RESEARCH ARTICLE

EFFECT OF DIFFERENT THERMAL ENVIRONMENTS ON THE GROWTH AND DEVELOPMENT OF WHEAT VARIETIES FOR CHHATTISGARH PLAIN

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Abstract: The effect of different thermal environments on the growth and development of wheat varieties for Chhattisgarh Plain. Higher number of ear heads/m^2 observed with 05 December and 15 December sowing may be due to favorable temperature conditions during tillering stage i.e., maximum was below 28°C, minimum was below 12°C and mean temperature was below 20°C. Length of ear heads of different wheat varieties was influenced due to temperature and shifting thermal environment. Longer ear head (9.4 cm) was observed in first and second date of sowing (25 November and 05 December) as compared to delayed sowing of 15 December, 25 December and 05 January. Longer ear head was observed in variety GW-273 (9.4) while minimum (8.4) was observed in Amar. The maximum number of grains/ ear head was observed in D_1 (52) as compared to other sowing dates (D_2, D_3, D_4 and D_5). The test weight of different wheat varieties was influenced significant by different thermal environment and delayed sowing ultimately resulted in lower test weight. On an average the higher test weight (40.1) was observed in D_1 (25 November) at par with 05 December sowing as compared to late sown condition. Maximum grain yield 3307 kg/ha was harvested in 2nd (05 December) date of sowing which was significantly higher as compared to before and delayed sowing. On an average significant higher grain yield was obtained in variety Kanchan (3190 kg/ha) followed by GW-273 whereas, the lower grain yield was recorded in variety Amar (2609 kg/ha) and Sujata (2740 kg/ha) being at par to each other. Higher straw yield (4667 kg/ha) was observed in Kanchan under 2nd sowing date (05 December) whereas the lowest (2703 kg/ha) was observed in variety Amar under 05 January sowing. On an average, in different sowing dates significantly, highest straw yield (3964 kg/ha) was recorded in variety Kanchan as compared to other varieties.

Keyword: Grain yield, Straw yield, Thermal environments

INTRODUCTION

Wheat (*Triticum spp*.) is the major Rabi crop in India and is sensitive to various biotic and abiotic stresses like weather and inter-seasonal climatic variability (in terms of changes in temperature, rainfall, radiation), soil conditions and agricultural inputs like nitrogen, water and pesticides. Three main species commonly grown in the world including India are the common wheat (*Triticum aestivum)* the marconi or durum wheat (*Triticum durum*) and the emmer wheat (*Triticum dicoccum*), out of these species maximum area is under *Triticum aestivum*. In India, more than 80 percent of the total wheat area is under this species whereas the area under marconi and emmer wheat, the area is only 12 per cent and 1 per cent respectively.

Bishnoi (2002) a field experiment was conducted during 1998-99 winter season with eight wheat varieties and three dates of sowing in split plot design with three replications. The magnitude of linear growth rate and duration of its phase largely determined the dry matter accumulation. Duration of linear phase was cultivar specific and strongly influenced by radiation, sunshine hours and saturation deficit, and explained about 70 per cent of its variations. Also sowing to anthesis and anthesis to maturity duration's were explained to 75 and 93 per cent variations when solar radiation, sun shine hours, saturation deficit were taken in to account.

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Aslam *et al*. (2003) reported that less number of tillers in late sowing was the result of less germination count per unit area which occurs due to low temperature. In case of delayed sowing the temperature was not according to the tillering requirement which results in less number of tillers m^{-2}. Differences in number of tillers m^{-2} among varieties might be attributed to their genetic diversity.

MATERIAL AND METHOD

Experimental Detail

The experiment consisting of 5 date of sowing and 4 wheat varieties were laid out in a randomized block design with three replications.

Post harvest observations

Number of ear heads per m^2

Number of ear heads were counted before harvesting from 3 randomly plots of 1 m^2 earlier fixed to record plant population, then averaged.

Length of ear head

Length of 10 ear heads randomly selected in each plot was measured from base to tip of ear head excluding awns and then averaged.

No. of grains per ear head

The ear heads used to measure the length were threshed and number of grains were counted and averaged.

Grain and Straw yield

The crop from each net plot was harvested and tied. The total biomass weight (grain and straw) was obtained by weighing the bundles after proper sun drying. The grain from each bundle was threshed out and the weights of cleaned grains were noted. The straw yield was obtained by subtracting the grain yield from the total biomass of respective treatments.

Statistical analysis

All the data were tabulated and analysed statistically as per the procedure suggested by Panse and Sukhatme (1967) and Chandel (1984). The F test was used for judging the significance of the treatment mean at 5% level. Whenever F test showed significant difference the differences between treatment means were further tested by using critical difference (CD) value.

To compare different mean value of treatments, critical difference (CD) values were calculated as follows:

$$\mathbf{SEm \pm} = \sqrt{\frac{\mathbf{Ems}}{\mathbf{n}}} \quad \text{(i)}$$

Where,

SEm ± = Standard error of mean

Ems = Error mean square

n = Number of observations on which the mean values is based

(ii) CD (5%) = SEm x$\sqrt{2}$ x t at 5 % for Error d.f. (2.02).

Regression equation were also worked out to find out the differet weather parameters on grain yield.

RESULT AND DISCUSSION

Growth parameters

Plant population

The data summarized the plant population per unit area under different thermal environments and varieties are shown in Table 1. It can be seen from the table that mean plant population was significantly higher with variety Sujata which was at par with Kanchan and Amar. Lowest plant population (212) was observed with variety GW-273, which may be due to higher seed index of this variety. The data (Table 1) showing plant population per m^2 area under different dates of sowing revealed that plant population influenced significantly due to different thermal environments. Significantly higher plant population was recorded with the crop sown on 05 and 15 December because of favorable temperatures during this period. The mean temperature during 05 and 15 December was near 20°C whereas during earlier or late sowing it was below 20°C. Aslam *et al*. (2003) reported that less number of tillers in late sowing was the result of less germination count per unit area which occurs due to low temperature. In case of delayed sowing the temperature was not according to the tillering requirement which results in less number of tillers m^{-2}.

