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RESEARCH ARTICLE

Crop geometry effects on relative humidity variation within wheat crop

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ABSTRACT : The present investigation was carried out at Research Farm, School of Climate Change and Agricultural Meteorology during 2012-13 and 2013-14. This study was planned to know the role of agronomic manipulation *i.e.,* change in row spacing and row direction in relative humidity profile within crop. The investigations were done under two field experiments. In first experiment, three wheat varieties *viz.,* HD 2967, PBW 550 and PBW 343 were sown under three row spacing *i.e.,*, 15 cm, 22.5 cm and 30 cm on 25th November during both crop seasons. In second experiment three varieties of wheat *viz.,* HD 2967, PBW 550 and PBW 343 were sown under two row directions *viz.,* North-South and East-West on 25th November during both crop seasons. The experiments were laid out in Split Plot Design, by keeping varieties in main plot and row spacing or row direction in sub plot. Diurnal cycles of relative humidity within crop canopy were recorded. Relative humidity was highest in 15 cm row spacing followed by 22.5 cm and 30 cm. In 15 cm row spacing almost 4 per cent more relative humidity was recorded than 30 cm row spacing. Among different row directions, more relative humidity was recorded in North-south row direction. This study indicated that microclimate of a crop can be modified by changing crop geometry.

Key Words :
Crop geometry, Microclimate, Row spacing, Row direction, Relative humidity

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Wheat (*Triticum aestivum* L.) is the second most important *Rabi* cereal crop in India after rice. Wheat is a photo-insensitive and thermo-sensitive long day plant. Both the start and end of wheat crop season are limited by the onset and end of favourable temperature regimes. Due to its wider adaptability it can be grown under diverse agro-ecological conditions ranging from temperate to subtropical climates. Thus, considerable climatic differences in temperature and relative humidity exist in these areas and wheat crop experiences wide seasonal variations which causes large annual fluctuations in the yield (Munjal and Dhanda 2005).Wheat requires cool climate during the early part of its growth. Wheat is primarily a crop of mid-latitude grasslands and requires a cool climate with moderate rainfall. The ideal wheat climate has winter temperature 10° to 15°C and summer temperature varying from 21°C to 26°C. The temperature should be low at the time of sowing but as the harvesting time approaches higher temperatures are required for proper ripening of the crop. But sudden rise in temperature at the time of maturity is harmful. Relative humidity (RH) directly influences the water relations of plant and indirectly affects leaf growth, photosynthesis, pollination, occurrence of diseases and finally economic yield. Climate and weather variability especially temperature significantly affect potential wheat yield under irrigated conditions in Punjab. A better understanding of weather resources can help to increase crop productivity. It will enhance the benefits by minimizing losses due to adverse weather conditions (Virmani, 1994).

Temperature, radiation and moisture are basic meteorological parameters of significance to agriculture. Under potential conditions, with adequate moisture and fertility, radiation plays the role of a decisive factor for crop growth and development. Relative humidity along with temperature, rainfall and wind velocity independently or in combination, can influence crop growth and productivity. For Indian conditions, 50-60 per cent relative humidity in air is optimum for wheat crop. If this is less, moisture loss occurs due to high evapotranspiration and results in more water requirement for irrigation. Disease infestation also increases when there is high humidity coupled with high temperature.Thus; manipulation of humidity profiles within a crop field by an appropriate adoption of crop stand geometry, like row orientation and row spacing can provide a means to create favourable conditions for crop canopy for the purpose of efficient harvest of natural energy for agricultural production. Row spacing can provide a physical barrier between the soil and atmosphere and consequently improve heat conditions at the soil surface. Keeping in view the importance of crop geometry in relative humidity variations within crop canopy the experiments were planned.

EXPERIMENTAL METHODOLOGY

The present investigation was carried out at Research Farm, School of Climate Change and Agricultural Meteorology, PAU, Ludhiana during 2012-13 and 2013-14. Ludhiana is situated at 30°90'N latitude and 75°81'E longitude and altitude of 247 m from mean sea level. This area is characterized by sub-tropical semi-arid type of climate with hot summer and very cold winters. This study was planned to know the role of agronomic manipulation *i.e.,* change in row spacing in microclimate modification. Three wheat varieties of wheat *viz.,* HD 2967, PBW 550 and PBW 343 were sown under three row spacing *i.e.,* 15 cm, 22.5 cm and 30 cm and in two row direction *viz.,* North-South (N-S) and East-West (E-W) on 25th November during both crop seasons. The experiment was laid out in split plot design, by keeping varieties in main plot and row spacing or row direction in sub plot. Diurnal cycles of relative humidity were measured at 1400 hours at different phenological stages with the help of Belfort Psychron (Model 566 series).

