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Microclimatic profiles under different sowing environments in wheat

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ABSTRACT

Field experiments were conducted at the Research Area of Department of Agronomy, CCS Haryana Agricultural University Hisar during rabi seasons of 2002-03 and 2003-04. The wheat variety WH-711 was sown on two dates: 20th November and 20th December under two planting systems (Flat bed and furrow irrigated raised bed planting system) and with three nitrogen levels (120 Kg N ha^{-1}, 150 Kg N ha^{-1} and 180 Kg N ha^{-1}). The temperature and relative humidity profiles were measured in wheat crop at anthesis and physiological maturity in all the treatments with the help of Assmann psychrometer. The diurnal (0800 to 1400 hrs) air temperature range was 8.1°C (17.4 to 25.5°C) in 2002-03 and 16.0°C (13.2 to 29.2°C) in 2003-04 at anthesis stage of wheat crop. The temperature profiles showed that air temperature were higher in second sowing date than the first. The diurnal variation of relative humidity was more in 20th December sown crop in comparison with 20th November sown crop. Leaf area index, dry biomass production, number of ears per plant and grain yield was recorded in all the treatments.

Key words : Microclimate, air temperature, relative humidity, profiles, planting system, sowing environment.

The low productivity of wheat in India is mainly attributed to the delayed sowing, imbalanced and lower doses of fertilizer application, poor irrigation facilities and adverse weather conditions. It depends largely on the prevailing weather conditions during crop growth period. Plant growth is an interaction of many complex processes, each of which is influenced by genetic and environmental factors. The microclimate of plants is primarily determined by the manner in which radiant energy or heat from the sun is portioned into different fluxes. time of sowing governs the crop phenological development and total biomass production along with efficient conversion of biomass into economic yield. The technique of wheat sowing named FIRBS (Furrow Irrigated Raised Bed Planting System) is a form of conventional tillage wherein sowing is done on the raised beds. The variation in planting/ cropping system modifies the macro and micro environment to which plants are exposed, hence there is need to study the microclimate profiles in wheat under different planting systems and sowing environments.

MATERIALS AND METHODS

Field experiments on "Microclimatic profiles under different planting systems and sowing environments in wheat" were conducted during two consecutive *rabi* seasons of 2002-03 and 2003-04 at the Research Area of the Department of Agronomy, CCS Haryana Agricultural University Hisar, which is situated at 29°10'N latitude, 75°46'E longitude and altitude of 215.2 meters above mean sea level. The main plot treatment consisted of two dates of sowing (20th November and 20th December) and two planting systems (Flat bed and furrow irrigated raised bed planting system) and three nitrogen levels (120 kg N ha^{-1}, 150 kg N ha^{-1} and 180 kg N ha^{-1}) in sub plots. The twelve treatment combinations were tested in split plot design with four replications. The wheat variety WH-711 was grown with all other recommended packages of practices by the University.

The observation on the days taken by various phenological events like crown root initiation, tillering, jointing, booting, anthesis, milking and physiological maturity were recorded on five tagged plants in each plot on alternate days during the both crop seasons. The plants from 25cm length were uprooted from each plot for leaf area measurement by detaching the leaf from each uprooted plant and then passing them through leaf area meter (Licor 3000) at different phenophases and leaf area index was calculated. The same plants were also used for dry matter observation. Sun dry plant samples were dried in oven at 65±5°C temperature till constant weight was attained. The dry weight was then converted to dry weight per square meter. The plant height, number of ears per plant and grain yield were recorded at the time of crop harvest.

Dry bulb and wet bulb temperature were measured on diurnal basis at different phenological stages during 0800-1600 hours at three levels of crop canopy: lower (ground level), middle (50cm) and upper (100cm) with the help of Assmann Psychrometer inside the crop and these values were used to find out daily relative humidity values within the crop using psychometric tables. The temperature and humidity profiles were drawn at two phenological stages of the crop to reflect the crop microclimate.

All the experimental data on growth and yield were statistically analysed and critical difference (CD) was worked out as described by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

The microclimate of a crop stand is largely influenced by air temperature within and above the canopy. Air temperature within canopy has direct effect on physiological process such as photosynthesis, transpiration and respiration. It also determines thermal environment within crop stand.

Temperature profiles

Temperature profiles were drawn at anthesis and physiological maturity of wheat crop in both crop seasons.