Plant height

The plant height is the best measures and index of the total performance and response of the crop to the weather condition. Response of wheat varieties on different thermal environment are given in table 2. The plant height of the different varieties at 10 days intervals from 30 DAS to maturity are sown in Table 2 and also depicted though fig. 1 and 2. It can be seen that the initial plant height up to 30 DAS was higher in GW-273 (37.4 cm) followed by Kanchan (35.6 cm). It was observed that the plant height increased rapidly from 40 DAS to 60 DAS that is till the crop entered reproductive stage. There after the increase in height was marginal. At maturity Sujata attained maximum height of 105.0 cm followed by Amar (101.0 cm) when the crop was sown on 05 December. GW-273 attained the highest height of (85.8cm) under 05 December followed by Kanchan (84.7 cm) in case of 25 November sowing. Regarding the thermal effect on plant height Sujata expressed the highest effect as the height reduced from 105.0 cm to 91.2 cm under D_2 to D_5, the same trend was followed by Amar (101.0 cm to 92.3 cm). GW-273 variety was least affected due to thermal stress where the decrease in height was from 85.8 cm to 80.5 cm i.e., 5.3 cm only.

It was observed that the plant height increased with advancement in crop growth and reached to maximum at maturity. The increase in plant height took place slowly up to 40 days after sowing. Maximum rate of increase in plant height was observed between 40 to 60 days after sowing when the crop was in ear emergence stage. In general, higher plant height was observed in varieties Sujata and Amar and lower plant height was recorded in varieties Kanchan and GW-273. It was observed that plant height decreased from the first date of sowing when the sowing was delayed of 25 November to 05 January. It was also observed that the average plant height varied among the varieties because of the genotypic characters of these varieties (Table 2, Fig. 1 and 2). Shahzad *et al*., (2002) found that the decrease in plant height in late sowing was due to shorter growing period. Early sown crop may have enjoyed the better environmental conditions especially the temperature and solar radiation which resulted to tallest plants. Naik *et al.*, (1991) and Behra (1994) also reported decrease on plant height under delayed sown conditions.

Dry Matter Production

The accumulated dry matter at 10 days interval from sowing to maturity for all the four varieties in respect of different thermal environments are shown in Table

3 and fig. 3 and 4. The data presented in table 3 revealed that at initial stage the dry matter was higher under 05 December sowing. The dry matter production was variable at 40, 50 and 60 days after sowing as well as later dates. Further it was observed that the rate of increase in dry matter was slow up to 40 days after sowing and continued up to maturity in all the varieties under all the sowing dates except last sowing date i.e. 05 January where it was only up to 80 days after sowing. The highest dry matter was observed at maturity with Kanchan (809.8 g/m^2) under 25 November sowing while lowest dry matter was observed in variety Amar (476.5 g/m^2) under 05 January sowing. The dry matter growth rate varied differently for different varieties. The dry matter decreased sharply at maturity when sowing was delayed beyond 15 December as the maximum, minimum and mean temperature increased considerably and recorded above 30°C under 25 December and 05 January sowing. It was also reported by may part workers that mean temperature above 30°C was not favorable for optimum growth of wheat crop during maturity stage. Decreases in dry matter due to thermal stress from D_2 to D_5 as compared to D_1 can be seen from the Table 3. The dry matter production decreased considerably in all the varieties, when sowing was delayed from 25 November to 05 December, 15 December, 25 December and 05 January. However, different varieties exhibited different trends of decrease in dry matter. At maturity lowest decrease in dry matter was observed in Sujata (137.2 g/m^2) in D_5 and it was maximum in GW-273 (246.7 g/m^2) in D_5. The biomass production is mainly governed by genetic potential of the varieties under given set of weather conditions. But, the extent of decline in dry matter under delayed sowing was due to the thermal stress tolerance capacity of a particular variety to higher temperatures. So, decrease in dry matter of Sujata was found to be more tolerant to thermal stress. Low temperature under late seeding delayed germination and hampered tillering which produced less number of leaves and consequently led to poor dry matter production than timely sown crop (Pal *et al.*, 1996). Rahman *et al*., (1997) also reported similar results.

CONCLUSION

Plant population per m^2 area under different dates of sowing revealed that plant population influenced significantly due to different thermal environments. Significantly higher plant population was recorded with the crop sown on 05 and 15 December because of favorable temperatures during this period. The mean temperature during 05 and 15 December was near 20°C whereas during earlier or late sowing it was below 20°C. It was observed that the plant height increased with advancement in crop growth and reached to maximum at maturity. The increase in plant height took place slowly up to 40 days after sowing. Maximum rate of increase in plant height was observed between 40 to 60 days after sowing when the crop was in ear emergence stage. In general, higher plant height was observed in varieties Sujata and Amar and lower plant height was recorded in varieties Kanchan and GW-273. The highest dry matter was observed at maturity for Kanchan (809.8 g/m^2) while lowest dry matter was observed in varieties Amar (476.5 g/m^2). The dry matter growth rate varied differently for different varieties. The dry matter decreased sharply at maturity when sowing was delayed beyond 15 December as the maximum, minimum and mean temperature increased considerably.

Higher number of ear head /m^2 (353) was observed 05 December sowing as compared to 25 November, 25 December and 05 January sowing (339, 305 and 234, respectively) but significantly at par with that with 15 December sowing (350). Ear heads/m^2 decreased slowly up to 25 December and after it decreased sharply when sowing was done on 05 January (D_5). Length of ear of different wheat varieties was influenced due to temperature and shifting thermal environment. Longer ear head (9.4 cm) was observed in first and second date of sowing (25 November and 05 December) as compared to delayed sowing of 15 December, 25 December and 05 January. Longer ear head was observed in variety GW-273 (9.4) while minimum (8.4) was observed in Amar. Number of grain/ear head with 05 December sowing was found next that of 25 November sowing but significant superior over 15 and 25 December sowing. Significantly lower number of grains/ear head was observed with 05 January sowing. Among different variety GW-273 produced significantly higher number of grains/ear head closely followed by Kanchan being at par to each other (50 and 48, respectively) Sujata and Amar produced lower number of grains/ear head and were found statistically similar to each other.

