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Abhijeet Sharma ML Khichar
Department of Agricultural Meteorology, CCS Haryana Agricultural University Hisar, Haryana, India

Neha Pandey Ram Niwas Premdeep
Department of Extension Education, Bihar Agricultural University, Sabour, Bihar, India

Surender Kumar
Department of Plant pathology, C.S.A. University of Agri & Tech, Kanpur, Uttar Pradesh, India

Correspondence
Abhijeet Sharma ML Khichar
Department of Agricultural Meteorology, CCS Haryana Agricultural University Hisar, Haryana, India

Quantification of microclimate of cotton hybrids under different sowing environments

Abhijeet Sharma ML Khichar, Neha Pandey Ram Niwas Premdeep and Surender Kumar

Abstract
An experiment was conducted to quantification of microclimate of cotton hybrids under different sowing environments at research farm of Department of Agricultural Meteorology, Chaudhary Charan Singh Haryana Agricultural University, Hisar (long.75^0 46 / E, lat. 29^{0}10 / N and alti. 215.2 meters MSL) during *kharif* season of the year 2013. The main plot treatments consist of three date of sowing i.e. D_1- 4th week of April, D_2- 2nd week of May, D_3- 4th week of May and sub plot treatments consist of two *Bt* hybrid i.e. V_1- Ankur 3028 BG II, V_2- BIO 6588 BG II and non *Bt* hybrid V_3- HHH 223 with two row orientations i.e. NS- North-South and EW- East-West. The eighteen treatment combinations were tested in split plot design with three replications. Dry and wet bulb temperatures were measured at a interval of three hours from morning to evening at the three levels of crop canopy i.e. lower, middle and upper with the help of Assmann Psychrometer at different phenophases of cotton. These values were used to find out the microclimate parameters i.e. temperature, relative humidity and vapour pressure with the help of psychrometric tables. Diurnal temperature and relative humidity profiles at different growth stages of different cotton under three sowing environments with two row orientations i.e. NS- North-South and EW- East-West were studied. The morning and evening time temperature profiles were inverse and lapse *i.e.* increase and decrease in temperature with height inside the crop canopy respectively, whereas, noon hours profiles were nearly isothermal. Diurnal temperatures were higher in east-west cotton hybrids as compared to north-south hybrids. The diurnal spread of temperature profiles was higher in first sown cotton hybrids as compared to late sown hybrids. The diurnal spread of temperature profiles was nearly same in all the cotton hybrids**.** The relative humidity profiles were lapse *i.e.* decrease in humidity with crop height in all the treatments under north-south and east-west conditions. The relative humidity was higher in north-south crop as compared to east-west hybrids. The diurnal spread of relative humidity profiles was less in case of north-south hybrids in comparison with east-west. Relative humidity was higher in crop canopy as compared to top of the canopy in all the treatment combinations. Studies clearly showed that the crop microclimate provide valuable information regarding the interaction of the crop with its environment. The sowing date and orientation are two most important variables for evaluation of optimum microclimate of the crop for maximum growth and yield.

Keywords: microclimate, hybrids, environments, profiles

Introduction
Cotton has retained its unique fame and name as the "king of fibres" and "white gold" because of its higher economical value among cultivable crops for quite a long period. Cotton is important commercial cash crop in India contributing a prominent share in foreign exchange earnings of the country. The meteorological factors play an important role in the development of plant growth and insect pest population. Untimely rainfall, as well as humid weather during later stages of cotton growth, primarily once the bolls begin to open, may complicate defoliation; reduce yield and quality, lower the crop's ginning properties (Freeland *et al*., 2004) [2]. A better understanding of weather resources can help increase the crop productivity (Kaur *et al*., 2004) [3]. Solar radiation provides the energy for the process that derive photosynthesis, affecting carbohydrates portioning and biomass growth of the individual plant components. Biomass accumulation by a crop depends on its ability to intercept and utilize solar radiation. That's why a better understanding of weather resources can help increase the crop productivity as well gives higher yield. Temperature regulates many of the physical and chemical processes within the plant, which in turn control the rate of growth and development toward maturity. The crop growth and development depends upon the thermal time or quantitative effect of temperature. Cotton requires a minimum daily air temp. of 15^{0}C for germination, 21-27^{0}C for vegetative growth and 27-32^{0}C for during the fruiting period. Current commercial hybrids generally need more than 150 days above 15^{0}C to produce a crop, become an active at temperature below 15^{0}C, and are killed by freezing temperatures

(Waddle, 1984) [6]. Adverse effects of temperature becomes more pronounced when it deviates from optimum during the period of crop growth. Major sources of temperature variations during the during *rabi season* over North India are the temporary warming and cooling of atmosphere caused by weather associated with passage of western disturbances in this season. While agronomic and physiological aspects of crop growth on cotton have been widely studied in the country, the influence of different agro meteorological indices (Thermal time, Heliothermal units. Photo-thermal units etc.) on crop growth are yet to be developed for cotton crop. The sowing time and planting direction are two most important variables bringing change in crop microclimate and consequently growth and yield of cotton. Crop geometry, through change in time and extent of crop canopy, will also influence microclimate and rate of crop growth. The variation in time and direction of sowing modifies the macro and microclimate to which plants are exposed, hence, there is need to study the effect of microclimate on crop growth. Therefore a research work has been carried out to quantify the microclimate of cotton hybrids under different sowing environments.

Material & Methods

A field experiment was conducted at research farm of Department of Agricultural Meteorology, Chaudhary Charan Singh Haryana Agricultural University, Hisar The experiment was laid in split-plot design with three dates of sowing D_1- 4th week of April, D_2- 2nd week of May, D_3- 4th week of May as the main plots treatments in combination with three cotton varieties viz. V1- Ankur 3028 BG II, V2-BIO 6588 BG II and V3-HHH-223 as the sub-plots having two row orientation i.e. NS- north-south and EW-east-west each.

Agrometeorological observations

The dry and wet bulb temperature were measured with the help of Assmann Psychrometer at different phenophases of cotton. For recording the agrometeorological observations, following methods were adopted: Dry and wet bulb temperatures were measured at a interval of three hours from 8:00 AM, 1.00 PM and 5:00 PM at the three levels of crop canopy : lower, middle and upper with the help of Assmann Psychrometer at different phenophases of cotton. These values were used to find out relative humidity and vapour pressure in the crop with the help of psychrometric tables.

Results and Discussions

Diurnal profiles of temperature and relative humidity

Temperature

Diurnal profiles of air temperature from 30 to 180 DAS in cotton hybrids ANKUR 3028 BG II, BIO 6588 BG II and HHH 223 in three growing environments under north-south and east-west conditions during 2013 are depicted in Figures. 1 to 8. Maximum temperatures were observed at 1400 hours in three growing environments and three hybrids under north-south as well as east-west conditions, whereas minimum temperatures were recorded at 0800 hours during 2013.

The morning (0800 hours) and evening time (1700 hours) temperature profiles were inverse and lapse *i.e.* increase and decrease in temperature with height inside the crop canopy respectively, whereas, noon hours profiles were nearly isothermal This might be due to deeper penetration of radiation inside crop canopy during noon than morning and evening hours. Khichar and Ram Niwas (2006) [6] also reported the simillar temperature profile in wheat crop under different sowing environments. Similar results on temperature profiles were found by Singh *et al.*, (2005) [5] in cotton crop and Bose (2008) in pearl millet.

Diurnal temperatures were higher in east-west cotton hybrids as compared to north-south hybrids. The diurnal spread of temperature profiles was higher in first sown cotton hybrids as compared to late sown hybrids. The diurnal spread of temperature profiles was nearly same in all the cotton hybrids.