EXPERIMENTAL FINDINGS AND DISCUSSION

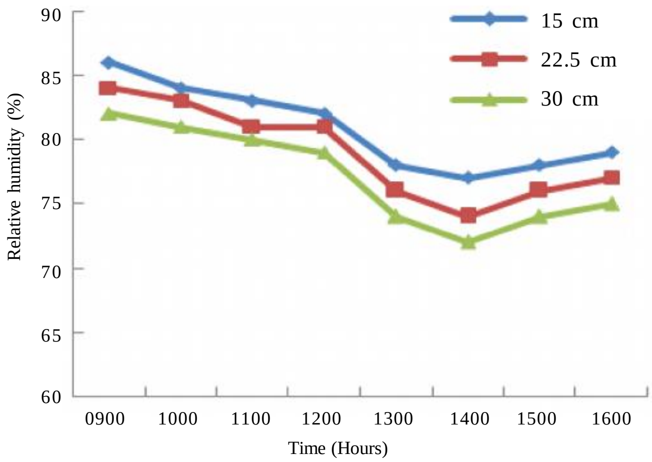
The findings of the present study as well as relevant discussion have been presented under following heads :

Relative humidity at phenological stages in different row spacing :

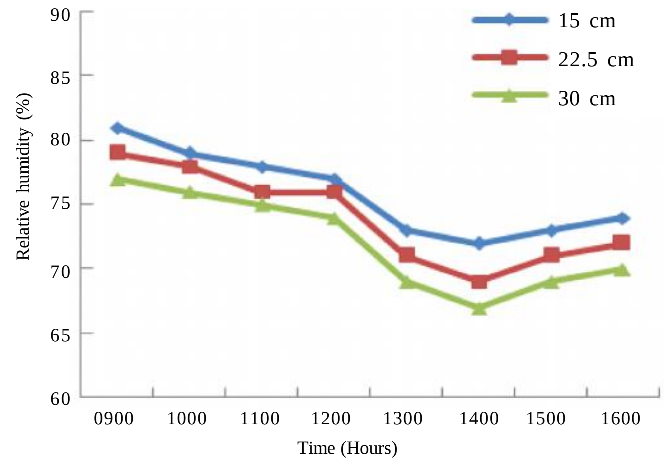
Humidity in atmosphere is of great biological importance. Atmospheric humidity influences the internal water potential of plants and the rate at which plants transpire water into the atmosphere. The relative humidity was recorded with the help of psychron at heading and soft dough stages. Relative humidity within crop canopy is higher than the atmospheric relative humidity. The relative humidity is maximum during morning hours after that it decreases then it again increases during evening hours. Relative humidity and temperature are inversely related to one another so during morning hours higher relative humidity due to low temperature, as temperature started rising during noon relative humidity percentage decreased with increase in temperature (Mavi, 1994).

Diurnal cycles of relative humidity were recorded under different treatments and are presented in Fig. 1, 2 and 3 (a-d). During 2012-13, the relative humidity in HD 2967 during heading stage was higher (86 %) in 15 cm sown crop in morning hours followed by 22.5 cm (84%) followed by 30 cm (81%). During afternoon the value of relative humidity was decreased, it was 78 per cent in 15 cm followed by 22.5 cm (76%) and 30 cm (74%). After noon hours value of relative humidity again increased. Roy and Tripathi (2006) also reported that a general decrease in day time relative humidity within and above the wheat canopy from morning to 1230 hours followed by almost a constant value until 1430 hours and a slight increase at 1630 hours, whereas daytime vapour pressure within and above the wheat canopy increased continuously from morning and reached its peak near midday.

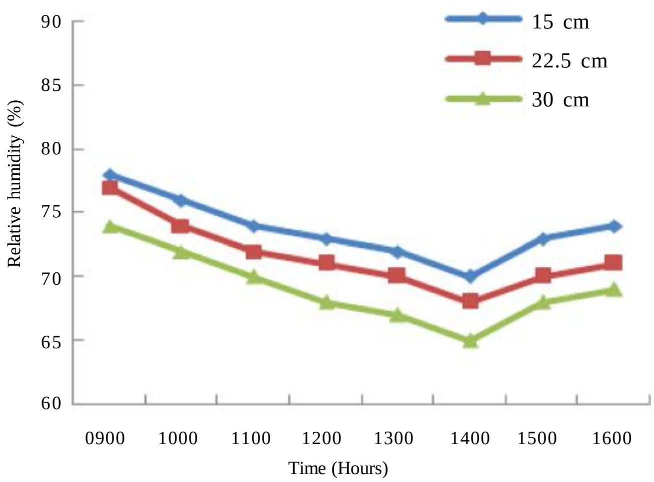
Relative humidity was higher at heading stage as compared to soft dough stage as at heading stage there was maximum leaf area which lead to higher relative humidity within crop. At soft dough stage, highest relative humidity was in HD 2967 (77,76 and 74 %) followed by PBW 343 (76,75 and 72 %) and PBW 550 (74, 73 and