Diurnal air temperature profiles in wheat crop in D_1, P_1 and N_3 treatments at anthesis stage during 2002-03 and 2003-04 are depicted in Fig. 1. The temperature profile indicates that the air temperature increased with crop height during morning hours (0800 and 1000 hrs) in all the treatments during 2002-03. While during 1200 and 1400 hours air temperature decreased with crop height. The shape of diurnal temperature profiles was similar during second season also i.e. 2003-04, but the air temperature values were comparatively higher in this season at anthesis stage in all the treatments. The slope of diurnal profiles among different treatments was some what similar, therefore profiles for above said three treatments were selected. The diurnal variation of temperature was from 17.4 to 25.5°C at anthesis inside the crop canopy during 2002-03. The corresponding diurnal variation during 2003-04 was from 13.2 to 29.2°C.

The crop canopy was cooler than above during morning and late afternoon hours. However, the crop canopy was warmer during noon hours, this might be because of more absorption of radiation by the lower canopy and soil surface.

The temperature profiles in wheat crop in D_1, P_1 and N_3 treatments at crop maturity during 2002-03 and 2003-4 are depicted in Fig. 2.

The temperature profiles show that crop canopy was cooler as compared to outside in morning hours. The march of temperature profiles with height was also some what similar as that of anthesis stage. The diurnal variation of temperature was between 21.0 and 32.4°C at physiological maturity irrespective of treatments during first season. The corresponding values during second season were between 22.7 and 38.9°C. The above data reveals that first crop season (2002-03) was cooler than second season (2003-04) at physiological stages. Baldocchi *et al.* (1983) and Ram Niwas *et al.* (1989) also studied the microclimate of soyabean and raya, respectively.

Relative humidity profiles

The relative humidity profiles were also drawn at anthesis and physiological maturity of wheat crop in different treatments.

The diurnal variations in relative humidity under D_1, P_1 and N_3 treatments at anthesis stage inside the crop canopy are shown in Fig. 3 during 2002-03 and 2003-04. The profiles of relative humidity indicate that relative humidity was higher in crop canopy than that of above crop canopy. Relative humidity values were higher inside the crop canopy thorough out the day in all the treatments. The diurnal relative humidity (0800 to 1400 hrs) ranged from 52 to 95

