	LS_2	Mean
Halna	68.80	55.39 (19.5)	41.11 (40.2)	55.10
Raj 3765	72.23	58.62 (18.8)	46.54 (35.6)	59.13
NW 1014	77.15	54.41 (29.5)	40.89 (46.9)	57.48
PBW 343	89.30	61.50 (31.1)	40.54 (54.6)	63.78
HD 2643	80.96	57.83 (31.1)	45.43 (54.6)	61.40
HP 1744	82.22	60.11 (26.9)	45.54 (44.6)	62.62
NW 2036	85.94	65.72 (23.5)	60.22 (29.9)	70.62
DBW 14	94.08	67.98 (27.7)	54.05 (42.5)	72.03
NW 1076	87.56	62.94 (28.1)	47.98 (45.2)	66.16
Sonalika	94.38	75.50 (20.0)	64.84 (31.3)	78.24
HD 2285	76.30	62.52 (18.1)	48.30 (36.7)	62.37
HD 2307	57.55	40.33 (29.9)	29.92 (48.0)	42.59
K 8962	58.22	47.84 (17.8)	35.75 (38.6)	47.27
UP 2425	69.39	46.22 (33.4)	40.11 (42.2)	51.90
HP 1633	68.02	49.01 (27.9)	34.48 (49.3)	50.50
Mean	77.47	57.72 (25.49)	45.04 (41.86)	
C.D. (P=0.05)	V = 5.4, S=4.12, V at S = 9.35, S at V = 9.70			

Grain yield is the product of number of ears plant^{-1}, ear length, number of seeds ear^{-1}, individual grain weight and biological yield and hence reduction in all these components under late sowing accounted for greater decrease in grain yield. The mean grain yield decreased by 24 and 46 per cent under 15 and 30 days late sowing, respectively. Under 30 days late sowing, maximum grain yield was observed in NW 2036 followed by Raj 3765, Sonalika and HD 2285 in both years and the average reduction in these varieties ranged from 35 to 39 per cent, however, higher reduction (51 to 59%) was recorded in HP 1744, PBW 343, UP 2425, HP 1633 and HD 2643. Similar to our studies Gupta *et al.* (2006) studied the genotypic variability in wheat for higher temperatures tolerance and found that HD 2285 had higher temperature tolerance than other varieties and hence lower yield reduction. The varieties with there greater stability in different yield components may perhaps be helpful in breeding wheat cultivars for late sown condition through their integration. Test weight under 30 days late sowing, maximum test weight was observed in Sonalika followed by HD 2285 and K 8962 and these varieties showed reduction of about 18 to 21 per cent, 14 to 19 per cent and 14 to 22 per cent, respectively. Varieties were identified as UP 2425, HP 1744, HD 2307, and HP 1733. Per cent reduction in these varieties under 30 days late sowing with respect to normal sowing ranged from 32 to 36 per cent and 29 to 35 per cent and 34 to 35 per cent, respectively.

Thus it is concluded from the above finding that wheat cultivars showed differential growth and yield sensitivity to rise in temperature during different growth phases. The reduction in grain yield was mainly attributed to marked decline in number of grain per ear owing to enhancement in small size of grains. Such information may be useful while assessing the loss of yield under climatic variability and helpful in selecting the wheat genotype with least hyper thermal and low light

sensitivity in grain yield.

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