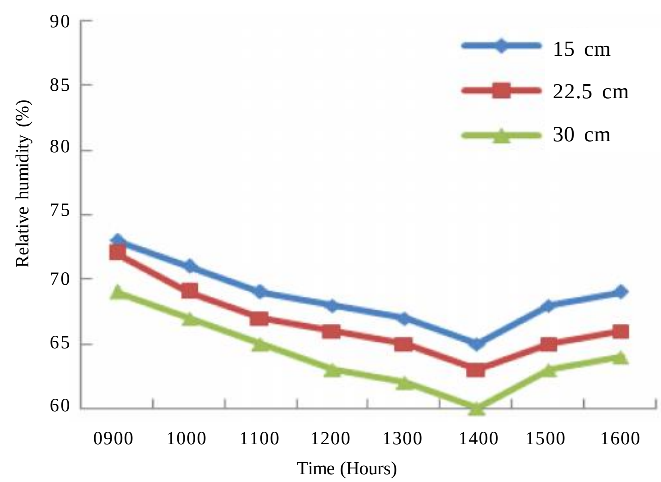
(a): Heading stage 2012-13



(b): Heading stage 2013-14

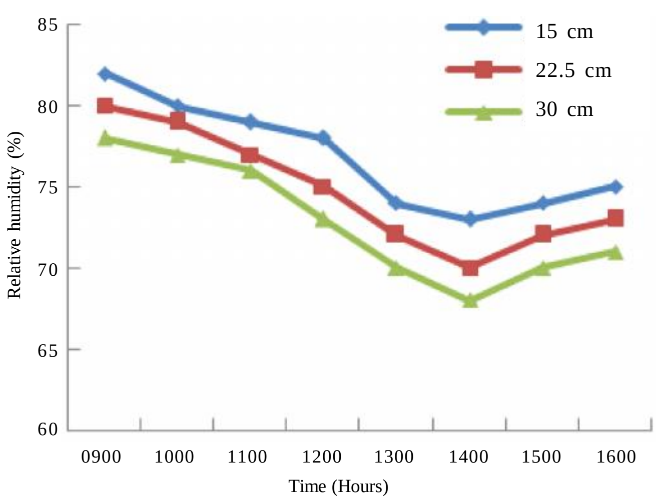


(c): Soft dough stage 2012-13

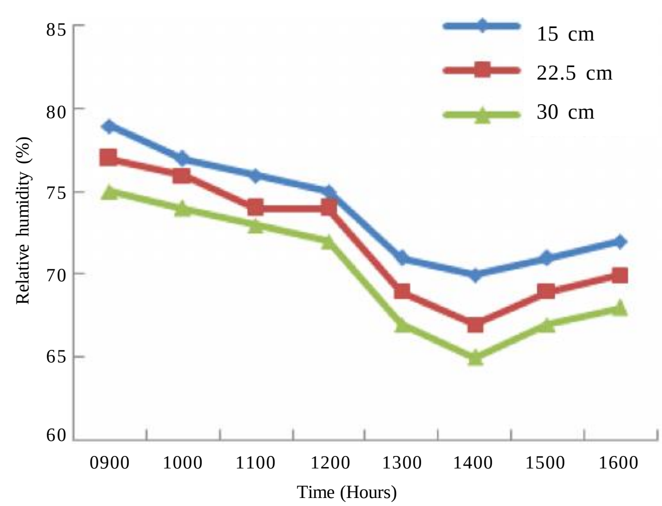


(d): Soft dough stage 2013-14

Fig. 1 (a-d) : Comparison of relative humidity in different row spacing in HD 2967 during 2012-13 and 2013-14