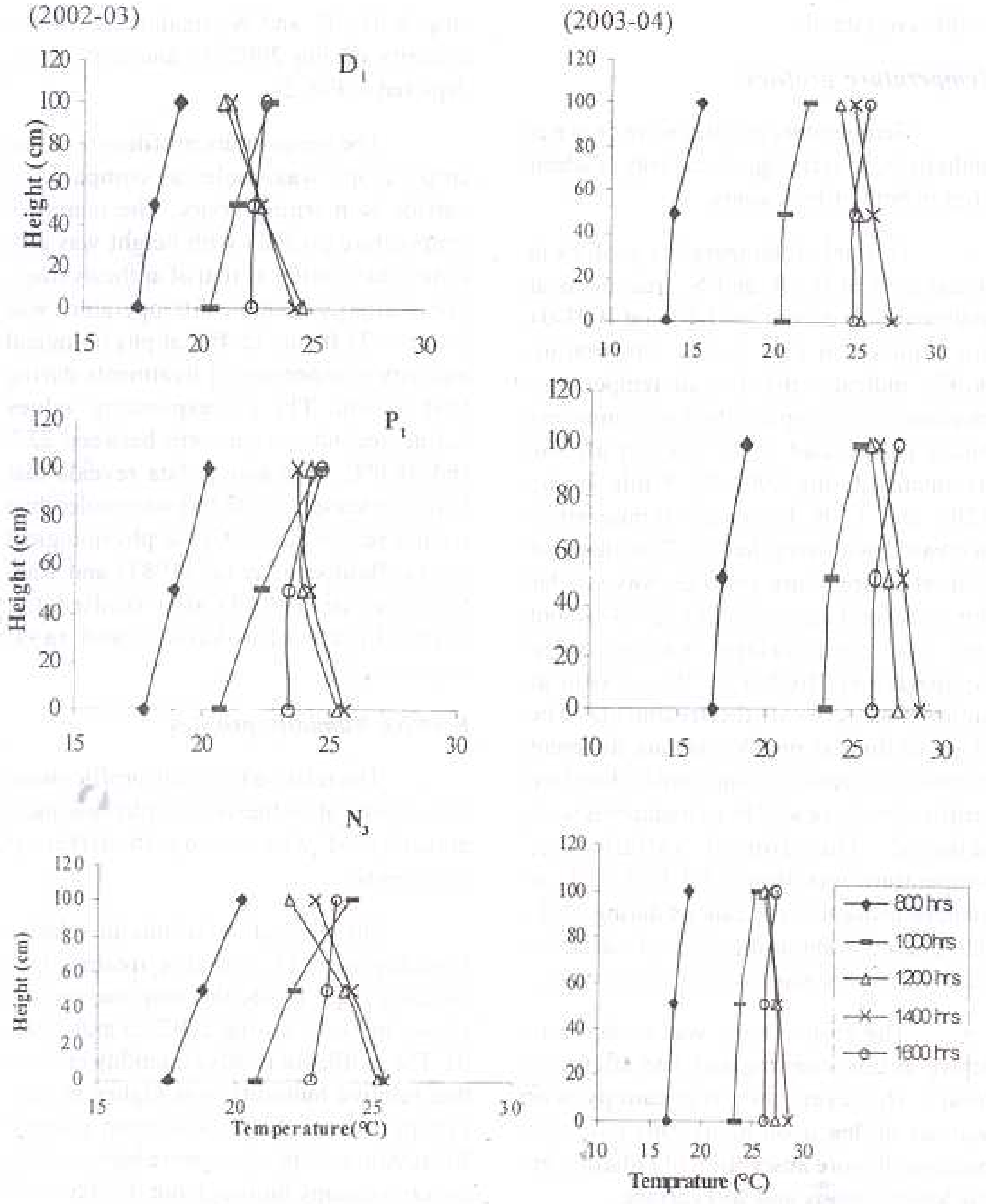

Fig. 1: Temperature profiles under different treatments at anthesis in wheat during 2002-03 and 2003-04.