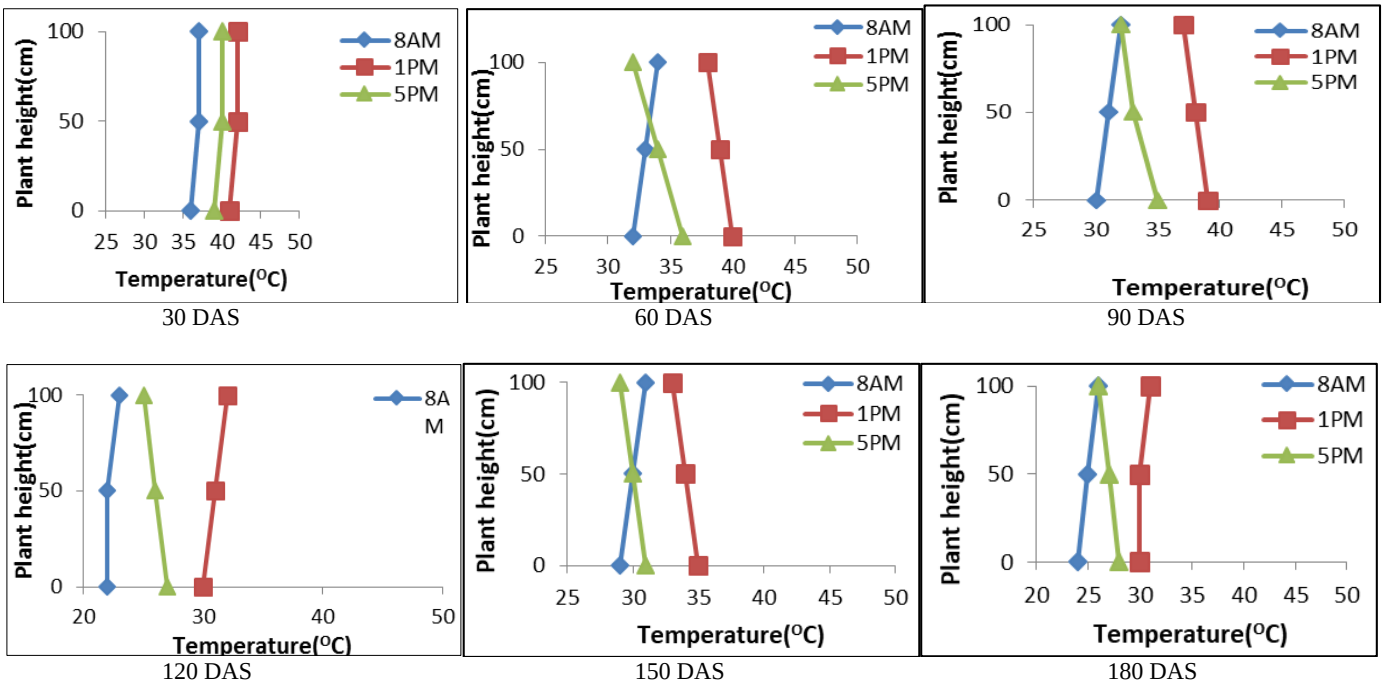


Fig 1: Diurnal profiles of temperature in cotton crop during first date of sowing (D_1)

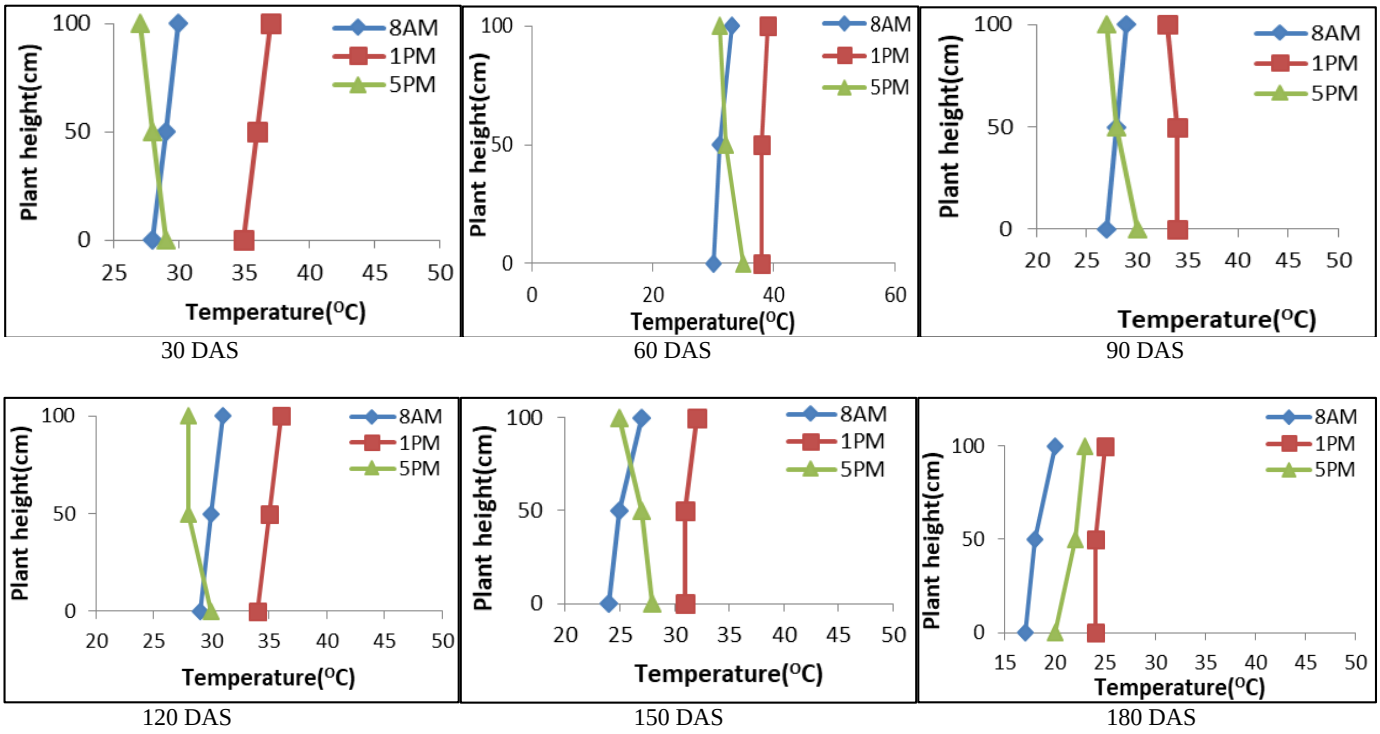


Fig 2: Diurnal profiles of temperature in cotton crop during second date of sowing (D_2)

