

# SOWING DATES AND VARIETAL EFFECTS ON LEAF AREA INDEX, MEAN TILT ANGLE AND HEAT SUSCEPTIBILITY INDEX OF WHEAT (*TRITICUM AESTIVUM* L.)

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**Abstract:** A field experiment was conducted at the Crop Research Center of Govind Ballabh Pant University of Agriculture & Technology, Pantnagar (Uttarakhand) during rabi season of 2008-09 to study the photosynthesis, growth and yield of wheat (*Triticum aestivum* L. emend. Fiori & Paol.) varieties at different sowing dates. The experiment was conducted in split plot design with 4 replications with treatments comprising six wheat varieties on Nov.14, Dec.4 and Dec.24. Delay in sowing adversely affected leaf area index. Reduction in leaf area index at 45, 60 and 75 day after sowing and at anthesis and two week after anthesis stage was observed due to late sowing. High leaf area index was noticed in variety UP 2526 at 75 day after sowing and at anthesis and variety DBW 17 followed by UP 2526 recorded highest leaf area index at two week after sowing. Heat susceptibility index computed for yield and yield attributes indicated that variety Raj 3765 was most heat tolerant variety. High grain yield of a genotype under late sown condition indicated the presence of gene for heat tolerance.

**Keywords:** Sowing date, Leaf area index, Mean Tilt angle, Heat susceptibility index, Yield

## INTRODUCTION

Wheat (*Triticum aestivum* L.) is one of the oldest cereals widely consumed by human being. Wheat is the most important rabi season crop in the country occupying about 50 % of the total area under food crops and accounting for more than 70 % of the total grain production in the rabi season. Moreover, the success of food grain production in India over the years is attributed mainly to the performance of wheat crop. The short day length and low temperature prolong vegetative plant growth phase. However, reproductive phase (anthesis) is highly sensitive to elevated temperature coupled with less humidity, dry air and sharp sun light (Singh *et al.*, 2006). It has been envisaged that at least 110 million tonnes of wheat will be needed by 2020A.D. for food security of Indian population. Since little scope exists for horizontal growth, the alternative seems to be vertical growth by increasing present productivity from 2.83 tonnes per ha to 4.0 tonnes per ha. Temperature is the main environmental factor which determines the rate of development possibly because all plants and processes of development are sensitive to it. Hence, temperature plays a key role in determining sowing time. High temperature (more than 30°C) during grain filling is one of the major constraints in increasing productivity of wheat in tropical countries like India (Rane and Nagarajan, 2004). Grain development in wheat under the north India conditions take place under rising temperature regimes during the month of February to April and as a growth factor, temperature is a major factor determining the grain yield of wheat. The crop environment varies with date of sowing and determines the yield of wheat.

## MATERIAL AND METHOD

### Selection of field

The field experiment was conducted at the Crop Research Centre of Govind Ballabh Pant University of Agriculture and Technology, Pantnagar, U.S. Nagar (Uttarakhand) during the winter season (*rabi*) of 2008-09. Pantnagar is situated at 29°N latitude and 79.3°E longitude and at an altitude of 243.83 m above mean sea level. Geographically Pantnagar comes under humid sub-tropical zone and is situated at the foothills of 'Shivalik range' of Himalayas. It falls under the 'Tarai' area which is narrow belt in the foothills of Himalayas. The soil was silty loam, rich in organic matter, high in available phosphorus and medium in available potassium and neutral in reaction. The experiment was laid out in split plot design with 4 replications with treatments comprising three dates of sowing viz, Nov. 14, Dec. 4 and Dec. 24 in main plots and 6 different wheat varieties viz. 'PBW 17', 'RAJ 3765', 'UP 2526', 'UP 2565', 'UP 2572' and 'UP 2584' in sub-plots. Sowing was done in rows spaced 23 cm apart at a depth of 5 cm. Recommended cultural practices for raising of wheat crop were followed.

### Leaf area index and Mean tilt angle

Plant Canopy Analyzer (LAI-2000, LI-COR, USA) was used to record leaf area index at different stages in this study. This instrument is helpful in indirectly recording leaf area index (LAI), mean tilt angle (an indicator of leaf angle) and gap fraction (proportion of area not covered in a crop canopy) by measuring attenuation of light passing through canopy at five zenith angles. The instrument was set to record one observation above the canopy and 4 observations below the canopy in four replication from each plot.

Therefore, observations from each plot were based on 60 pairs of observations (4 below canopy observation  $\times$  4 replications  $\times$  5 angles). Sixteen below canopy observations were recorded in four separate inter row spacings in net plot area by placing sensor close to left and right rows and in the middle of inter row space. These observations were recorded in diffused light in evening.

