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Varietal behaviour of wheat (*Triticum aestivum*) to dates of sowing under *Tarai* region of Uttar Pradesh

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ABSTRACT

A field experiment was conducted at Govind Ballabh Pant University of Agriculture and Technology, Pantnagar, during the winter season of 1995–96 and 1996–97 with 2 dates of sowing (27 November and 27 December) and 12 varieties of wheat [*Triticum aestivum* L. emend. Fiori. & Paol.] ('HD 2402', 'UP 2338', 'GW 190', 'HUW 234', 'PBW 226', 'Raj 3077', 'Raj 3765', 'UP 2402', 'UP 2425', 'HS 240', 'UP 2121'), and 'UP 2449'. Late sowing reduced the grain as well as straw yield during both the years. 'Raj 3077' gave the highest yield, and 'UP 2121' gave the minimum.

Key words : Wheat, Varietal behaviour, Late sowing, Heat tolerance

Wheat (*Triticum aestivum* L. emend. Fiori & Paol.) is one of the most important cereal crops of India. A major constraint limiting wheat production in northern parts of India is its late planting, which ultimately results in exposure of plants to high temperature at grain-development stage. Singh and Uttam (1994) reported that grain yield decreased with delay in sowing date beyond 27 November and it varied from variety to variety. The present experiment was undertaken to study the effect of rising temperature on grain development and grain yield of different wheat genotypes so that resistant ones may be identified for use in development of heat–tolerant genotypes of wheat.

MATERIALS AND METHODS

A field experiment was conducted at the Crop Research Centre, of GBPUAT, Pantnagar in the winter (*rabi)* season of 1995–96 and 1996–1997. The total of 176.2 mm rainfall was received during experimental period. The weekly mean maximum and minimum temperatures ranged from 20.5 to 39.2°C and 2.1 to 17°C respectively. The experimental plot had silty loam soil (organic carbon 1.06 to 1.07%, available phosphorus 27.8 kg/ha, available potassium 135.3 kg/ha and pH 7.1).

The treatments consisted of 2 dates of sowing, i.e. D_1 (27 November) and D_2 (27

December); and 12 varieties, i.e. V_1 to V_{12} ('HD 2402', 'UP 2338', 'GW 190', 'HUW 234', 'PBW 226', 'Raj 3765','Raj 3077', 'UP 2402', 'UP 2425', 'HS 240', 'UP 2121'and 'UP 2449'). The experiment was conducted in split-plot design with 4 replications. Dates of sowing were taken as main-plot treatments and varieties as subplot treatments. Urea was applied to the crop @ 120 kg N/ha. Half the nitrogen was applied as basal dressing and half before first irrigation. The crop was sown by hand at a row spacing of 23 cm. Other packages of practices were followed as per recommendation for wheat crop.

RESULTS AND DISCUSSION

Grain yield

The average grain yield decreased significantly with delay in sowing after 27 November (Table 1). Kumar *et al.* (1994) reported that the highest mean yield was obtained from early sown wheat whereas poorer grain and straw yields were obtained from late–sown wheat. The crop sown on 27 November gave 8.6% higher grain yield than that sown on 27 December. Varieties showed significant differences in their grain yields. 'Raj 3077' recorded the highest grain yield and was on a par with 'UP 2338' and 'PBW 226'. Lowest grain yield was observed in 'UP 2121', which was on a par with 'GW 190', 'HUW 234', 'UP 2402' and 'UP 2425'. Interaction effect between dates of sowing and varieties was non-significant. In the present investigation, high grain yield of 27 November sown crop may be jointly due to

Table 1. Effect of sowing dates and varieties on plant count, grain and straw yields (pooled data of 2 years)

Treatment	Plant count (m^2)	Grain yield (t/ha)	Straw yield (t/ha)
Sowing date			
D_1 (27 Nov.)	118.0	3.66	8.26
D_2 (27 Dec.)	85.9	3.37	7.76
CD (P=0.05)	5.0	0.20	0.29
Varieties			
V_1 ('HD 2402')	112.3	3.57	8.32
V_2 ('UP 2338')	109.1	3.93	8.10
V_3 ('GW 190')	104.6	3.36	7.72
V_4 ('HUW 234')	96.6	3.15	6.75
V_5 ('PBW 226')	95.7	3.69	7.84
V_6 ('Raj 3077')	97.4	*3.98*	*7.82*
V_7 ('Raj 3765')	95.8	3.54	*9.04*
V_8 ('UP 2402')	100.3	3.29	8.74
V_9 ('YP 2425')	101.7	3.35	8.09
V_{10} ('HS 240')	121.0	3.66	8.59
V_{11} ('UP 2121')	91.7	3.14	*6.63*
V_{12} ('UP 2449')	96.9	3.52	8.38
CD (P = 0.05)	8.2	0.30	0.52

high number of ear–bearing tillers, grain number and grain weight/spike and 1,000 grain weight from the crop sown on 27 December. A positive and significant correlation was observed between number of spikes/unit area, 1,000 grain weight and grain yield by Joshi and Singh (1983) and Das *et al.* (1995).