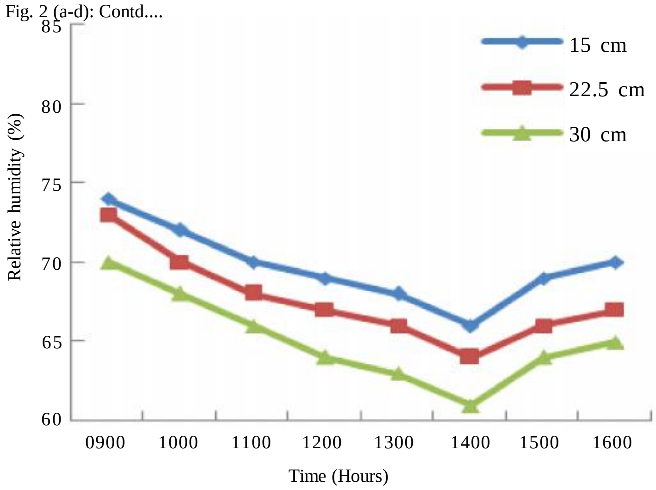
(a): Heading stage 2012-13



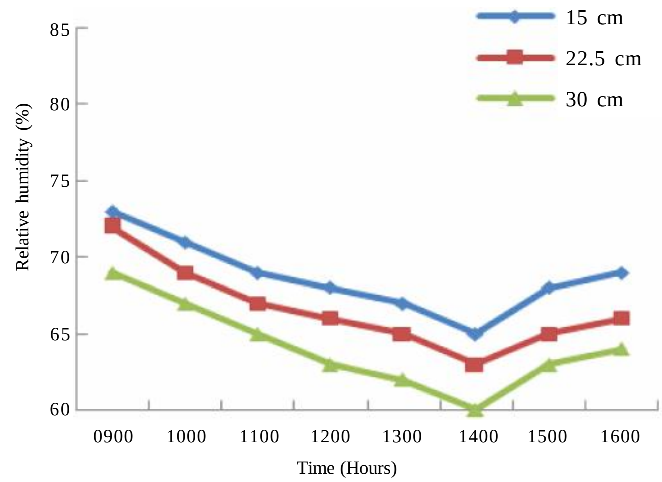
(b): Heading stage 2013-14

Fig. 2(1-d): Contd....

Fig. 2 (a-d): Contd....

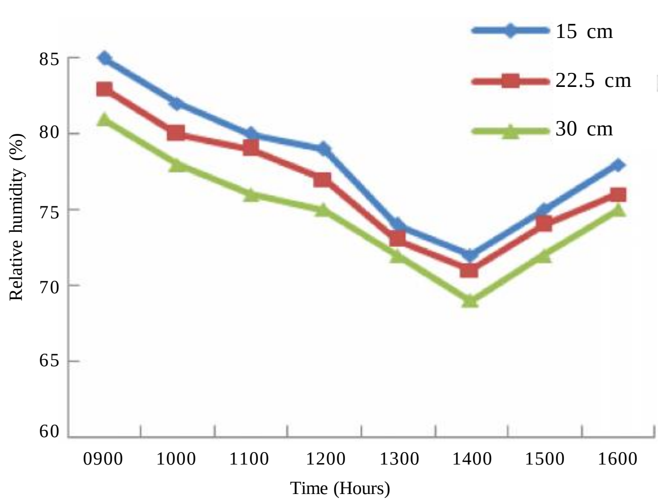


(c): Soft dough stage 2012-13

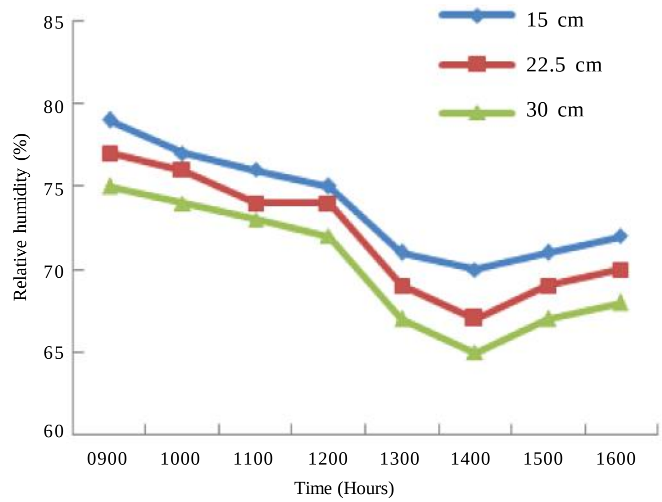


(d): Soft dough stage 2013-14

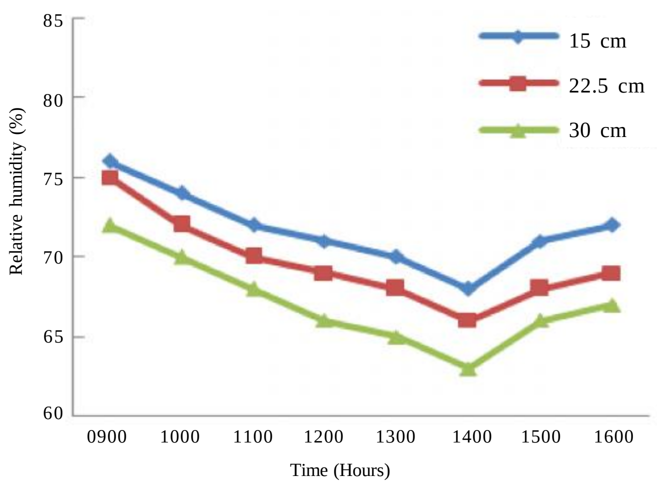
Fig. 2 (a-d) : Comparison of relative humidity in different row spacing in PBW 550 during 2012-13 and 2013-14