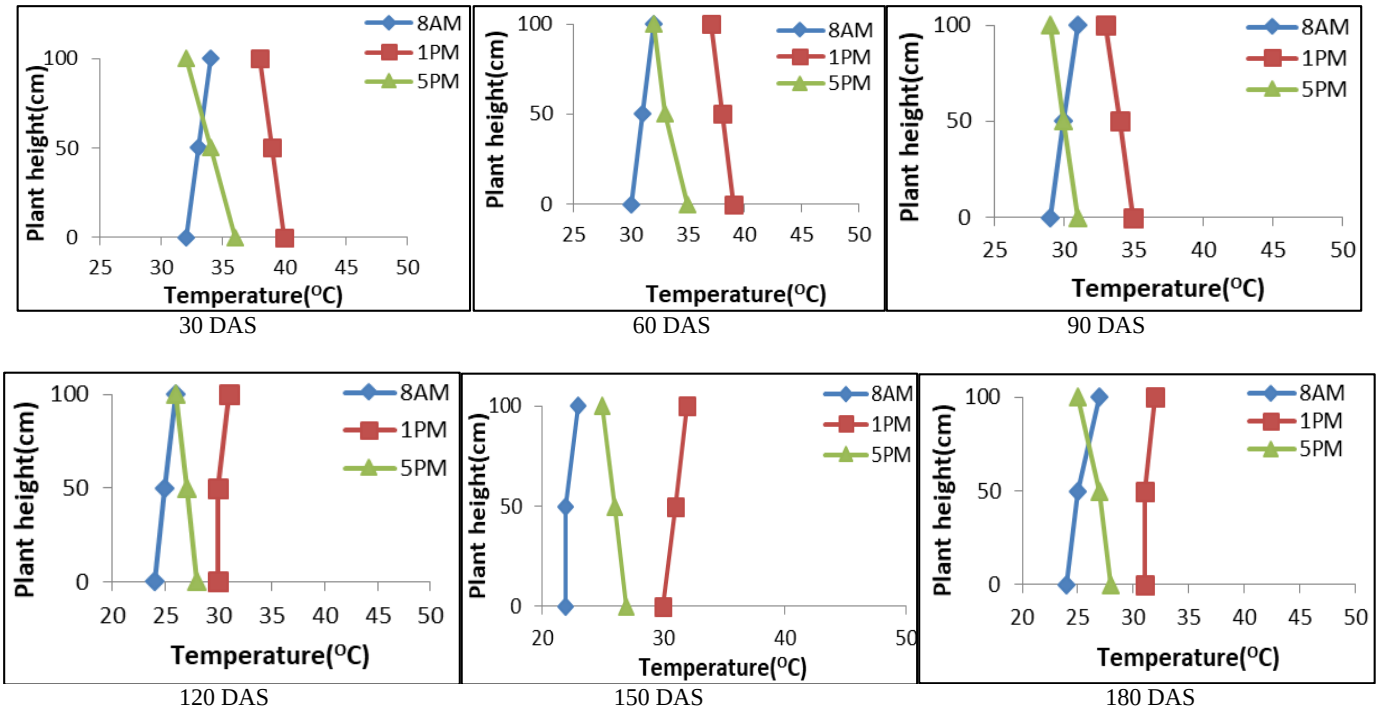
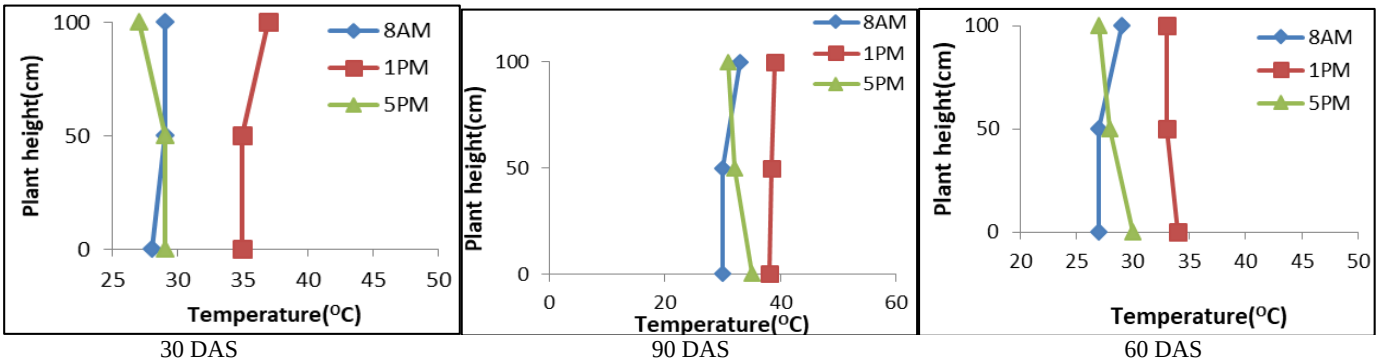
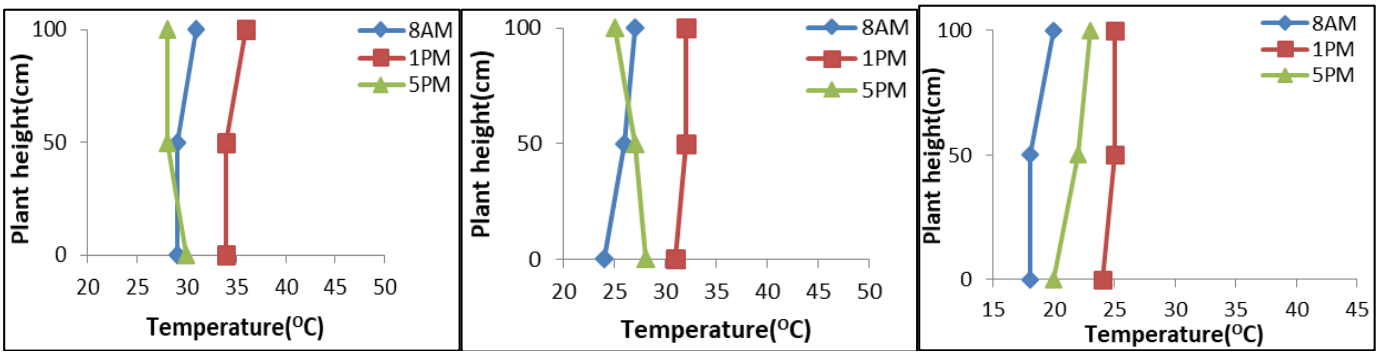


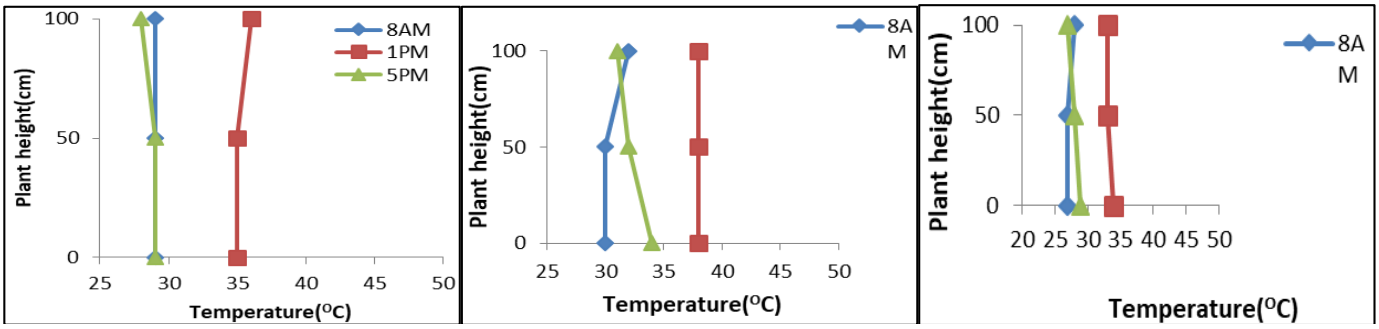
Fig 3: Diurnal profiles of temperature in cotton crop during third date of sowing (D_3)



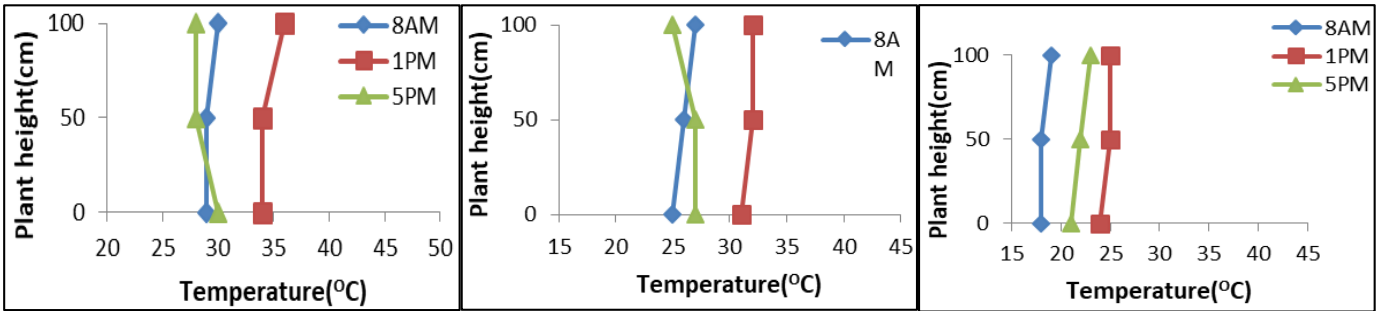


120 DAS 150 DAS 180 DAS

Fig 4: Diurnal profiles of temperature in cotton hybrid (Ankur 3028 BG II)