Maximum grain yield 3307 kg/ha was harvested in 2nd (05 December) date of sowing which was significantly higher as compared to before and delayed sowing. On an average significant higher grain yield was obtained in variety Kanchan (3190 kg/ha) followed by GW-273 whereas, the lower grain yield was recorded in variety Amar (2609 kg/ha) and Sujata (2740 kg/ha) being at par to each other. This may be attributed to the fact that sowing of wheat on 05 December and 15 December provided sufficient period for vegetative growth of the crop and favorable temperature resulting in higher yield. The test weight of different wheat varieties was influenced significant by different thermal environment and delayed sowing ultimately resulted in lower test weight. On an average the higher test weight (40.1) was observed in D_1 (25 November) at par with 05 December sowing as compared to late sown conditions.

Higher straw yield (4667 kg/ha) was observed in Kanchan under 2nd sowing date (05 December)

whereas the lowest (2703 kg/ha) was observed in variety Amar under 05 January sowing. On an average, in different sowing dates significantly, highest straw yield (3964 kg/ha) was recorded in variety Kanchan as compared to other varieties. Straw yield influenced by sowing dates and temperature.

Among the four varieties, GW-273 was found to be moderately susceptible while other varieties are susceptible for thermal stress; this might be probable reason for reduction total duration and stunted crop growth. Based on the above results it was concluded that under Raipur conditions, if the sowing was delayed after 15th December GW-273 varieties should be sown to get higher yield.

Table 1. Plant population of wheat varieties as influenced by different thermal environments

Varieties	Plant population/m^2					
	D_1	D_2	D_3	D_4	D_5	Mean
Kanchan	216	226	246	211	210	222
GW-273	210	248	215	195	191	212
Sujata	200	250	238	225	215	226
Amar	215	243	240	211	203	222
Mean	210	242	235	211	205	
	SEm+/-	**CD (P=0.05)**	**CV (%)**			
D	3.5	9.9	5.4			
V	3.1	8.9				
DXV	7.0	19.9				

Table 2. Plant height (c.m.) per plant of wheat varieties at 10 days intervals under different thermal environments

Sowing dates	Days after sowing							
	30	40	50	60	70	80	90	Maturity
Kanchan								
D_1-25 Nov.	35.6	47.2	64.6	77.7	79.5	82.1	83.0	84.7
D_2-05 Dec.	34.3	41.6	55.8	71.3	73.3	78.0	78.2	80.3
D_3-15 Dec.	34.0	39.4	52.1	66.2	73.4	77.7	79.6	80.0
D_4-25 Dec.	31.6	40.8	50.6	69.1	69.8	75.0	75.4	77.1
D_5-05 Jan.	24.8	38.7	46.0	57.0	67.6	68.0	69.6	74.1
GW-273								
D_1-25 Nov.	37.4	44.2	61.3	74.3	76.7	78.0	82.8	84.6
D_2-05 Dec.	31.4	49.8	64.1	75.7	78.2	80.6	83.3	85.8
D_3-15 Dec.	31.0	40.4	53.2	68.7	72.4	76.7	80.2	82.6
D_4-25 Dec.	30.3	38.4	51.5	68.0	70.9	75.1	78.7	81.9
D_5-05 Jan.	28.2	37.1	46.4	58.7	67.2	72.4	78.5	80.5
Sujata								
D_1-25 Nov.	30.4	52.8	60.1	78.0	90.7	94.0	95.5	98.7
D_2-05 Dec.	37.2	54.2	66.7	81.3	93.4	101.4	103.0	105.0
D_3-15 Dec.	30.4	42.0	56.7	75.8	80.6	91.6	94.5	96.4
D_4-25 Dec.	30.0	40.3	48.9	55.8	75.5	88.7	90.4	93.5
D_5-05 Jan.	28.7	35.8	37.8	51.0	66.1	86.9	88.4	91.2
Amar								
D_1-25 Nov.	34.6	44.4	62.7	76.5	87.9	94.4	96.6	98.1
D_2-05 Dec.	31.9	51.6	61.9	76.7	94.3	97.4	99.1	101.0
D_3-15 Dec.	31.6	41.2	52.9	68.2	81.5	91.9	94.3	96.3
D_4-25 Dec.	30.0	40.5	51.4	59.7	78.4	88.4	92.0	94.4
D_5-05 Jan.	28.3	33.9	37.4	51.6	63.8	86.3	89.7	92.3