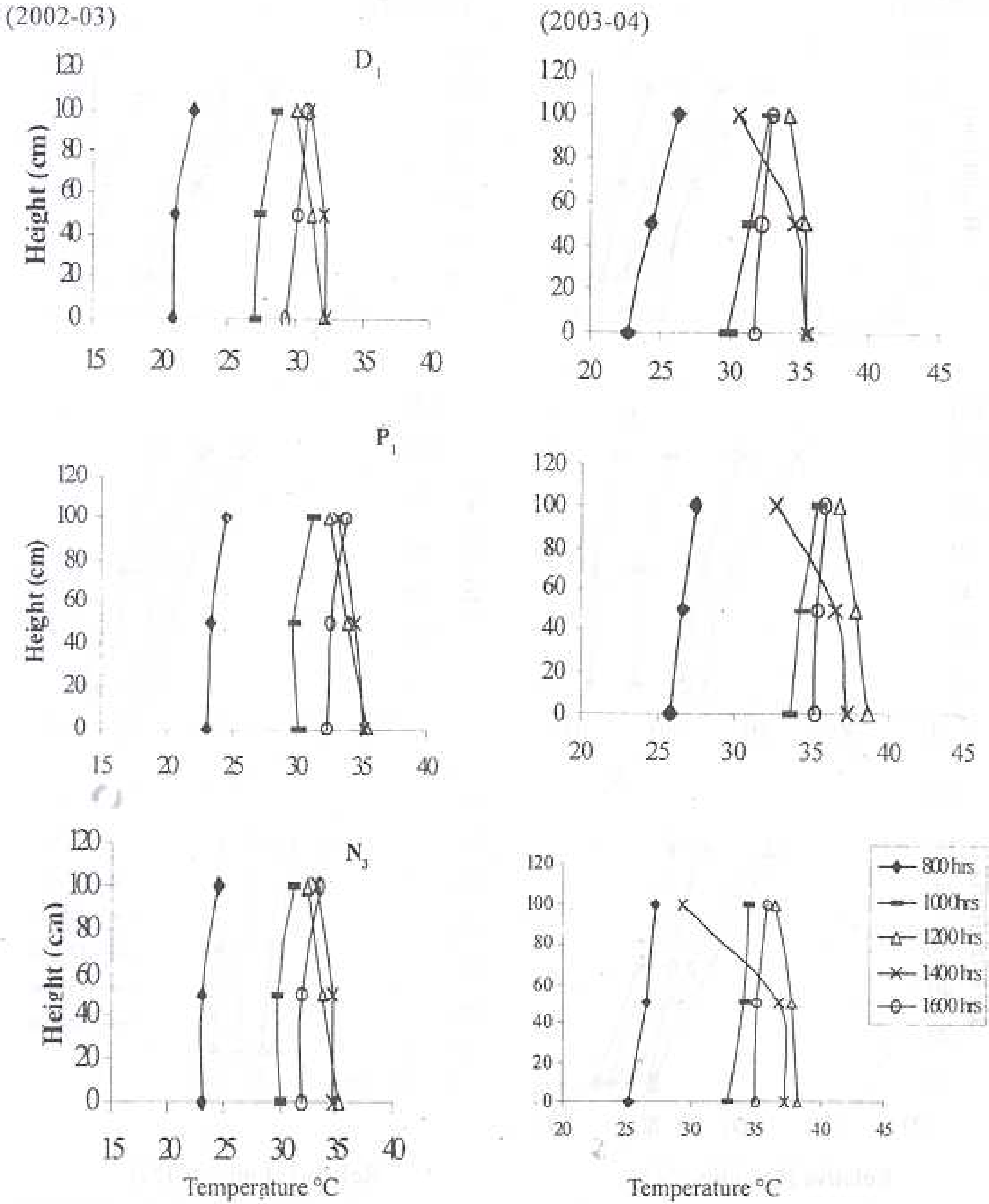

Fig. 2: Temperature profiles under different treatments at physiological maturity in wheat during 2002-03 and 2003-04.