Straw yield

Significantly lower straw yield was recorded in the crop sown on 27 December than that sown on 27 November (Table 1). Rao (1986) reported the highest straw yield in 3 December sowing, which decreased with delay in sowing. Varieties differed in their straw yield significantly. 'Raj 3077', followed by 'UP 2402' and 'HS 240' recorded significantly higher straw yields than other varieties. 'UP 2121', followed by 'HUW 234', recorded the lowest straw yield. These varieties were on par with each other. Interaction effect was non significant.

Yield attributes

The crop sown on 27 November produced significantly higher number of seedlings and effective tillers/unit area and more grain weight/spike and 1,000 grain weight than that sown on 27 December, whereas sowing date did not influence the number of grains spike (Tables 2, 3). Varieties showed differential response to sowing dates in producing number of effective shoots. The number of effective tillers significantly decreased in all the varieties except 'UP 2402', 'UP 2427' and 'UP 2121' with delay in sowing from 27 November to 27 December (Table 2). Variety 'UP 2449' produced significantly higher number of effective shoots than all other varieties except 'HD 2402', 'UP 2338' and 'Raj 3765' under 27 November sowing, whereas in 27 December sowing 'UP 2427', having the highest number of spikes, was on a par with 'UP 2402'. Late-sown crop is exposed to higher temperature during the reproductive growth. Temperature had complex relationship with spikelet formation, ripening and grain yield than other weather parameters (Saini *et al.*, 1988).

Number of grains/spike

Delay in sowing resulted in lesser number of grains/spike. Interaction effect of sowing dates and varieties on the number of grains/spike was significant (Table 2). There was reduction in grain number/spike with shift of sowing date from 27 November to 27 December in all the varieties except 'HD 2402', 'PBW 226', 'Raj 3077' and 'UP 2121'. 'Raj 3765', which recorded the highest number of grains/spike in both the sowing dates had significantly higher number of grains than all the varieties except 'GW 190' and 'HS 240' in 27 November-sown crop. But this variety was at par with 'HD 190', 'UP 2338', 'PBW 226' and 'HS 240' in 27 December-sown crop. Wardlaw *et al.* (1989) reported that grain number was most sensitive to temperature after anthesis. They indicated a general reduction in yield/ear of 3–4% for each 1° rise in temperature above a mean of 15°C.

Grain weight/spike

Interaction effect of sowing dates and varieties on grain weight/spike was

Table 2. Effect of sowing dates, varieties and their interaction on plant height, number of effective shoots, grain number and grain weight per spike (pooled data of 2 years)

Variety	Plant height (cm)			Effective shoots (m^2)			Grain number/spike			Grain weight/spike		
	27 Nov.	27 Dec.	Mean	27 Nov.	27 Dec.	Mean	27 Nov.	27 Dec.	Mean	27 Nov.	27 Dec.	Mean
V_1 'HD 2402'	91.2	91.9	91.6	347.3	301.0	324.1	33.0	36.4	34.7	1.39	1.19	1.29
V_2 'UP 2338'	105.0	92.9	98.9	348.9	297.5	323.2	37.6	32.9	35.2	1.36	1.06	1.21
V_3 'GW 190'	102.1	95.4	98.8	340.8	288.8	314.8	42.7	31.9	37.3	1.22	0.94	1.08
V_4 'HUW 234'	105.6	99.3	102.4	311.1	267.0	389.1	34.9	31.0	32.9	1.20	0.89	1.05
V_5 'PBW 226'	102.3	102.5	102.4	325.1	269.5	297.3	29.3	34.4	31.8	1.21	0.94	1.08
V_6 'Raj 3077'	105.1	100.2	102.6	332.0	270.1	304.6	28.2	32.0	30.1	1.22	0.89	1.05
V_7 'Raj 3765'	103.5	93.8	98.7	356.8	310.6	333.7	43.7	36.7	40.2	1.47	1.30	1.39
V_8 'UP 2402'	101.4	98.2	99.8	316.9	366.9	341.9	32.5	31.3	31.9	1.20	0.95	1.08
V_9 'UP 2425'	101.0	96.2	98.6	330.9	374.8	352.8	31.5	29.2	30.3	1.39	0.95	1.17
V_{10} 'HS 240'	111.7	103.5	107.6	343.3	299.5	321.4	39.9	33.9	36.9	1.23	1.1.2	1.18
V_{11} 'UP 2121'	105.5	100.6	103.1	310.3	313.6	311.9	27.0	29.3	28.1	1.07	0.94	1.00
V_{12} 'UP 2449'	100.3	95.6	97.9	361.6	300.9	316.3	35.3	30.3	32.8	1.63	1.05	1.34
Mean	102.9	97.5	100.2	332.9	305.6	319.2	34.6	32.4	33.5	1.30	1.02	1.16
	CD (P = 0.05)			*CD (P = 0.05)*			*CD (P = 0.05)*			*CD (P = 0.05)*		
Date	1.3			5.4			2.3			0.07		
Variety	1.6			11.9			3.1			0.13		
For comparing two varieties at same sowing date	2.2			16.8			4.3			0.18		
For comparing two dates for same or different varieties	2.5			16.9			4.7			0.19		