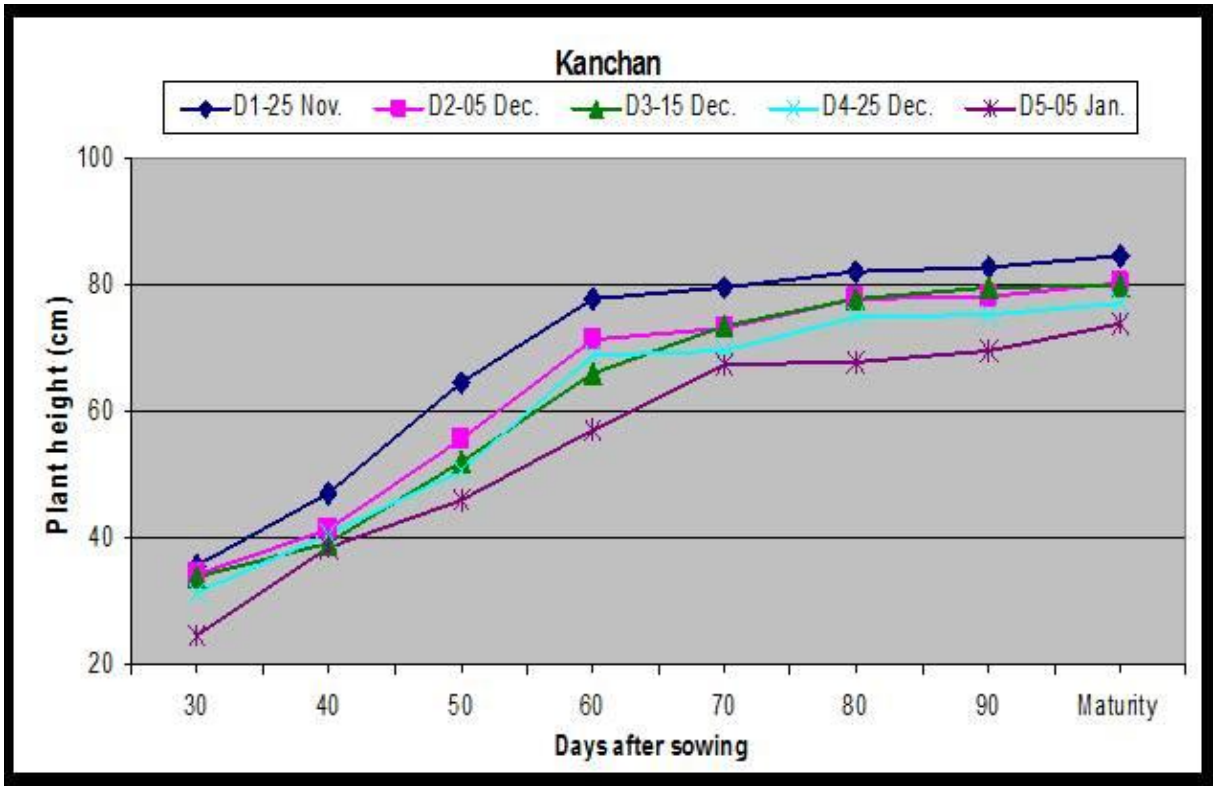
Table 3. Dry matter production per g/m^2 of wheat varieties at 10 days interval under different thermal environments

Sowing Dates	Days after sowing							
	30	40	50	60	70	80	90	Maturity
Kanchan								
D_1-25 Nov.	37.2	93.6	110.4	221.8	292.6	439.0	585.2	736.2
D_2-05 Dec.	52.0	60.1	194.2	266.9	390.1	588.9	653.7	809.8
D_3-15 Dec.	23.1	57.5	155.7	335.7	399.2	551.9	598.6	653.2
D_4-25 Dec.	34.8	78.5	156.3	431.4	453.9	496.2	576.7	621.5
D_5-05 Jan.	23.3	82.4	235.0	287.0	332.8	499.3	513.9	532.4

GW-273								
D_1-25 Nov.	45.4	100.7	112.6	290.6	322.2	376.2	631.5	773.6
D_2-05 Dec.	58.3	91.2	212.3	259.9	465.1	575.9	618.3	716.8
D_3-15 Dec.	30.1	82.9	142.8	312.4	528.7	580.0	662.0	736.8
D_4-25 Dec.	30.3	75.1	183.5	326.8	425.4	492.5	575.0	683.5
D_5-05 Jan.	26.7	99.6	206.8	259.7	326.3	476.6	484.6	526.9
Sujata								
D_1-25 Nov.	41.1	100.1	115.6	220.1	257.4	391.5	488.8	625.1
D_2-05 Dec.	41.8	79.8	176.3	208.0	323.5	468.8	561.1	666.5
D_3-15 Dec.	31.4	72.1	170.6	283.9	446.9	462.8	511.1	559.7
D_4-25 Dec.	41.5	103.1	187.0	327.9	435.7	456.6	495.3	559.9
D_5-05 Jan.	31.2	105.9	204.4	255.0	314.9	410.7	442.9	487.9
Amar								
D_1-25 Nov.	40.3	82.0	108.2	267.7	314.5	398.4	523.1	659.8
D_2-05 Dec.	50.5	82.9	137.9	247.5	336.2	438.9	577.7	626.0
D_3-15 Dec.	27.2	79.4	183.5	297.7	408.7	489.1	536.9	625.5
D_4-25 Dec.	40.0	71.5	169.6	361.9	383.1	416.2	503.9	617.2
D_5-05 Jan.	35.0	61.3	191.0	228.5	300.6	382.1	426.9	476.5

Table 4. Changes in dry matter production due to thermal stress in D_2, D_3, D_4 and D_5 as compared to D_1

S. No.	Variety	Increase/Decrease in Dry matter (g / m^2) From D_1 to			
		D_2	D_3	D_4	D_5
1.	Kanchan	+73.6	-83	-115	-203.8
2.	GW-273	-56.8	-36.8	-90.1	-246.7
3.	Sujata	+41.4	-65.4	-65.2	-137.2
4.	Amar	-33.8	-34.3	-42.6	-183.3