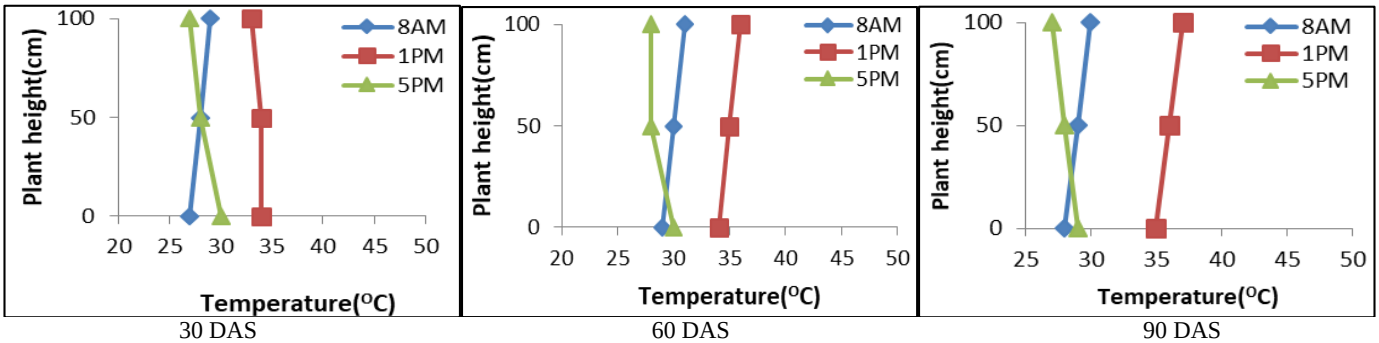


30 DAS 60 DAS 90 DAS

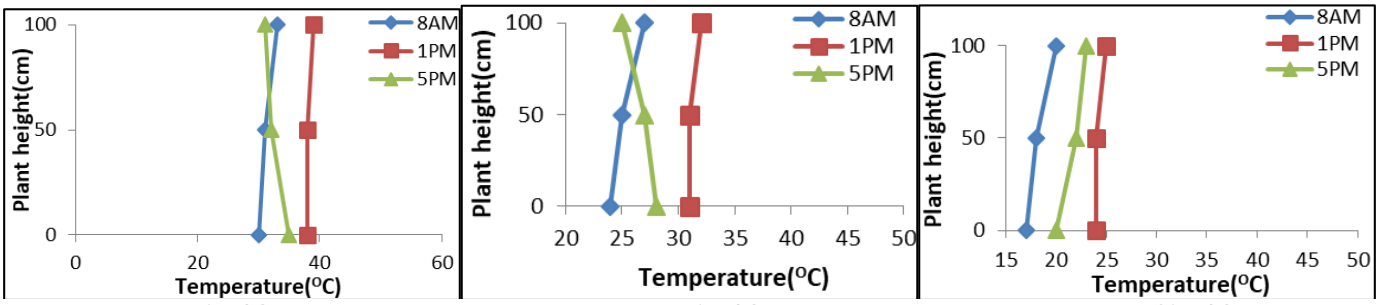


120 DAS 150 DAS 180 DAS

Fig 5: Diurnal profiles of temperature in cotton hybrid (BIO 6588 BG II)



30 DAS 60 DAS 90 DAS



120 DAS 150 DAS 180 DAS

Fig 6: Diurnal profiles of temperature in cotton hybrid (HHH 223)

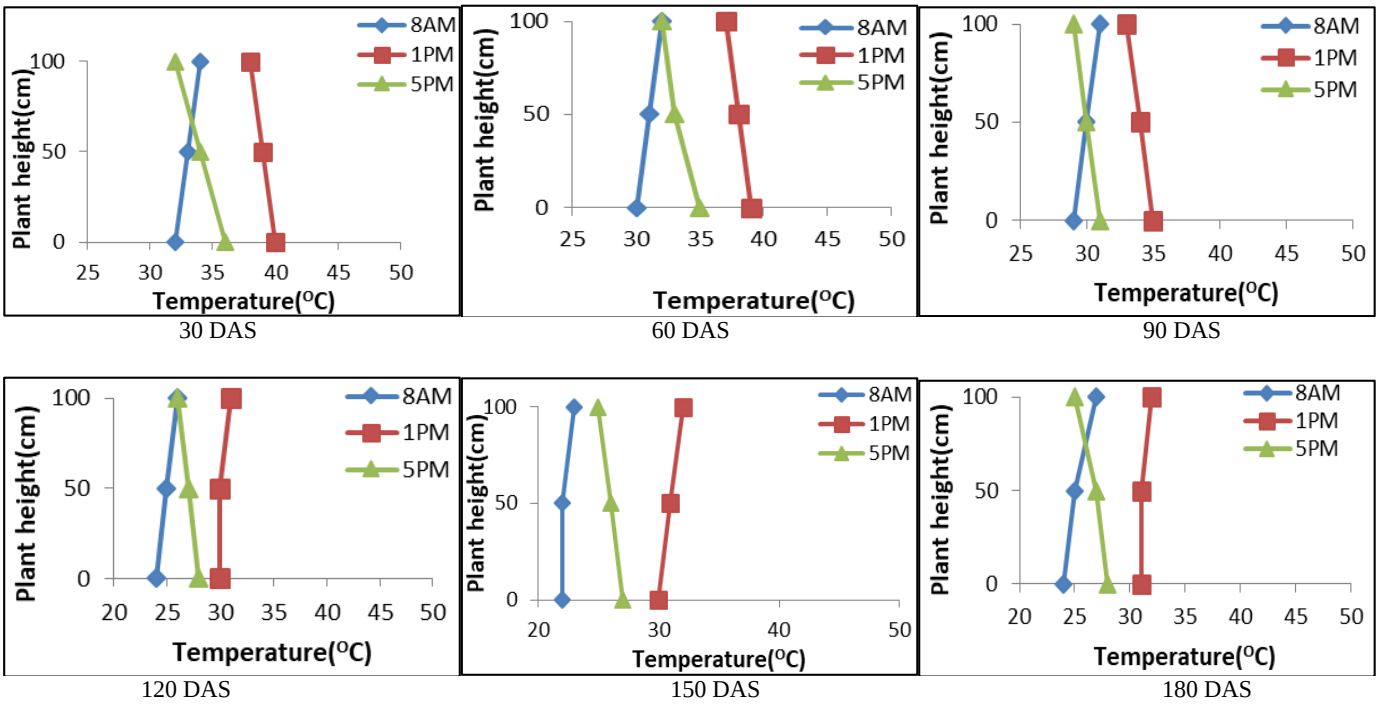


Fig 7: Diurnal profiles of temperature in cotton crop sown in North-South direction