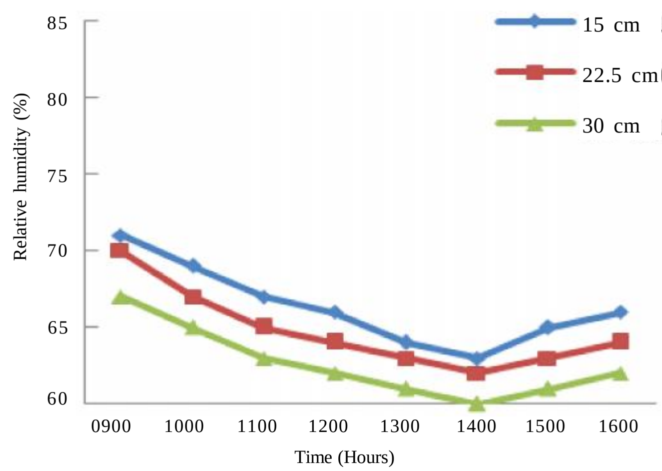
(a): Heading stage 2012-13



(b): Heading stage 2013-14

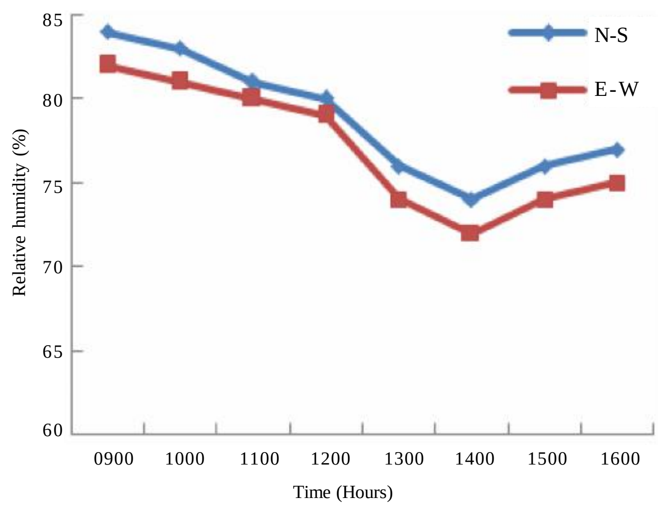


(c): Soft dough stage 2012-13

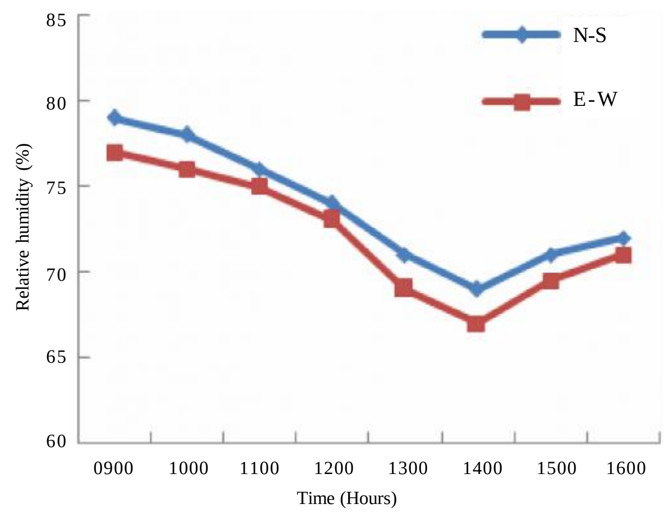


(d): Soft dough stage 2013-14

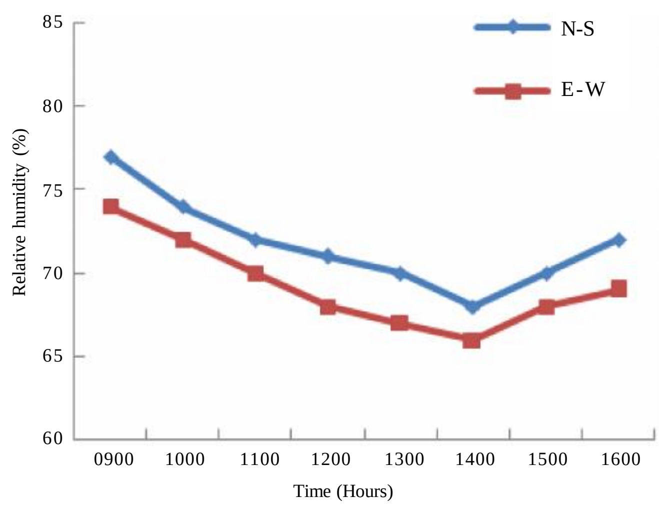
Fig. 3 (a-d) : Comparison of relative humidity in different row spacing in PBW 343 during 2012-13 and 2013-14