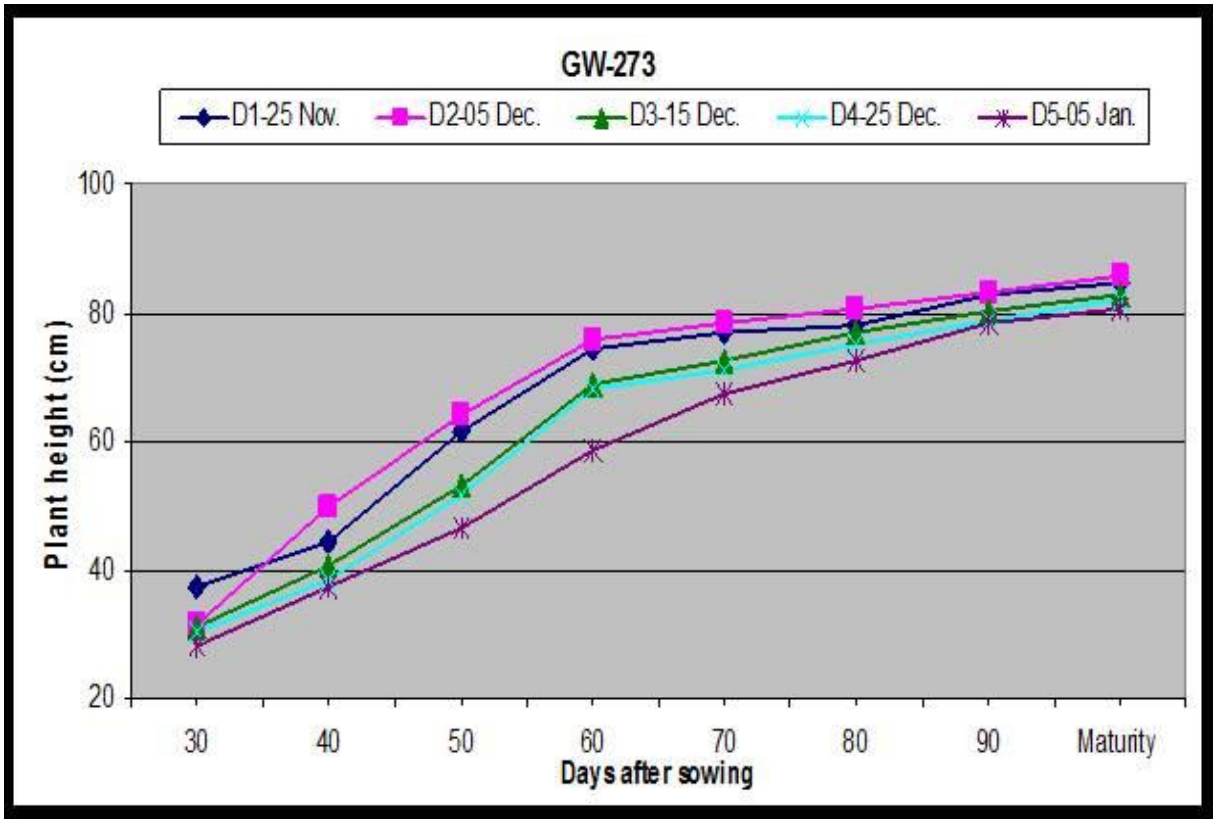
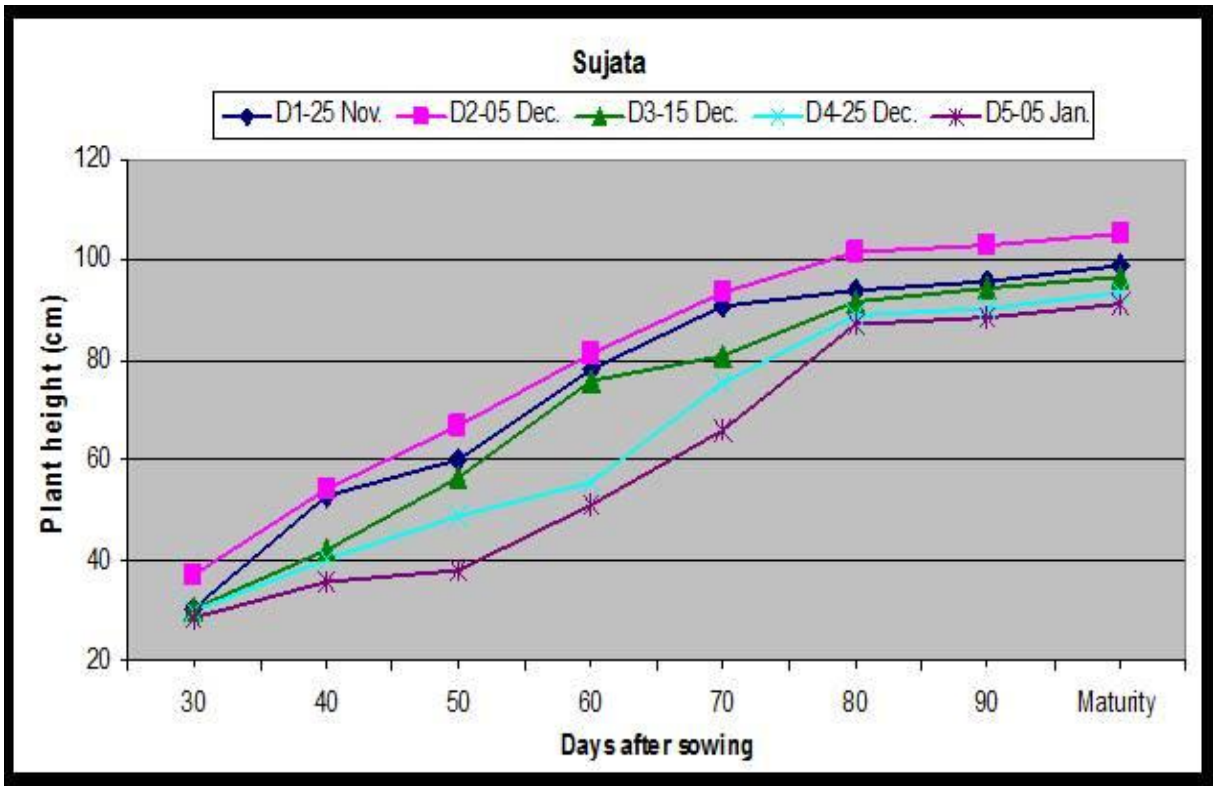


Fig.1. Plant height of varieties Kanchan and GW-273 under different thermal environments (D1 to D5)