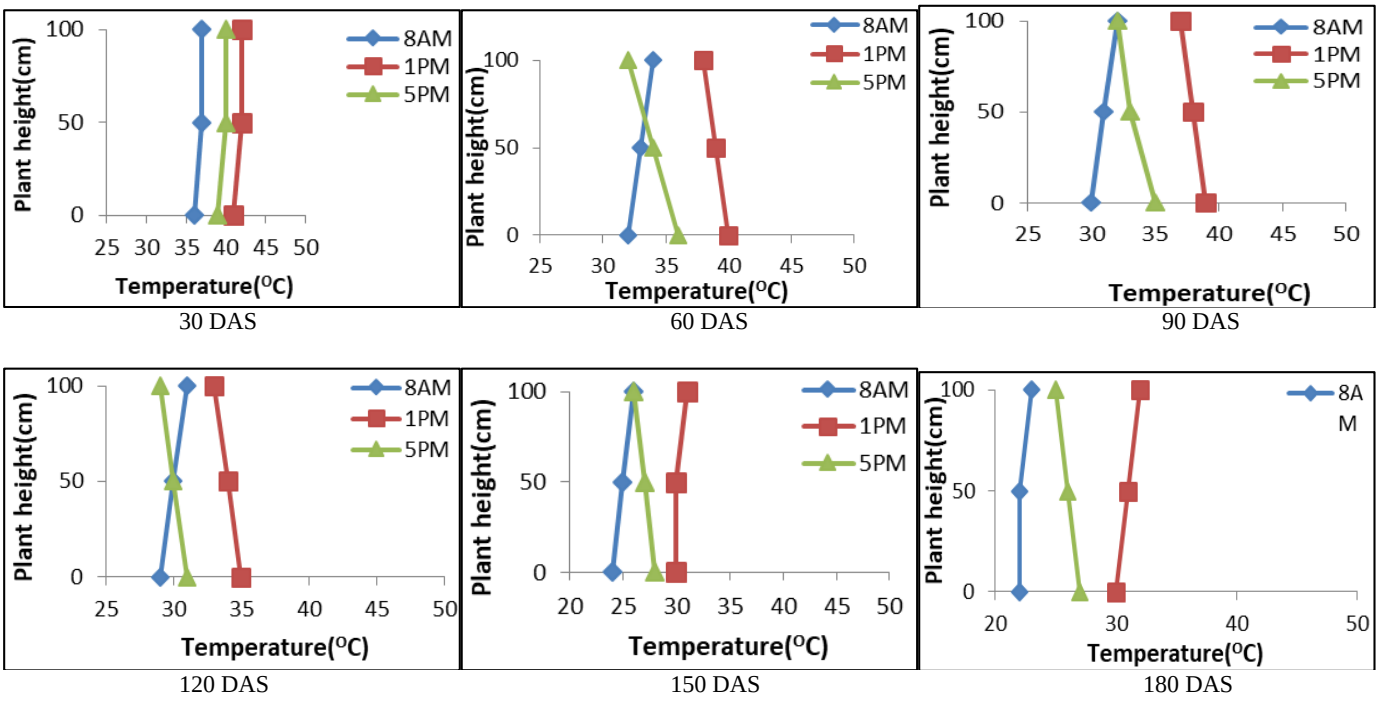
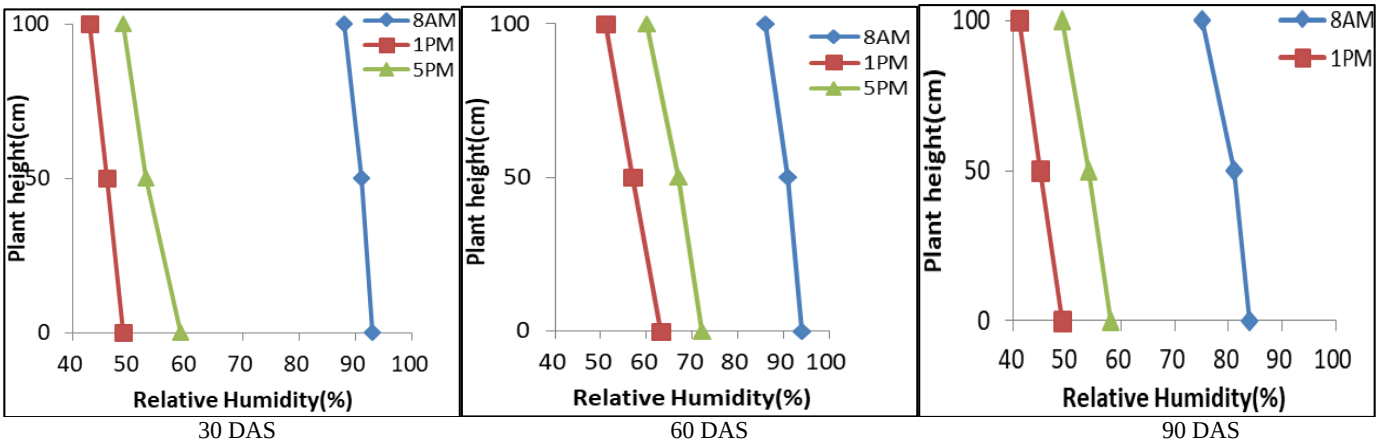


Fig 8: Diurnal profiles of temperature in cotton crop sown in east-west direction



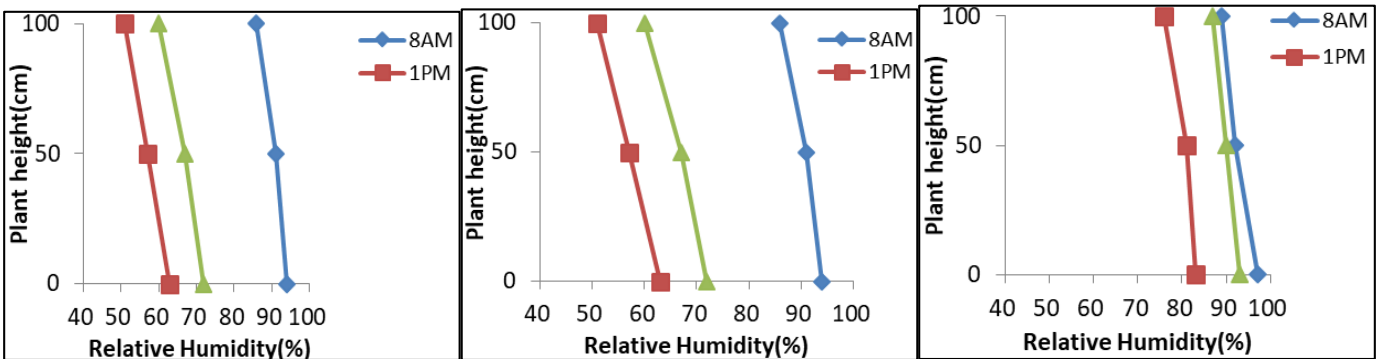


Fig 9: Diurnal profiles of relative humidity in cotton crop during first date of sowing