### Heat susceptibility index

Heat susceptibility index was given by Fisher and Maurer (1978). Heat susceptibility index (HSI) for all the varieties was calculated for grain yield and other attributes on the basis of high temperature stress (December 24 sowing) and non-stress environments (November 14 sowing) by using the formula as presented by Fisher and Maurer:

$$HSI = (1 - Y_D/Y_P)/D$$

Where,

- HSI = Heat susceptibility index  
 $Y_D$  = mean of genotype in high temperature stress environment  
 $Y_P$  = mean of genotype under non-stress environment  
 $D$  =  $1 - (\text{mean } Y_D \text{ of all genotypes} / \text{mean } Y_P \text{ of all genotypes})$

## RESULT AND DISCUSSION

Leaf area indices recorded at different stages were significantly affected due to main effect of sowing dates and varieties at all the stages. In general, leaf area index increased upto anthesis and declined thereafter. Successive delay in sowing also caused gradual reduction in LAI. November 14 sown crop produced significantly higher LAI than other two sowings at all the stages except 45 and 60 days after sowing where differences in leaf area indices between November 14 and December 4 sown crops were non-significant. December 4 sown crop showed higher LAI than December 24 sown crop at all the stages but the difference was non-significant at 45 and 75 days after sowing (Table 1). At 45 days after sowing, the highest LAI was recorded in Raj 3765 (2.19) followed by UP 2526, UP 2565 and UP 2572. These varieties significantly differed from each other in their LAI. The lowest LAI was recorded in UP 2584 (1.44) which was *at par* with DBW 17 at this stage.

At 60 days after sowing, the highest leaf area index was noticed in variety UP 2572 which was statistically superior to all other varieties. It was followed by UP 2526, Raj 3765 and UP 2565 which were *at par* with each other. The lowest leaf area index was produced by variety UP 2584 which was *at par* with DBW 17. At 75 days after sowing, the highest LAI was observed in variety UP 2526 followed by UP 2572, Raj 3765, UP 2565 and UP 2584. The differences in leaf area indices between any two consecutive varieties were non-significant.

Variety DBW 17 had significantly lower LAI than all other varieties.

At anthesis, variety UP 2526 (4.30) produced significantly higher leaf area index than all other varieties. It was followed by UP 2572 and Raj 3765 which were *at par* with one another. The lowest leaf area index exhibiting variety DBW 17 (3.74) was *at par* with UP 2584 and UP 2565. Variety DBW 17 followed by UP 2565 and UP 2572 produced the highest leaf area index two weeks after anthesis. These varieties being *at par* with each other produced significantly higher leaf area indices than rest of the varieties. Variety UP 2584 being *at par* with UP 2565 produced the lowest leaf area index. The similar results were found by Mishra (2002), Tripathi (2003) and Pande (2009) also reported that timely sown crop had higher LAI than late sown crop.

### Mean tilt angle (MTA)

It can be inferred from Table 2 that mean tilt angle of the crop declined with successive delay in sowings. But differences in mean tilt angle due to sowing dates were non significant at 45 days after sowing. November 14 sown crop being *at par* with December 4 sown crop showed significantly higher mean tilt angle than that of December 24 sown crop at all stages except 45 days after sowing. December 4 and December 24 sown crops statistically did not differ from each other at 75 days after sowing, at anthesis and two weeks after anthesis.

At 45 days after sowing, variety UP 2565 followed by DBW 17, UP 2572, UP 2584 recorded the highest mean tilt angle. Variety Raj 3765 and UP 2526 jointly showed the lowest mean tilt angle. However, varietal differences in mean tilt were non-significant at this stage. At 60 days after sowing, variety DBW 17 had significantly higher mean tilt angle than all other varieties except UP 2584 and UP 2565 which were *at par* with each other. The lowest mean tilt angle was observed in UP 2526 followed by UP 2572, Raj 3765 and UP 2565 which was *at par* with each other. At 75 days after sowing, DBW 17 had significantly higher mean tilt angle than all other varieties except UP 2565 and UP 2584. Variety UP 2565 and UP 2584 being *at par* with each other recorded significantly higher mean tilt angle than Raj 3765. UP 2572 which showed the least mean tilt angle value was *at par* with UP 2526 and Raj 3765.

At anthesis, the highest canopy angle was observed in UP 2565 (50.4°) which was statistically superior to all other varieties except Raj 3765. The lowest mean tilt angle of 47.5° was observed in variety UP 2526 which was *at par* with all other varieties except UP 2565. At two weeks after anthesis, variety UP 2565 showed significantly higher mean tilt angle than all other varieties except UP 2584 and Raj 3765. Varieties UP 2584, Raj 3765, UP 2526 and DBW 17 being *at par* with each other recorded significantly higher mean tilt angle than UP 2572 which had the

lowest mean tilt angle. The similar results were agreement with the result of Mishra (2002) and Pande (2009).