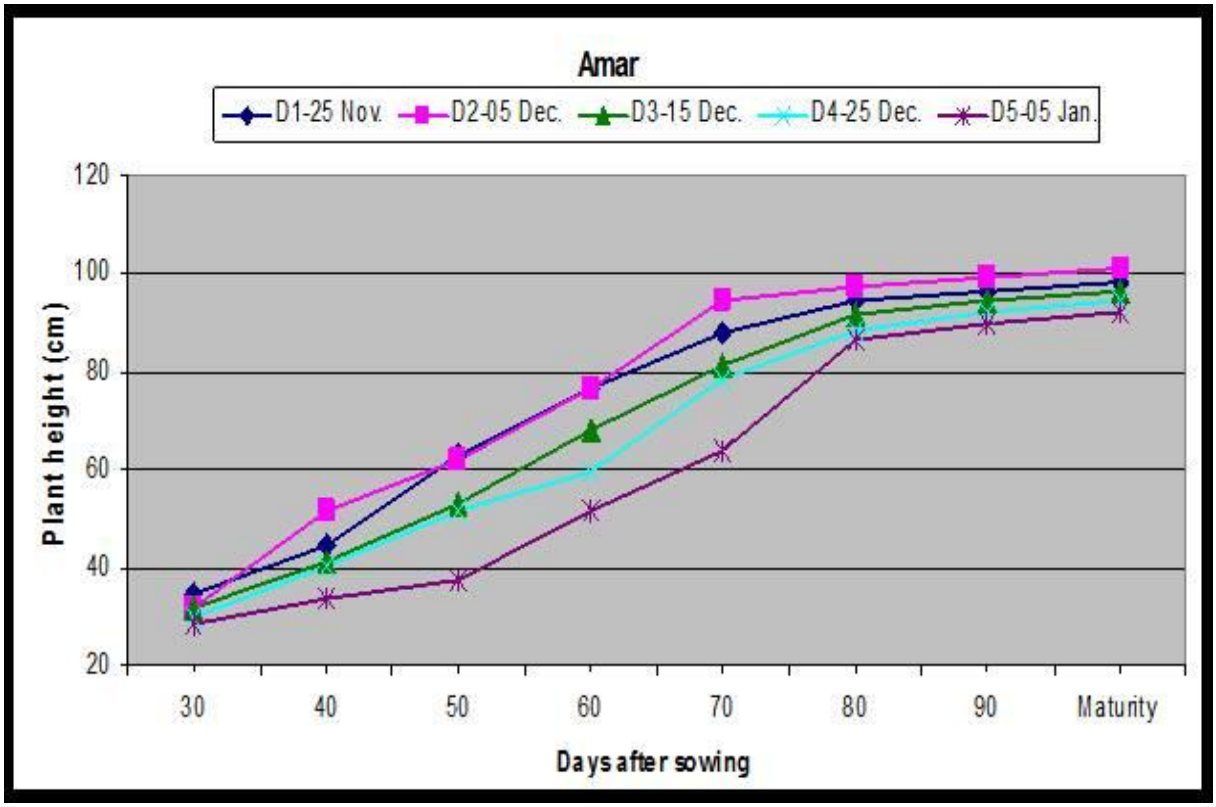
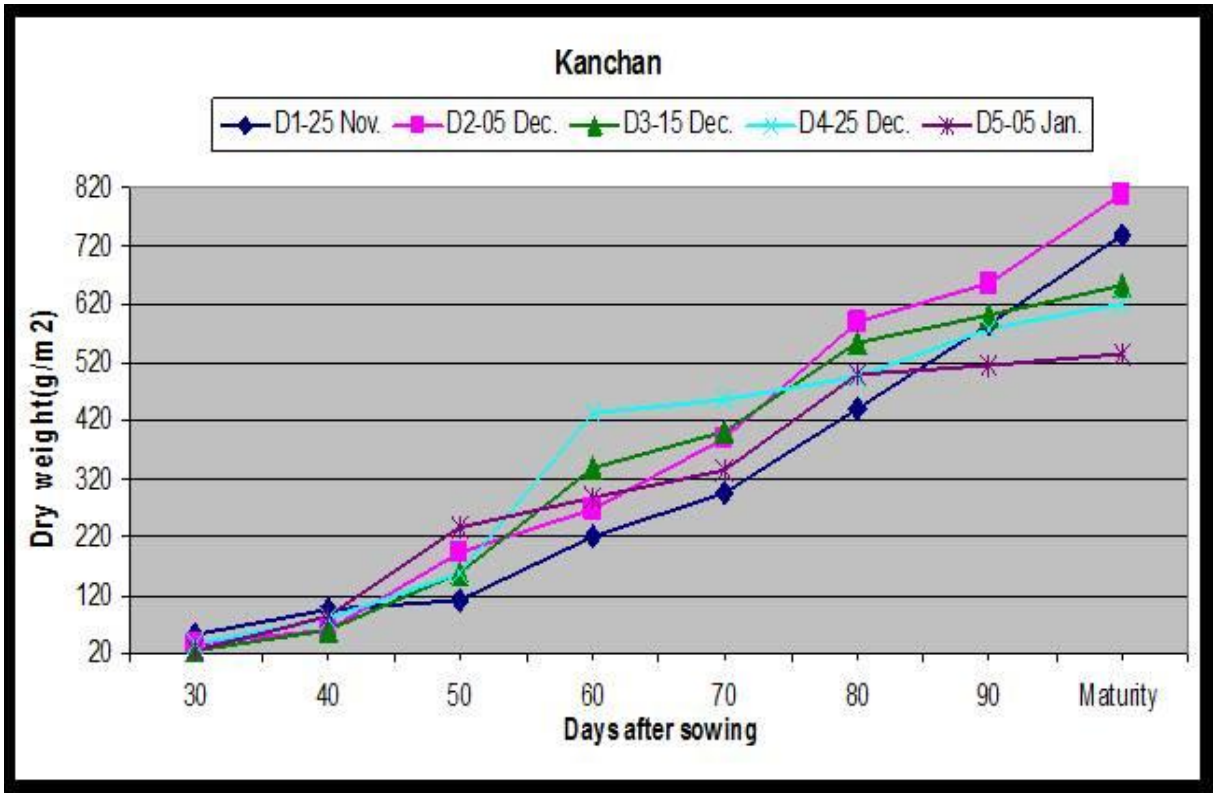