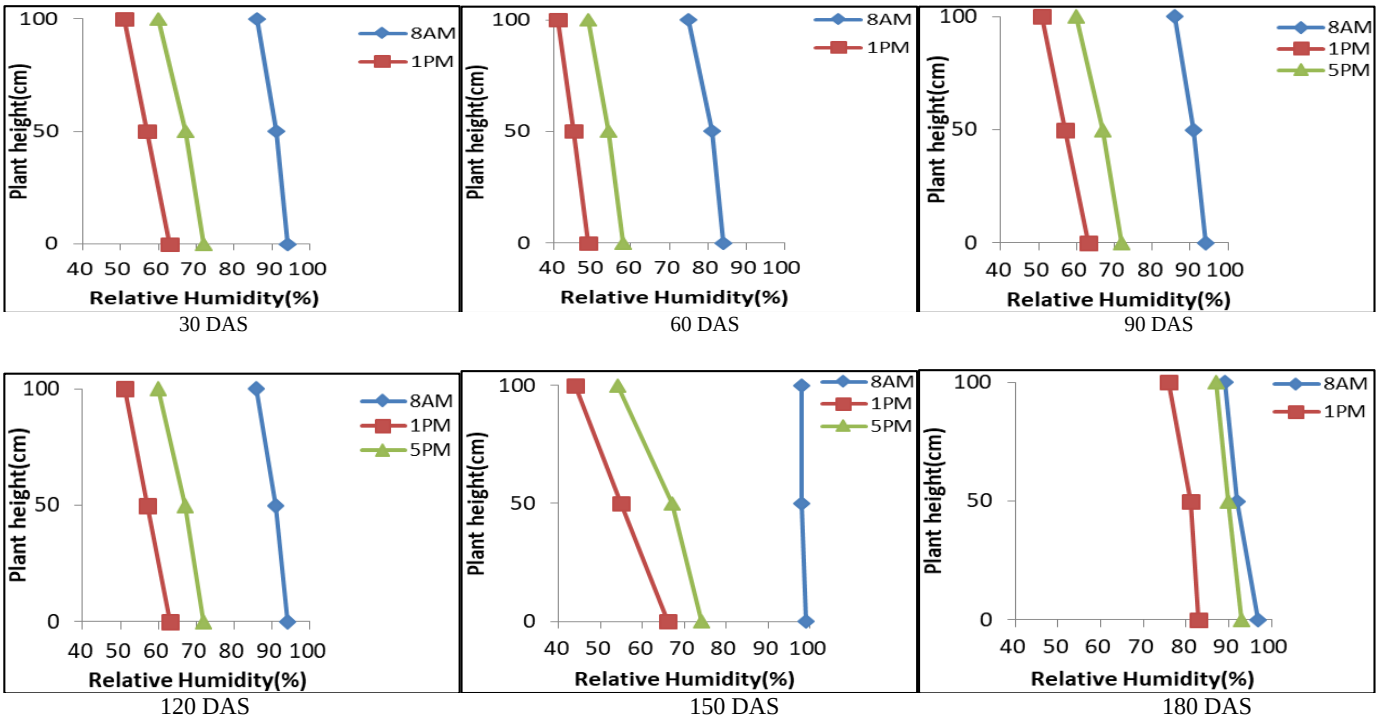


Fig 10: Diurnal profiles of relative humidity in cotton crop during second date of sowing

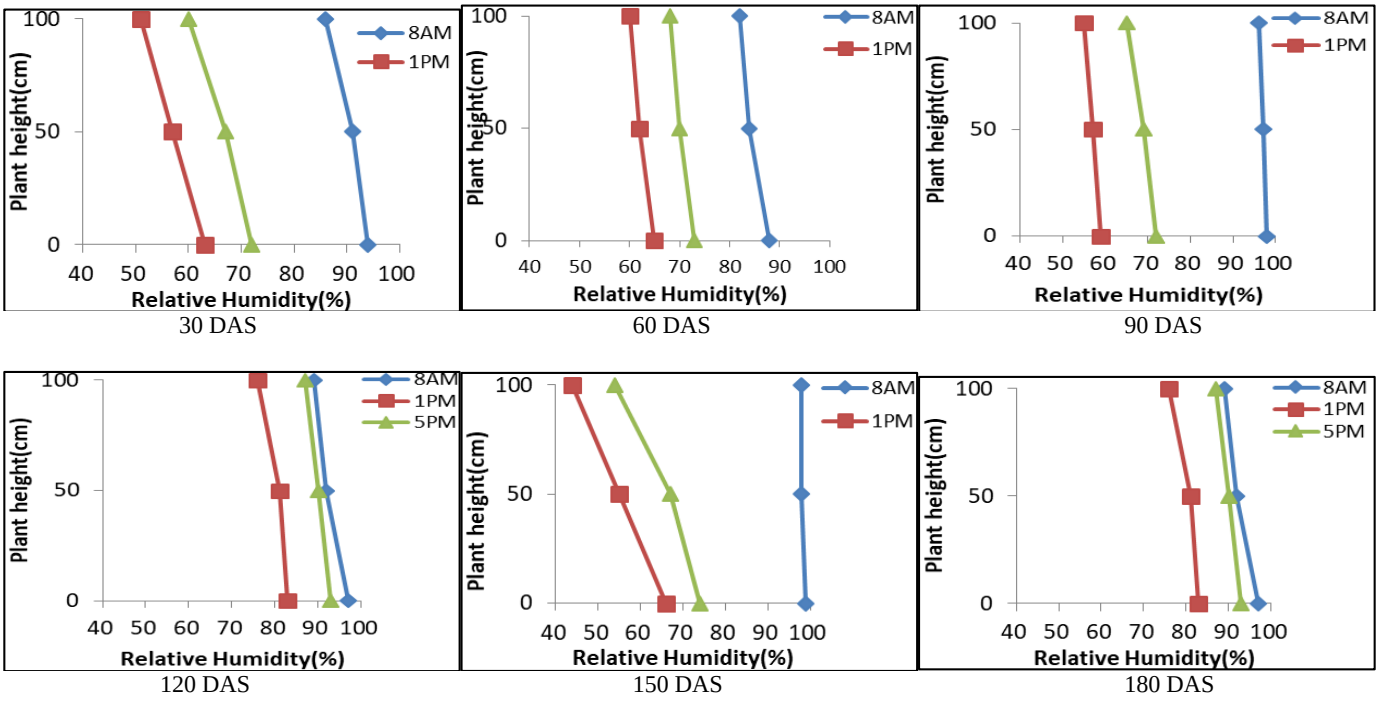


Fig 11: Diurnal profiles of relative humidity in cotton crop during third date of sowing

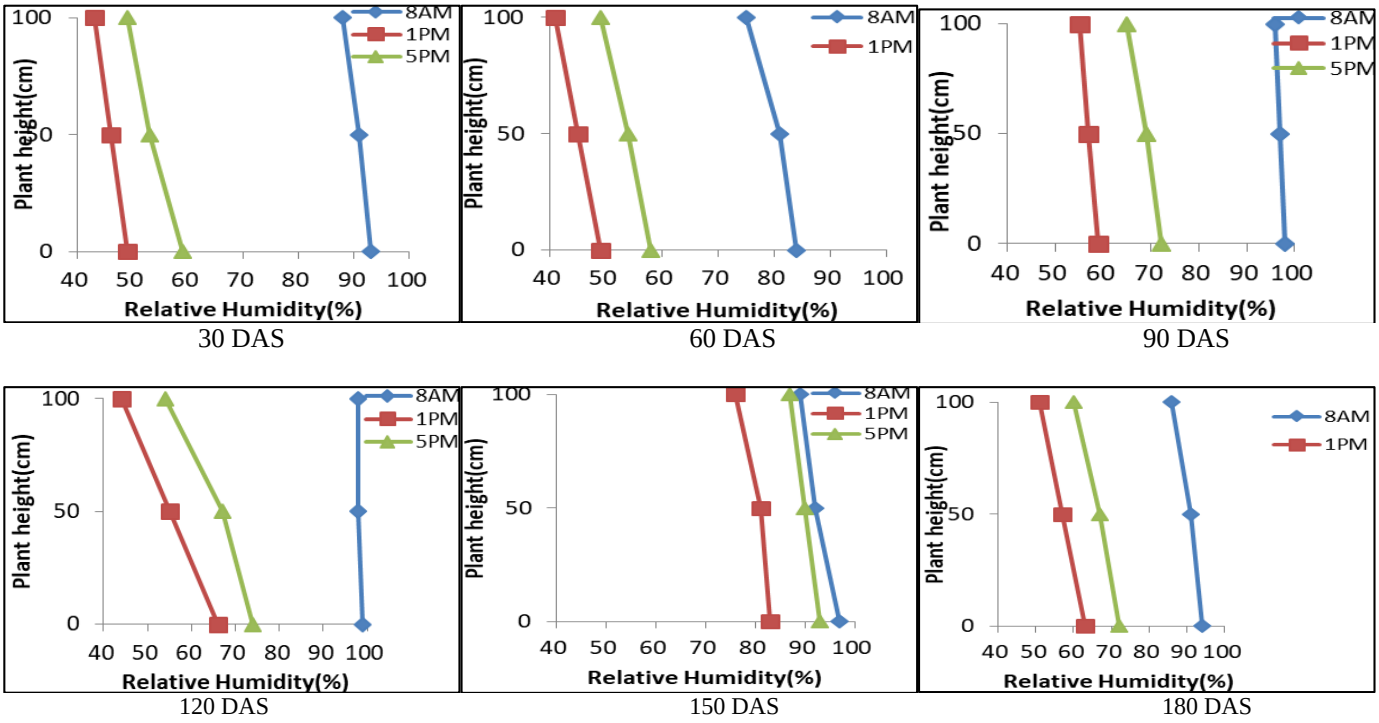


Fig 12: Diurnal profiles of relative humidity in first Bt cotton hybrid (V1)