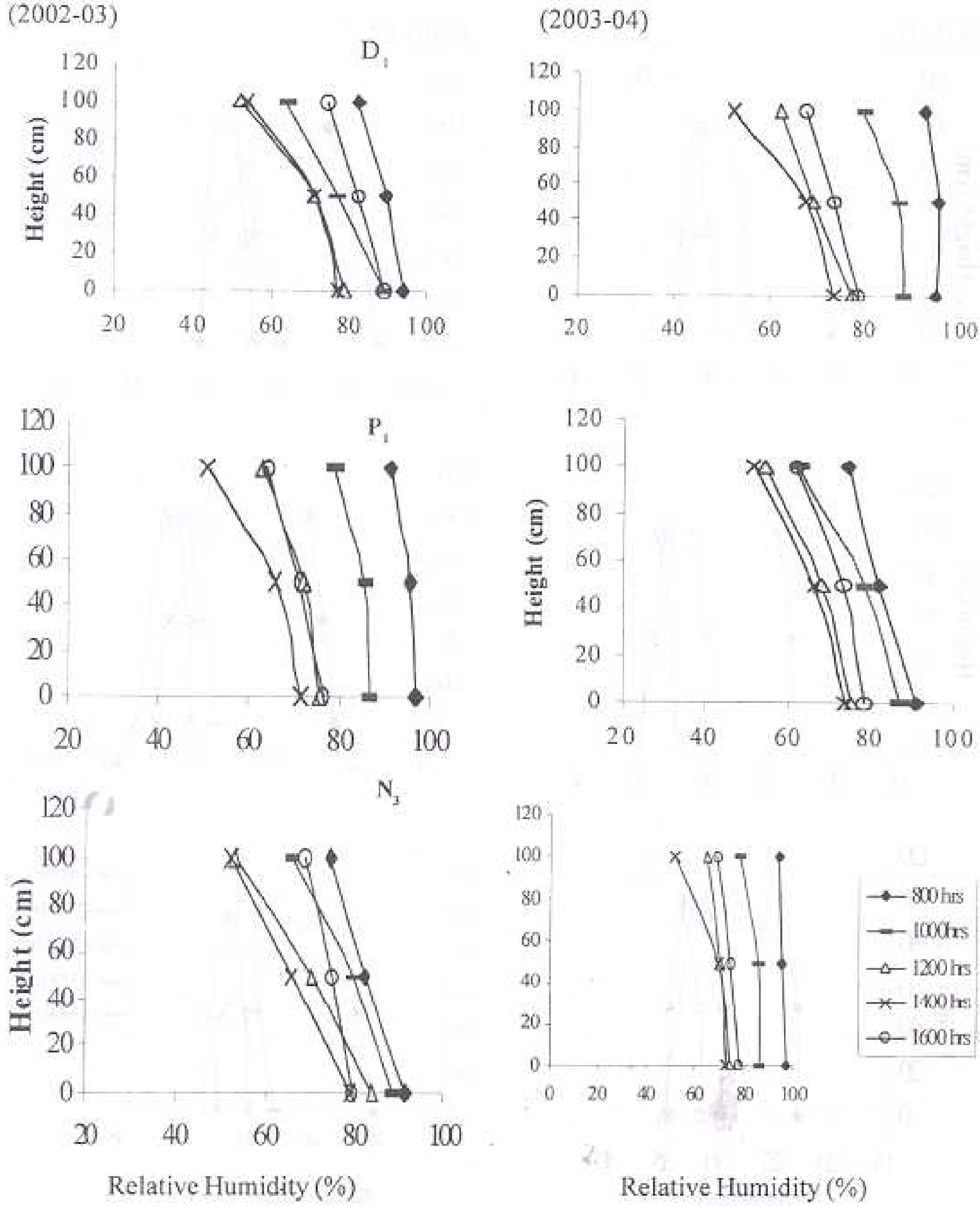

Fig. 3: Humidity profiles under different treatments at anthesis in wheat during 2002-03 and 2003-04.

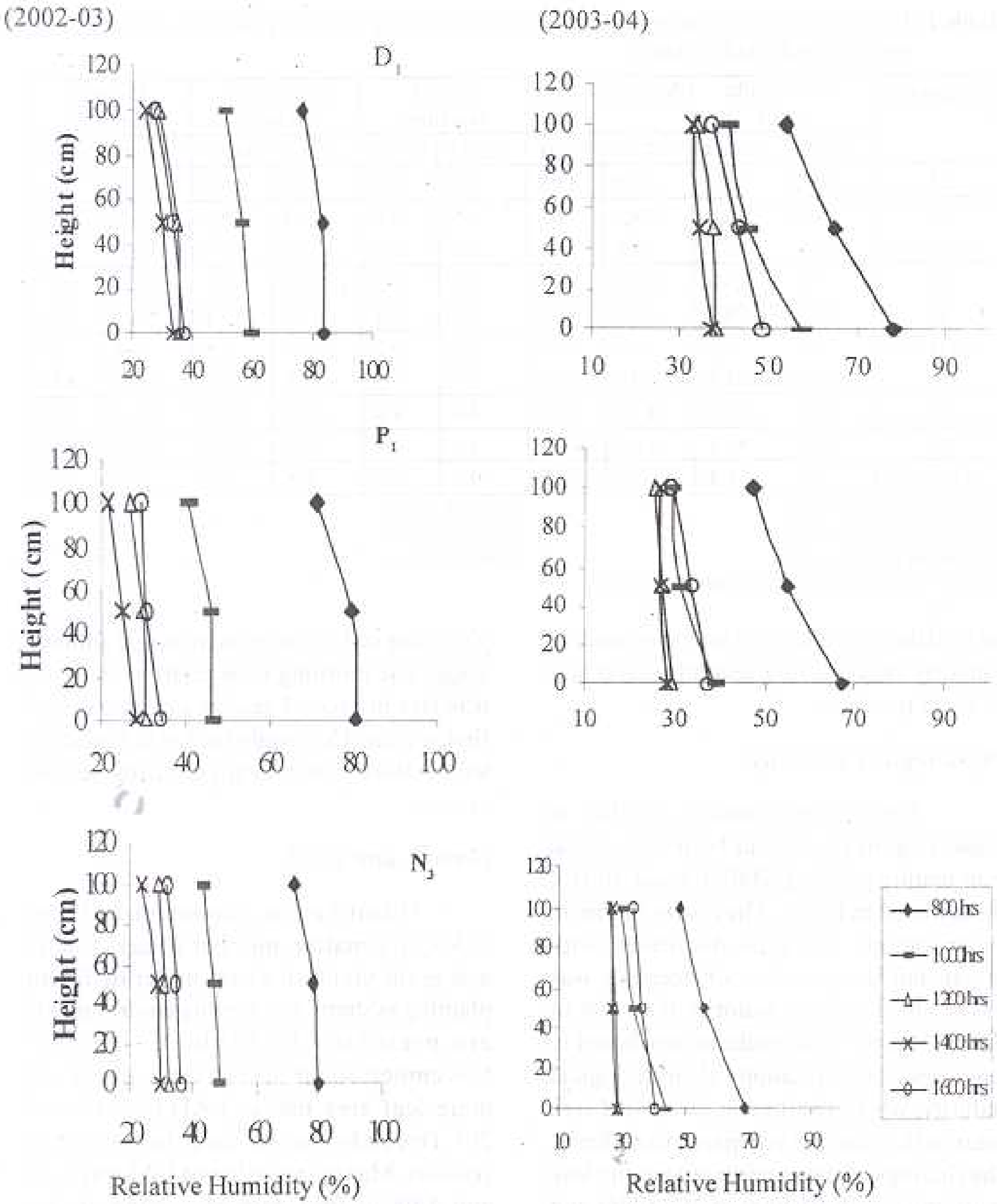

Fig. 4: Humidity profiles under different treatments at physiological maturity in wheat during 2002-03 and 2003-04.