Fig. 2. Plant height of varieties Sujata and Amar under different thermal environments (D1 to D5)



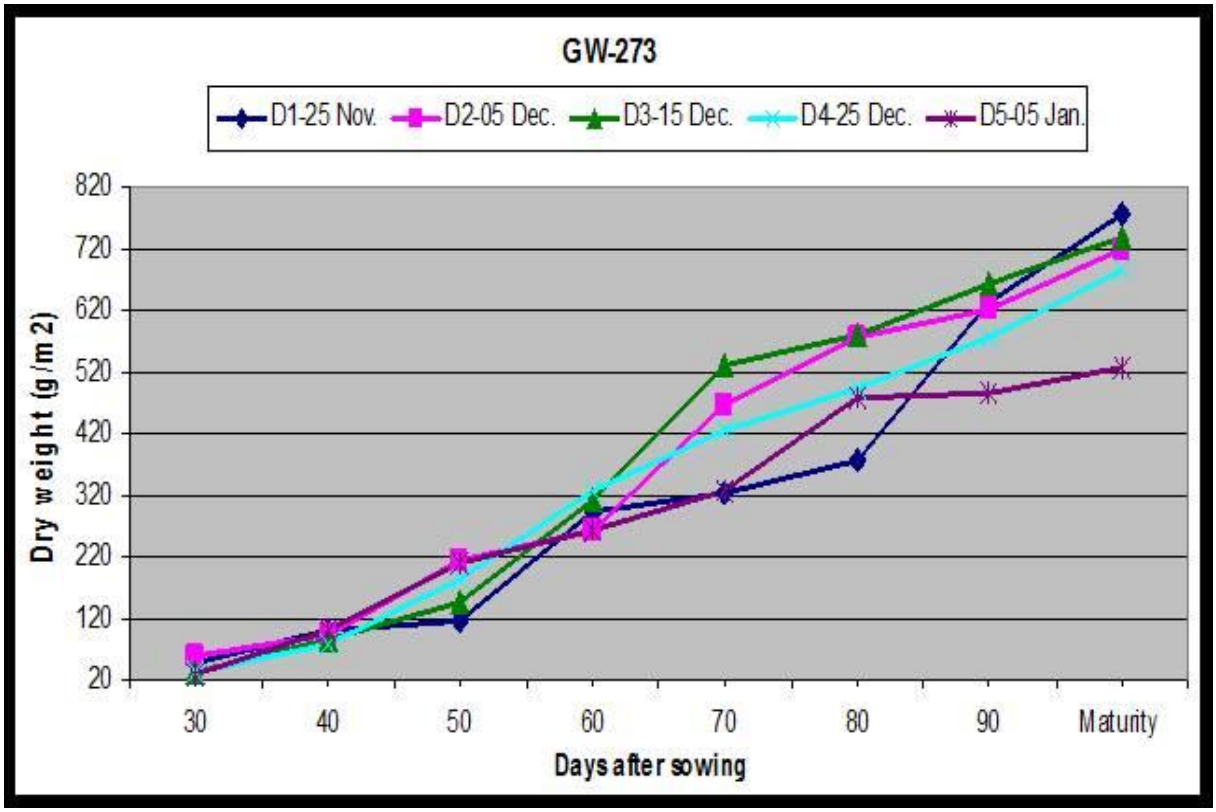
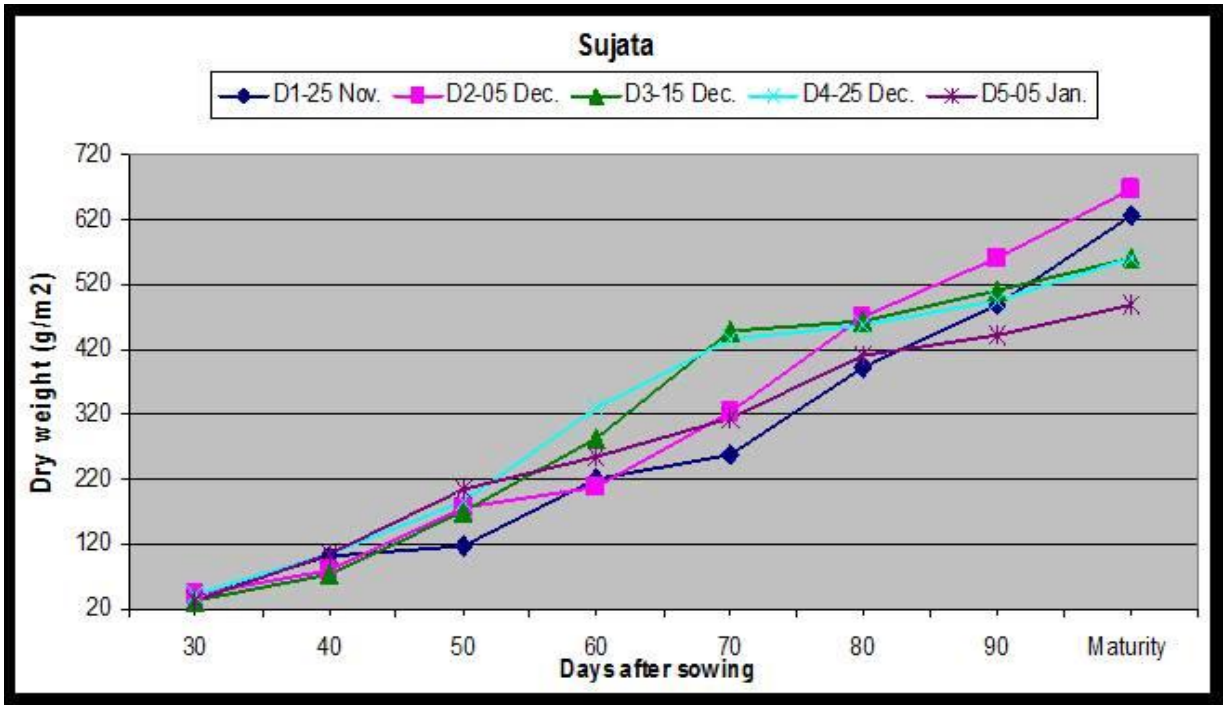