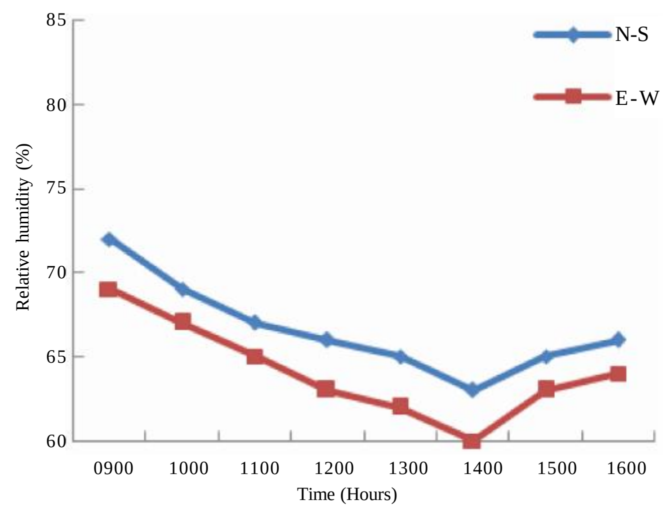
(a): Heading stage 2012-13



(b): Heading stage 2013-14

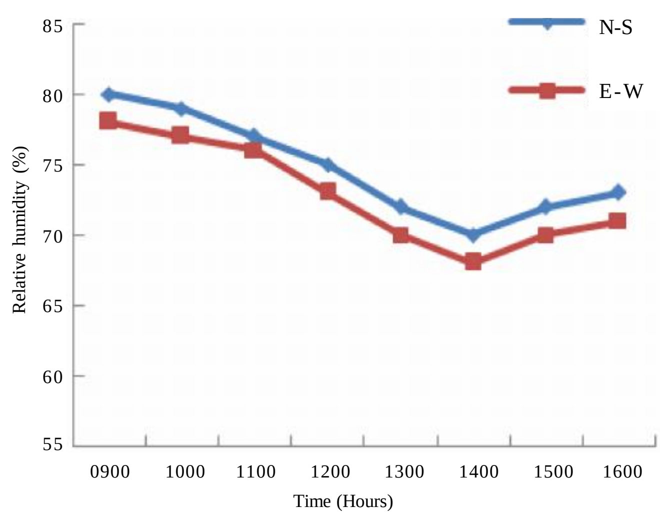


(c): Soft dough stage 2012-13

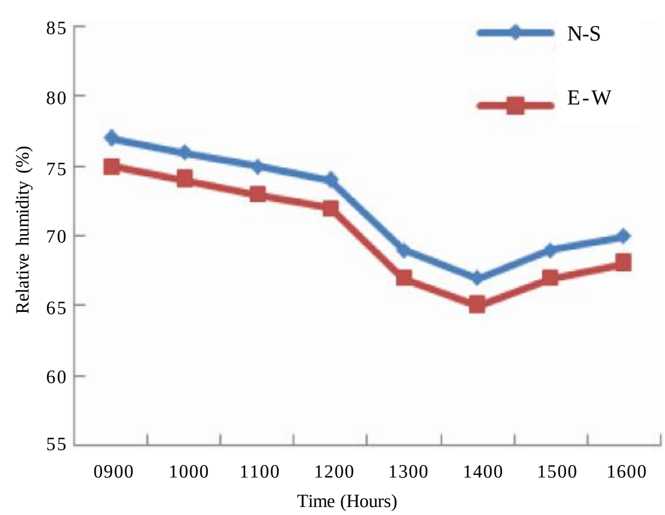


(d): Soft dough stage 2013-14

Fig. 4 (a-d) : Comparison of relative humidity in different row direction in HD 2967 during 2012-13 and 2013-14