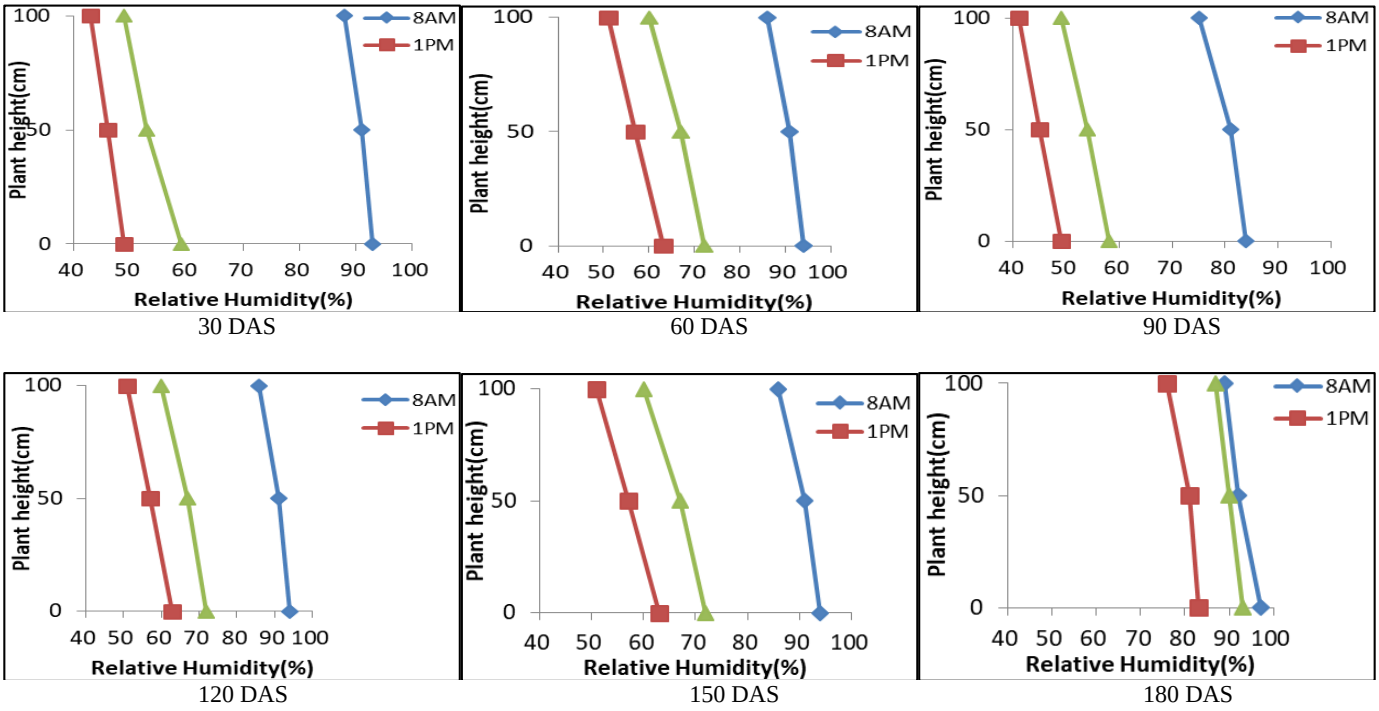
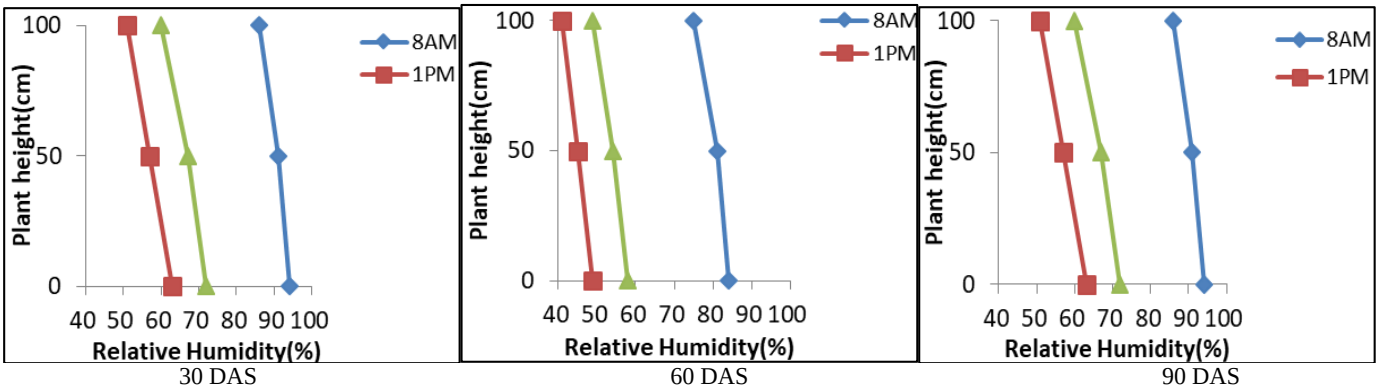


Fig 13: Diurnal profiles of relative humidity in second *Bt* cotton hybrid (V_2)



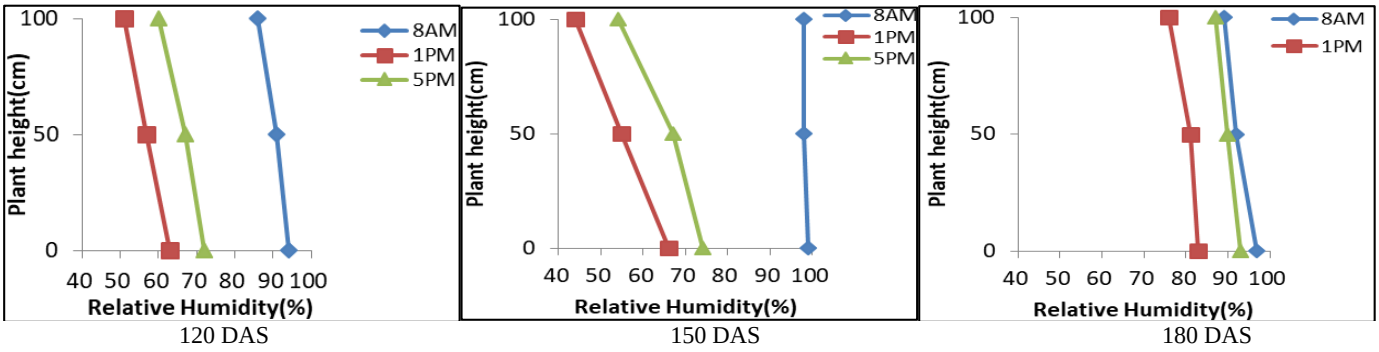


Fig 14: Diurnal profiles of relative humidity in third non *Bt* cotton hybrid (V_3)