**Heat susceptibility index**

To estimate the heat susceptibility index, six most important yield characters namely grain yield, biological yield, number of ear bearing shoots, grain weight per spike, number of grains per spike and 1000-grain weight were selected. Heat susceptibility index computed for yield and yield attributes indicated that variety Raj 3765 was most heat tolerant variety as it had minimum heat susceptibility indices for all the parameters except biological yield where it was very close to UP 2565 which had the lowest heat susceptibility index of 0.61 (Table 3). Heat susceptibility index for biological yield indicated that variety UP 2584 followed DBW 17 and UP 2572 were most susceptible varieties. Heat susceptibility index for grain yield and 1000-grain

weight showed that Raj 3765 followed by UP 2526, UP 2565 and UP 2572 were the least heat susceptible varieties whereas variety UP 2584 followed by DBW 17 were most heat susceptibility varieties.

For number of ear bearing shoots, Raj3765 followed by UP 2526 and UP 2565 were most heat stress tolerant and UP 2584 followed by UP 2572 and DBW 17 were most heat susceptible varieties. Heat susceptibility index for number of grains per spike was lowest for Raj 3765 followed by UP 2565, UP 2584, UP 2572, UP 2526 and DBW 17 which had the highest heat susceptibility index. Heat susceptibility index for grain weight per spike was lowest in Raj 3765 followed by UP 2565, UP 2526 and UP 2572. The highest value of heat susceptibility index for grain weight per spike was observed in DBW 17 which was followed by UP 2584. High grain yield of a genotype under late sown condition indicated the presence of gene for heat tolerance.

**Table 1:** Effect of sowing dates and varieties on leaf area index at 45, 60, 75 DAS\*, at anthesis and two weeks after anthesis

Treatment	Leaf area index				
	45 DAS*	60 DAS*	75 DAS*	At anthesis	2 weeks after anthesis
<b>Sowing dates</b>					
November 14	1.82	3.07	4.18	4.26	3.64
December 4	1.67	3.05	3.77	3.98	3.19
December 24	1.62	2.90	3.65	3.65	2.74
S.Em.±	0.06	0.03	0.05	0.04	0.08
CD (5%)	0.21	0.10	0.17	0.12	0.28
<b>Varieties</b>					
DBW 17	1.47	2.76	3.47	3.74	3.46
Raj 3765	2.19	3.10	3.96	3.98	3.10
UP 2526	1.87	3.13	4.17	4.30	3.39
UP 2565	1.70	3.08	3.82	3.87	2.99
UP 2572	1.58	3.37	4.02	4.07	3.34
UP 2584	1.44	2.62	3.76	3.82	2.86
S.Em.±	0.04	0.06	0.07	0.06	0.07
CD (5%)	0.12	0.18	0.20	0.16	0.19

\*DAS : Days after sowing

**Table 2 :** Effect of sowing dates and wheat varieties on mean tilt angle (°) at 45, 60, 75 DAS\*, at anthesis and two weeks after anthesis

Treatment	Mean tilt angle (°)				
	45 DAS*	60 DAS*	75 DAS*	At anthesis	2 weeks after anthesis
<b>Sowing dates</b>					
November 14	47.0	50.4	52.5	49.5	47.8
December 4	46.0	49.0	50.0	48.7	46.5
December 24	42.9	44.6	47.4	47.4	45.7
S.Em.±	1.5	1.0	0.8	0.4	0.4
CD (5%)	NS	3.5	2.9	1.4	1.5
<b>Varieties</b>					
DBW 17	45.8	50.6	51.4	48.2	46.3
Raj 3765	44.6	47.3	49.0	49.0	47.1
UP 2526	44.6	45.8	48.9	47.5	46.4
UP 2565	47.1	48.1	51.3	50.4	48.2

UP 2572	45.0	46.3	48.2	47.7	44.7
UP 2584	44.8	49.7	50.9	48.5	47.3
S.Em.±	0.8	0.9	0.6	0.6	0.5
CD (5%)	NS	2.6	1.7	1.8	1.5

\*DAS : Days after sowing

**Table 3 :** Heat susceptibility indices for different parameters in wheat varieties

Varieties	Characters					
	Grain yield (t ha <sup>-1</sup> )	Biological yield (t ha <sup>-1</sup> )	Number of ear bearing shoots m <sup>-2</sup>	Grain weight per spike (g)	Number of grain per spike	1000-grain weight (g)
DBW 17	1.27	1.19	1.24	1.36	1.68	1.29
Raj 3765	0.63	0.64	0.52	0.54	0.37	0.46
UP 2526	0.85	0.85	0.63	0.95	1.62	0.74
UP 2565	0.68	0.61	0.78	0.74	0.50	0.85
UP 2572	1.07	1.29	1.35	1.02	1.31	0.86
UP 2584	1.45	1.38	1.42	1.32	1.03	1.63

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