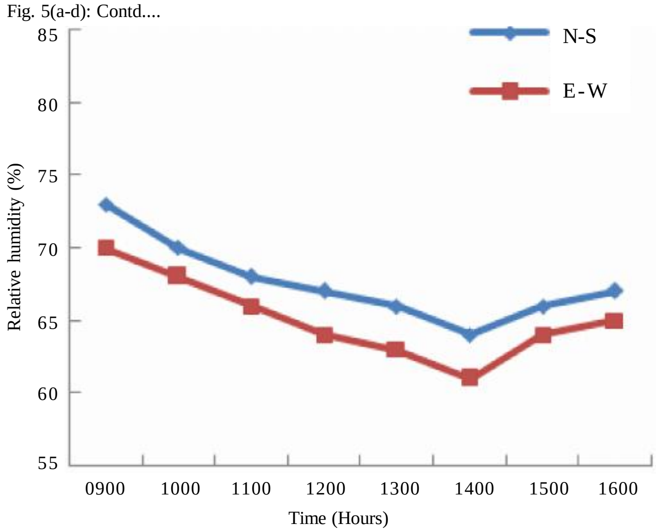
(a): Heading stage 2012-13



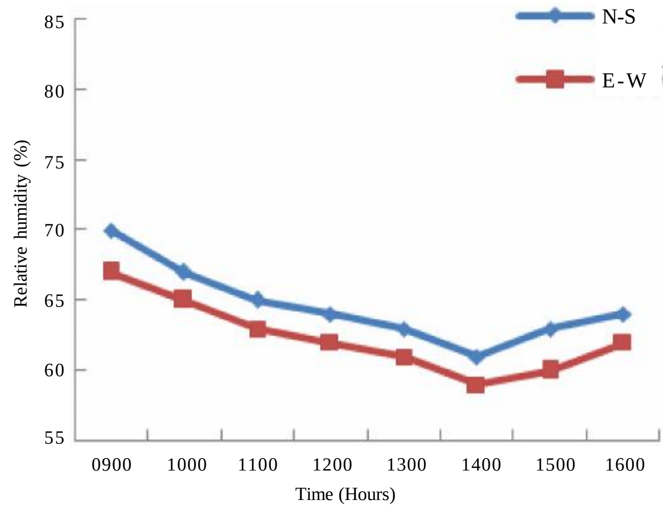
(b): Heading stage 2013-14

Fig. 5(a-d): Contd....

Fig. 5(a-d): Contd....

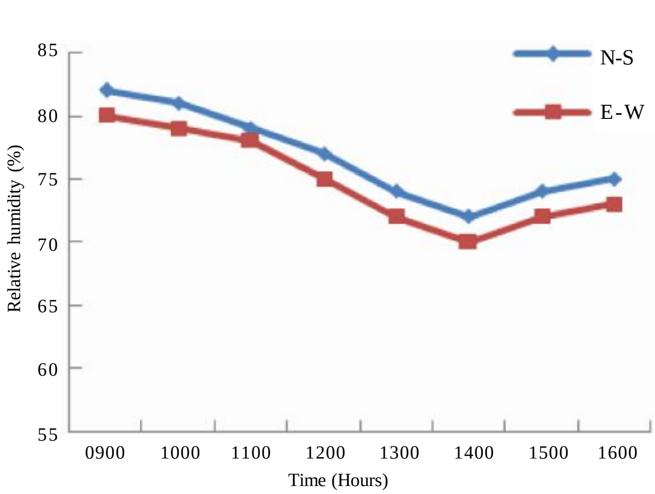


(c): Soft dough stage 2012-13

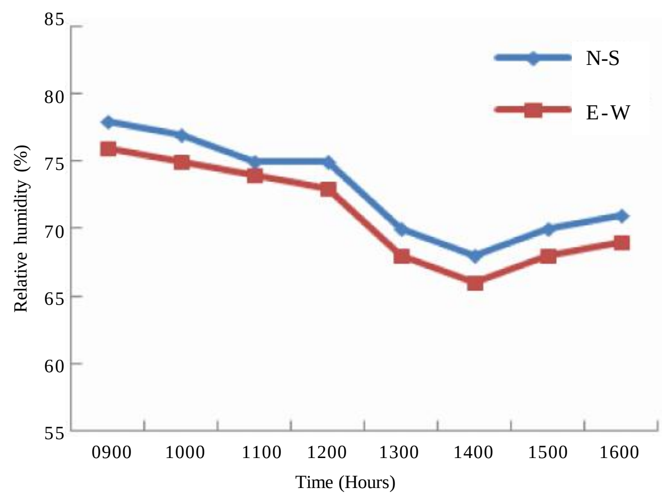


(d): Soft dough stage 2013-14

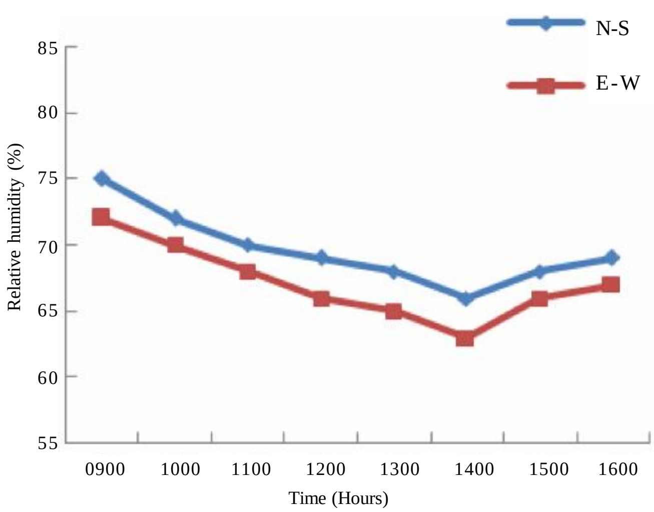
Fig. 5 (a-d) : Comparison of relative humidity in different row direction in PBW 550 during 2012-13 and 2013-14