Table 1: Effect of different treatments on plant height, leaf area index, dry biomass, number of ears per plant and yield of wheat

Treatment	Plant height (cm)		Maximum LAI		No. of ears/plant		Grain yield (q ha^{-1})		Biomass (q ha^{-1})	
	02-03	03-04	02-03	03-04	02-03	03-04	02-03	03-04	02-03	03-04
D_1	83.7	80.3	4.38	4.08	4.9	4.7	51.3	46.2	108.5	98.6
D_2	77.4	74.4	3.85	3.67	3.9	3.6	44.4	40.2	93.2	87.2
CD at 5%	1.3	1.7	0.4	0.3	0.3	0.2	0.7	0.6	2.8	2.1
P_1	79.1	76.3	4.19	3.93	4.2	3.9	48.6	44.1	102.7	94.7
P_2	82.1	78.4	4.04	3.83	4.6	4.4	47.0	42.4	99.1	91.0
CD at 5%	1.3	1.7	0.3	0.2	0.3	0.2	0.7	0.6	2.8	2.1
N_1	74.6	71.4	3.45	3.35	3.9	3.6	43.6	38.8	91.7	84.0
N_2	81.2	77.6	4.28	3.90	4.6	4.0	49.0	43.9	103.4	94.2
N_3	85.9	83.1	4.61	4.38	4.7	4.9	50.9	47.0	107.6	100.5
CD at 5%	1.9	1.8	0.3	0.2	0.2	0.2	0.8	1.0	2.5	2.5

D_1-20th November sowing
D_2-20th December sowing
P_1- Flat bed planting system
P_2- Furrow irrigated raised bed planting system
N_1-120 kg N ha^{-1}
N_2-150 kg N ha^{-1}
N_3-180 kg N ha^{-1}

per cent during 2002-03. The corresponding humidity range during second season was 50 to 98 per cent.

Physiological maturity

The relative humidity profiles in wheat crop in D_1, P_1 and N_3 treatments at crop maturity during 2002-03 and 2003-4 are depicted in Fig. 4. They were higher in lower canopy and than decreased with height, but the quantum of decrease was less at physiological maturity than that of anthesis stage. This might be attributed to senescence of crop canopy at physiological maturity, which resulted in lower leaf area index at this stage as compared to anthesis. The findings of the experiment are in close conformity with Bishnoi *et al.* (1996) and Sattar *et al.* (2003). The humidity values during 0800 to 1600 hours were lower at physiological maturity than that of anthesis stage. The morning time relative humidity was less in second season as compared to first season. This might be due to higher air temperature that prevailed during second season.

Growth and yield

Plant height, maximum leaf area index, dry matter, number of ears plant^{-1} and grain yield of wheat under different planting systems and sowing environments are presented in Table 1. The 20th November sown wheat crop produced more leaf area index (LAI) than that of 20th December sown crop in both crop seasons. Maximum value of LAI was 4.38 and 4.08 in first date of sowing during 2002-03 and 2003-04, respectively. The LAI was lower in second season, probably due to higher temperature observed in this season. Bishnoi *et al,* (1996) reported higher values of LAI for wheat in optimum date of sowing 25th November as compared to delayed one.

The dry biomass, yield attributes and grain yield were higher in first season as compared to second season. As depicted in temperature profiles, the second was warmer than first season, which caused forced maturity in wheat crop and ultimately reduction in grain yield. Dry biomass and grain yield were maximum in 20th November sown wheat crop in both years. Prabhakar *et al,* (2002) and Singh *et al,* (2003) also reported that delayed sowing significantly reduced the grain yield. The grain yield and dry biomass were higher in flat sowing as compared to ridge bed planting system. Jat and Singhi (2003) reported that conventional planting system produced some more grain yield as compared to furrow irrigated ridge bed planting system.

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