Table 3. Effect of sowing dates, varieties and their interaction on thousand-grain weight, number of days taken to 75% anthesis, 75% maturity an grain growth duration (pooled data of 2 years)

Variety	75% anthesis			75% maturity			Grain growth duration			1,000-grain weight (g)		
	27 Nov.	27 Dec.	Mean	27 Nov.	27 Dec.	Mean	27 Nov.	27 Dec.	Mean	27 Nov.	27 Dec.	Mean
V_1 'HD 2402'	102.4	89.1	95.8	134.4	134.4	121.9	32.0	22.9	27.4	39.51	32.21	35.86
V_2 'UP 2338'	105.8	90.6	98.2	131.5	113.0	122.3	25.8	22.4	24.1	38.75	31.69	35.22
V_3 'GW 190'	102.9	91.3	97.1	130.9	*113.8*	122.3	28.0	22.5	25.3	32.89	28.00	30.44
V_4 'HUW 234'	93.4	88.0	90.7	131.1	109.3	120.1	38.0	22.3	30.1	34.31	28.88	31.69
V_5 'PBW 226'	94.1	85.0	89.6	128.6	106.8	117.1	34.5	21.8	28.1	35.52	30.48	33.00
V_6 'Raj 3077'	94.0	84.8	89.4	128.0	107.1	117.6	34.0	22.4	28.2	36.56	30.46	33.51
V_7 'Raj 3765'	101.8	89.9	95.8	136.0	111.3	123.6	34.0	21.4	27.7	*40.29*	34.10	37.19
V_8 'UP 2402'	102.3	88.8	95.5	130.9	109.0	119.9	28.6	20.3	24.4	34.16	29.23	31.69
V_9 'UP 2425'	94.3	81.5	87.9	129.9	109.0	119.4	32.6	27.5	30.1	36.59	27.76	32.18
V_{10} HS 240'	102.4	91.0	96.7	129.3	110.8	120.0	26.4	19.9	23.1	35.41	30.29	32.85
V_{11} 'UP 2121'	98.0	87.4	92.7	*134.8*	110.9	122.8	36.8	23.5	30.1	34.08	28.91	31.49
V_{12} UP '2449'	95.1	87.5	91.3	129.3	106.5	117.9	34.1	19.0	26.6	36.18	29.70	32.92
Mean	98.6	87.9	93.4	131.2	109.7	120.5	32.1	22.1	27.1	36.19	30.14	33.16

	CD (P = 0.05)	*CD (P = 0.05)*	*CD (P = 0.05)*	*CD (P = 0.05)*
Date	1.1	1.0	1.2	0.90
Variety	1.4	1.9	1.7	0.81
For comparing two varieties at same sowing date	2.0	2.8	2.4	1.14
For comparing two dates for same or different varieties	2.2	2.8	2.6	1.39

significant (Table 2). 'UP 2449' recorded the highest grain weight/spike in 27 November sown crop, but had lower grain weight/spike than 'HD 2402', 'UP 2338', 'Raj 3765' and 'HS 240' in 27 December-sown crop.

1,000-grain weight

With 1 month delay in sowing after 27 November there was significant reduction in 1,000-grain weight (Table 3). The interaction effect of sowing dates and varieties was significant. 'UP 2425' recorded the lowest weight of 1,000-grains in 27 December sowing, but it had higher 1,000-grain weight in 27 November sowing.

Immature and shrivelled grains are produced in late sown crop, which remains in the milk stage during the period of high temperature. On the other hand, the timely sown crop gets an advantage because after having completed its vegetative growth satisfactorily it comes in the earing stage when the temperature is quite favourable. The grain development and maturity keep a favourable balance with the steady rise in temperature afterwards, which is clearly indicated by the 1,000-grain weight and number of grains/spike.

Plant height

Significant reduction in plant height was recorded in late sowing in all the varieties except 'HD 2402' and 'PBW 226'. Among varieties, 'HS 240' produced the tallest plants in both the sowing, which was at par with 'PBW 226' in 27 December sown crop (Table 2).

Days to anthesis and maturity

Number of days to anthesis and maturity was significantly affected by sowing dates, varieties and their interaction.