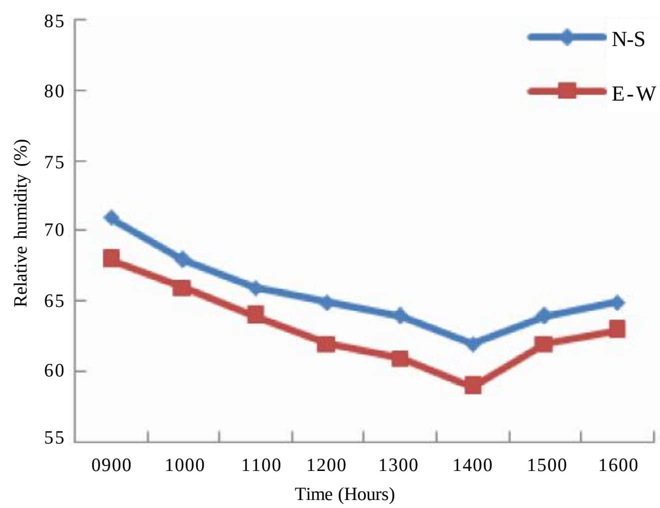
(a): Heading stage 2012-13



(b): Heading stage 2013-14



(c): Soft dough stage 2012-13



(d): Soft dough stage 2013-14

Fig. 6 (a-d) : Comparison of relative humidity in different row direction in PBW 343 during 2012-13 and 2013-14

70 %) in 15 cm, 22.5 and 30 cm row spacing, respectively. At soft dough stage, relative humidity was less as compared to heading stage. Zhou *et al.* (2012) also observed diurnal variation in relative humidity and found that relative humidity was comparatively higher in narrow row spacing as compared to wider row spacing. During 2013-14, relative humidity followed same trend as in 2012-13. Due to prevailing weather conditions, relative humidity was slightly higher in 2012-13 as compared to 2013-14. Tompkins *et al.* (1993) observed differences in relative humidity between treatments were greatest in the midmorning and late afternoon with a maximum difference of about 4.5 per cent between the 9 cm and the 36 cm treatments. Increased wind penetration during the midday period resulted in a reduction in relative humidity for the 36 cm row spacing treatments relative to the 9 cm treatment. High overnight RH values, which were typically greater than 90 per cent, dropped to below 60 per cent during the day. Yang *et al.* (2008) reported relative humidity decreased with increase in row spacing.

Relative humidity at phenological stages in different row direction :

Relative humidity observed in the different wheat varieties under different row direction are presented in Fig. 4, 5 and 6 (a-d). Daytime cycles of relative humidity were taken from 0900 to 1600 hours. Relative humidity was maximum at 0900 hours and decreased with the progress of day. Relative humidity is directly proportional to vapour pressure and inversely proportional to saturation vapour pressure.

During 2012-13, afternoon the value of relative humidity was decreased, in variety HD 2967 it was 75 per cent in N-S row direction and 72 per cent in E-W row direction. After noon hours value of relative humidity again increased. Relative humidity was higher at heading stage as compared to soft dough stage as at heading stage there was maximum leaf area which lead to higher relative humidity within crop. At heading stage, highest relative humidity was in HD 2967 (84%) followed by PBW 343 (82%) and PBW 550 (80%) in N-S row direction and in E-W relative humidity was 82 per cent, 80 per cent and 78 per cent in HD 2967, PBW 343 and PBW 550, respectively. At soft dough stage, relative humidity was less as compared to heading stage. In HD 2967, relative humidity was 77 per cent and 74 per cent in N-S and E-W row direction.

During 2013-14, relative humidity followed same trend as in 2012-13. Due to prevailing weather conditions, relative humidity was slightly higher in 2012-13 as compared to 2013-14. Humidity in atmosphere is of great importance. Sattar *et al.* (2003) concluded that relative humidity profiles showed diurnal variation and value was maximum at 0730 hours and minimum at 1230 hours.

Conclusion :

Change in crop geometry influenced relative humidity within crop canopy. Relative humidity was highest in 15 cm row spacing followed by 22.5 cm and 30 cm. In 15 cm row spacing almost 4 per cent more relative humidity was recorded than 30 cm row spacing. Among different row directions, about 2-3 per cent more relative humidity was recorded in North-south row direction as compared to east-west row direction. This study indicated that microclimate of a crop can be modified by changing crop geometry.

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