Fig. 3. Dry matter production of varieties Kanchan and GW-273 under different thermal environments (D1 to D5)



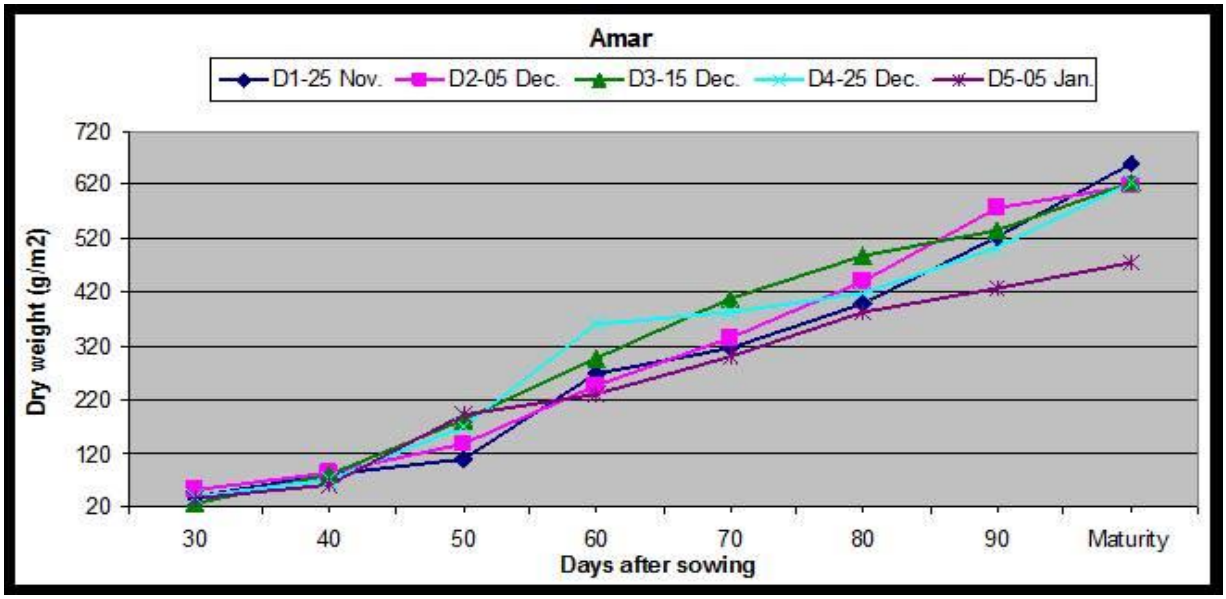


Fig. 4. Dry matter production of varieties Sujata and Amar under different thermal environments (D1 to D5)

REFERENCES

Agrawal, K. K., Sanker, U., Upadhyay, A. P. and Gupta, V. K., (1999). Accumulated heat unit requirements for different phenophases of wheat (*Triticum aestivum*) cultivars as influenced by sowing dates at Jabalpur. *Journal of Agro meteorology*. **1 (**2): 173-176.

Aslam, M., Hussain, M., Akhtar, M., Cheema, M.S. and Ali, L., (2003). Response of wheat varieties to sowing dates. *Pakistan Journal of Agronomy*. **2** (4): 190-194.

Behra, A. K. (1994). Response of wheat (*Triticum aestivum*) varieties to sowing dates. *Indian Journal of Agronomy*, **39** (1): 171-173.

Bishnoi, O. P. (2002). Impact of meteorological variables on the growth and development of wheat varieties. *Journal of Agrometeorology*. **4** (1): 9-15.

Chandel, S. R. S. (1984). A hand book of Agricultural Statistics. Achal Prakashan Mandir, Kanpur (U.P.) India. Pp: 149-318.

Dubey, A. P., Singh, C. B. Khan, N., Yadav, P. N. and Tiwari, A. N. (2008). Influence of weather parameters on wheat yield under varying sowing dates. *Journal of Agrometeorology*: 457-461.

Kant, S., Verma, P. and Pahuja, S. S. (2003). Growth and yield maintenance in bread wheat by seed priming under late-sown conditions. *Acta Agronomica Hungarica*. **51** (4): 445-453.

Naik, P. L., Patel, B. A. and Kalaria, K. K. (1991). Response of wheat (Triticum aestivum) varieties to sowing date and seed rate. *Indian Journal of Agronomy*. **36** (Supplement): 225-226.

Pal, S. K., Kaur, J., Thakur, R., Verma, U. N. and Singh, M. K., (1996). Effect of irrigation, seeding date and fertilizer on growth and yield of wheat (*Triticum aestivum*). *Indian Journal of Agronomy*, **41** (3): 386-389.

Panse, V. G. and Sukhatme P. V. (1967). statistical method for Agricultural workers. Second Edition Indian Council of Agricultural Research, New Delhi.

Rahman, M. M., Hossain, A. B. S., Saba, N. K. and Malker, P. K. (1997). Selection of morpho-physiological traits for heat tolerance in wheat. *Bangladesh Journal of Scientific and Industrial Research*. **32** (2): 161-165.

Shahzad, K., Bakht, J., Shah, W. A., Shafi, M. and Jabeen, N. (2002). Yield and yield components of various wheat cultivars as affected by different sowing dates. *Asian Journal of Plant Science*. **1** (5): 522-525.

Singh, A. K., Tripathi, P. and Mishra, S. R. (2001). Phenology, growing degree-days and phasic development model of wheat (*Triticum aestivum*) under rice (*Oryza sativa*) wheat cropping system. *Indian Journal of Agricultural Science.* **71** (6): 363-366.

Tewari, S. K. and Singh, M. (1993). Yielding ability of wheat (*Triticum aestivum* L.) at different dates of sowing a temperature dependent performance. *Indian Journal of Agronomy*. **38** (2): 204-209.