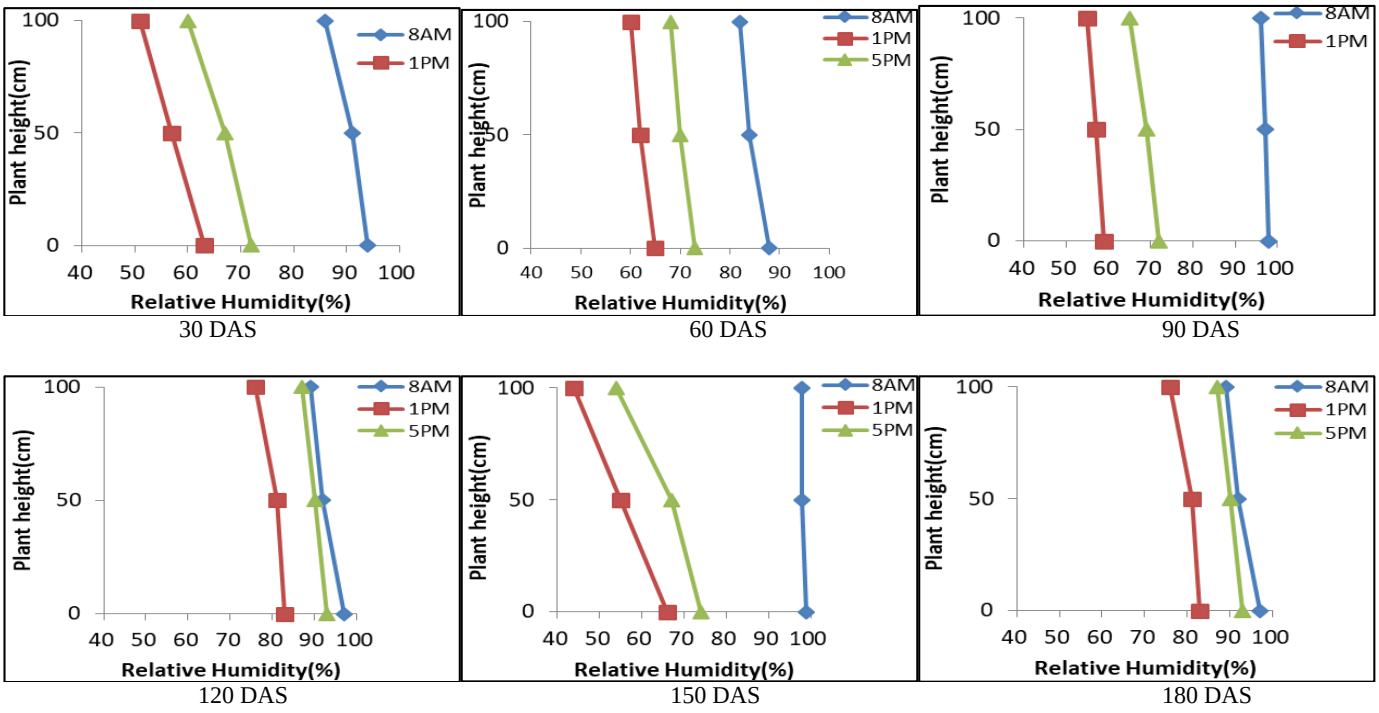


Fig 15: Diurnal profiles of relative humidity in cotton crop sown in north south direction

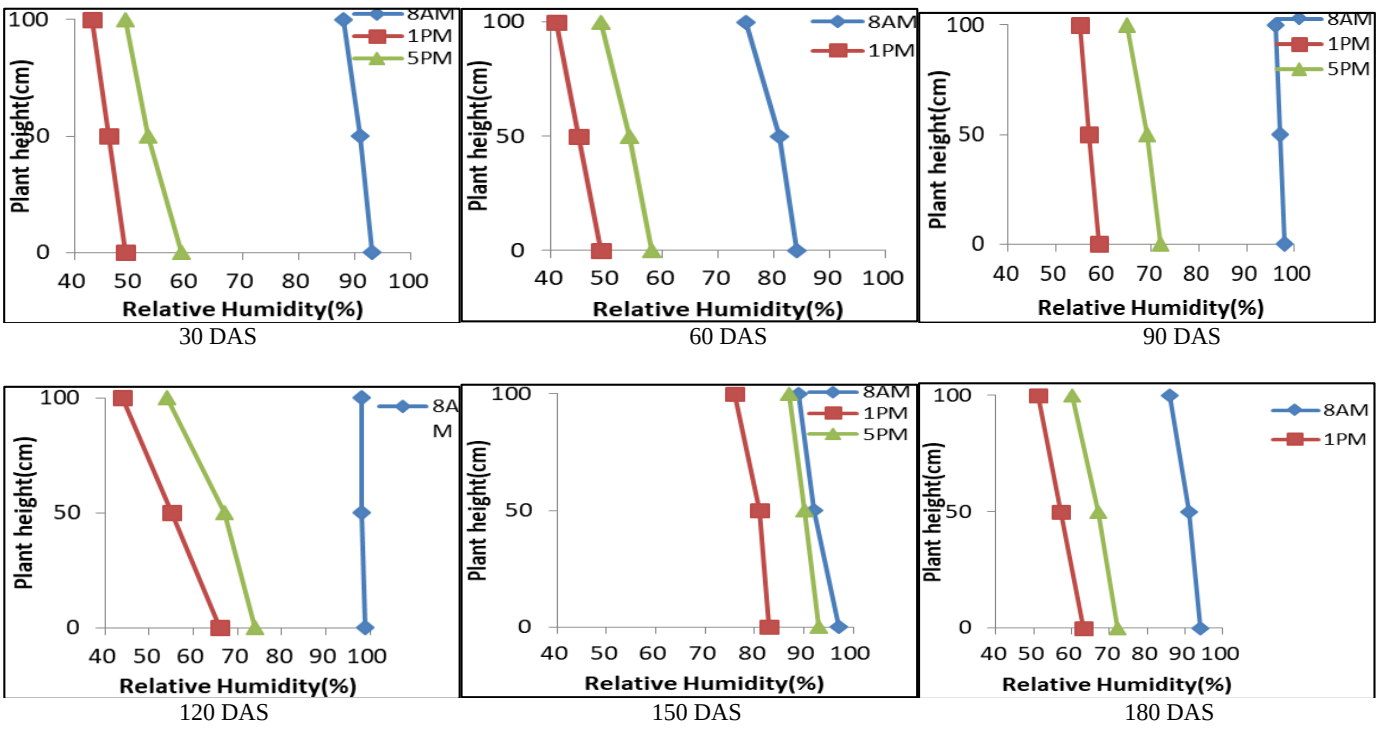


Fig 16: Diurnal profiles of relative humidity in cotton crop sown in east west direction

Relative humidity

The results reavealed that effect of growing environment on diurnal profiles of relative humidity of cotton hybrids under north-south and east-west orientation are depicted in Figures 9 to 16**.** The relative humidity profiles were lapse *i.e.* decrease in humidity with crop height in all the treatments under north-south and east-west conditions. But the rate of decrease in humidity with height was less at 0800 hours as compared to other hours of the day. The relative humidity was higher in north-south crop as compared to east-west hybrids. The diurnal spread of relative humidity profiles was less in case of north-south hybrids in comparison with east-west. Among the three growing environments the diurnal spread of relative humidity profiles was higher in 30th May sown crop as compared to 15th May and 30th April sown crop. Relative humidity was higher in crop canopy as compared to top of the canopy in all the treatment combinations. Similar results on relative humidity profiles were found by Singh *et al.,* (2005) [5] in cotton, Bose (2008) [1] in pearl millet and Khichar and Ram Niwas (2006) in wheat [1].

Conclusion

Studies clearly showed that the crop microclimate provide valuable information regarding the interaction of the crop with its environment. The date of sowing and orientation are two most important variables for evaluation of optimum microclimate of the crop for maximum growth and yield.

The results conclued that the Diurnal temperatures were higher in three growing environments and three hybrids at 1300 hours as compared to other hours of the day under north-south and east-west orientation. The morning (0800 hours) and evening time (1700 hours) temperature profiles were inverse *i.e.* increase in temperature with height inside the crop canopy, whereas, noon hours profiles were nearly isothermal. Temperatures were higher in east-west cotton crop as compared to north-south crop. The relative humidity was higher in north-south oriented crop as compared to east-west oriented crop. The diurnal spread of relative humidity profiles was less in case of north-south crop in comparison with east-west crop. Among the growing environments the diurnal spread of relative humidity profiles was higher in 30th May sown crop as compared to 30th April and 15th May sown crop. In case of cotton hybrids diurnal spread of relative humidity profiles was nearly same in all the three growing environments.

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