Sowing dates had dfferential effect on days taken to anthesis of different varieties (Table 3). Shifting of sowing from 27 November to 27 December significantly reduced the period from sowing to anthesis in all the varieties. Variety 'HUW 234', which took the least number of days from sowing to anthesis in November sowing, took the higher number of days, which were more than all the varieties except 'HD 2402', 'GW 190', 'UP 2338', 'Raj 3765', 'HS 240' and 'UP 2402' in December sowing.

Interaction effect of sowing dates and varieties on days taken to maturity was significant. 'GW 190' which took maximum number of days to mature in 27 December sowing, took fewer number of days in 27 November sowing than most of the varieties. Randhawa *et al.* (1992) reported that when the crop is sown late, its flowering period is shortened because by the time it comes to flowering, the atmospheric temperature starts rising. Therefore, the late sown crop is forced to flower and mature early. This is the main reason for reduction in yield under late-sown conditions. Final kernel weight is determined by rate and duration of dry-matter accumulation. Generally, lower kernel weight of heat stressed wheat is due to reduction in duration rather than reduction in the rate of grain growth. Heat stress during grain filling hastens maturation of the crop, resulting in small, shrunken grains.

In this case the reduction in yield and yield attributes was due to increase in tem-

perature, which forced the crop to mature early. The minimum and maximum ranges of temperature were 8.8 to 17.8°C and 23.8 to 37.0°C respectively in timely sown crop, and 8.8 to 16.8°C and 26.7 to 39.2°C respectively in late–sown crop at grain development stage. The average minimum and maximum temperatures were 12.4 and 31.0°C respectively in timely sown crop, and 15.1 and 35.8°C respectively in late–sown crop, at this stage. Due to increase in temperature at the time of maturity in late-sown crop, there was reduction in grain and straw yields, number of grains/spike, grain-weight/spike and 1,000-grain weight.

Based on these findings, it can be concluded that 1,000-grain weight was most severely affected compared with other yield attributes in late sowing, which was primarily because of shortening of grain-growth duration. Delay in sowing after 27 November resulted in reduced vegetative phase. Higher metabolic activity along with longer vegetative/reproductive period in timely sown crop may be responsible for higher yield compared with that in late-sown crop. Varieties with short duration were found to be more suited to late-sown condition, as duration from anthesis to maturity was less altered due to higher temperature during maturation phase. Varieties having attributes like higher spike number/unit area, grain number/spike and 1,000 grain weight and with duration of mininum 1 month from anthesis to maturity are likely to perform better under late-sown conditions. For timely sowing, 'PBW 226' and 'HS 240', and for late sowing 'UP 2449' and 'HD 2402' are suitable. 'Raj 3077', 'HS-240' and 'UP 2338' are suitable for both the sowing dates.

REFERENCES

Das, K., Das, S.Y. and Guha, B. 1995. Effect of sowing times on rainfed wheat varieties in Assam. *Annals of Agricultural Research* **16** : 518–519.

Joshi, N. L. and Singh, H. G. 1983. Performance of wheat for grain growth rate under different sowing dates on semi–arid lands. *Indian Journal of Agricultural Sciences* **28** : 54–58.

Kumar, R., Medan, S. and Yunus, H. 1994. Effect of planting dates on yield and quality in durum varieties of wheat. *Haryana Agriculture University Journal of Research* **24** : 186–188.

Randhawa, A. S. Kahlon, P. S. and Dhaliwal, H. W. 1992. Rate and duration of grain filling in wheat. *Indian Journal of Genetics and Plant Breeding* **52** : 161–163.

Rao, Y. H. 1986. Influence of sowing dates on growth, grain development and yield of wheat genotypes. Ph.D. (Agron.) thesis, G.B.Pant Univ. of Agric. and Technology, Pantnagar (U.S. Nagar).

Reynolds, M.P., Balota, M., Delgado, M. B., Amani, I. and Fischer, R.A. 1994. Physiological amorphological traits associated with spring wheat yield under hot, irrigated conditions. *Austration Journal of Plant Physiology* **21** : 713–730.

Saini, A.D., Dadhwal, V.K. and Nanda, R. 1988. Pattern of changes in yield of Kalyansona and Sonalika varieties of wheat in sowing date experiments at different locations (*fide Field Crop Abstracts* 1989, **42** : 6777).

Singh, V.P.N. and Uttam, S.K. 1994. Effect of different sowing dates on yield attributes and yield of different cultivars in late sowing conditions. *Bharatiya Krishi Anusandhan Patrika* **8** : 158–162.

Wardlaw, I. L., Dawson, L.A., Mumbai, P. and Frwski, R. 1989. The tolerance of wheat to high temperature during reproductive growth. I. Survey procedures and general response patterns. *Australian Journal of Agricultural Research* **40** : 1–13.