Effects of Microclimate on Barley (*Hordeum vulgare L.*) Cultivars Grown under Different Dates of Sowing under Semi-Arid Regions of Haryana

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Abstract: ***Field experiment was conducted during rabi season of 2016-17 and 2017-18 to study the microclimate over barley cultivars viz., V_1-BH 393, V_2-BH 902, V_3-BH 946 and V_4-BH 885 at different growth stages, sown under different growing environments, viz. D_1- 3rd November; D_2- 18th November; D_3- 3rd December and D_4- 19th December. The experimental results revealed that D_1 sowing date of barley crop absorbed more PAR at vegetative phase; the reflection of radiation and transmission of radiation was highest at physiological maturity whereas, transmission of radiationwas higher at D_4 sowing date during both the crop seasons. However, among varieties the above results found at par at all growth phases. The net radiation (Rn) and latent heat of vaporization (LE) were higher at anthesiswhereas; Soil heat flux (G) and sensible heat flux (A) was highest at physiological maturity among varying growing environments. The higher Tc was observed at physiological maturity on 14:00 hour during both crop seasons. The canopy temperature varied between 11.8-26.4^{o}C at vegetative, 12.7-33.8^{o}C at anthesis and 17.6-35.1^{o}C at physiological maturity phases among varying dates of sowing and cultivars sown during both the crop seasons, respectively. The maximum value of temperature profile was recorded at physiological maturity, because of less ground area covered by the crop whereas, the higher temperature was recorded during crop season 2016-17 as compared to 2017-18 at all phenophases. The temperature varied between 14.0-28.4^{o}C at vegetative, 15.1-30.3^{o}C at anthesis and 13.4-44.8^{o}C at physiological maturity phases and the relative humidity varied between 38.1-96.6% at vegetative, 45.0-88.6% at anthesis and 50.5-82.9% at physiological maturity phases in the cropped and bare soil, respectively among at varying dates of sowing and cultivars sown during both the crop seasons, respectively. The maximum relative humidity during the day was observed at 9:00 hours. The highest humidity was measured at vegetative phase among different growing environments and different barley cultivars, during both crop seasons.***

Keywords: Rabi barley, Microclimate, Phenological stages, Growing environment

1. Introduction

Barley (*Hordeum vulgare* L.), which is grown on an area of 35 thousand hectares with a productivity of 3418 kg/ha (Agriharyana, 2017-18) is an important rabi crop in Haryana.It is used as a component of various health foods. The main advantage of incorporating barley in diets nowadays is due to its potential health benefits. Lowering of blood cholesterol, with b-glucans (Bchall *et al*., 2004), and the glycemic index (Cavallero *et* al., 2002) by barley has been reported widely (Pins and Kaur, 2006). It serves as a major animal fodder, base malt for beer and certain other distilled beverages. Barley is a short growing season crop and has good drought and salinity tolerance. It is productive under adverse environments than other cereals. In India, it is cultivated as a winter crop in tropical regions and as a summer crop in temperate region.

Micrometeorological aspects show variation with type of vegetation. Due to variation in solar radiation/short wave radiation distribution over various vegetation/ecosystems (agricultural, grassland, forest, desert, bare land etc.), it is obvious that all other micrometeorological factors such as, soil temperature, air temperature, soil moisture, relative humidity, reflectivity/albedo, net radiation and finally energy budget components would be expected different. Micrometeorology includes exchange of heat, water and gases among soil, plant and atmosphere (Rosenberg *et. al.*, 1983). The net radiation is the fundamental quantity of energy available at the earth's surface to drive the processes of evaporation, air and soil heating, as well as small energy consuming process such as photosynthesis (Denmead *et al.*, 1962). Higher air temperature increases the canopy temperature in dense populated communities. Canopy temperature is closely related to solar radiation and it changes slowly when solar radiation changes with cloud cover. Regions of high temperature could develop within the crop canopy resulting sensible heat transport to the soil surface and the upper canopy; simultaneously that influences the latent heat flux. When the soil is moist almost all of energy supplied by Rn is consumed as latent heat (Fritschen, 1962) and results small quantities of energy are distributed to the soil and sensible heat flux from early morning until about 1500 hours. Maximum PAR interception is observed at reproductive phase in cereals; radiation energy is higher at 1300 hours, whereas latent heat is higher at 1400 hours.The temperature profiles are inversed throughout the day within the canopy. Over the top of the crop canopy the temperature profile is lapse whereas, the relative humidity profiles are lapse inside the crop canopy throughout the day but profiles were near iso-humic at 900 hours at different growth stages during varying crop seasons in rabi crops. Since several co-workers have studied the effect of microclimate over field crops but information is scanty in barley crops. Hence, there is need to study the microclimate profiles in barley under different growing environments.

2. Material and methods

The Field experiments were conducted at Research farm of the Department of Agricultural Meteorology, CCSHAU, Hisar (Lat. 29^{0}10' N; Log.75^{0}46' E &215.2 m AMSL) during *Rabi* season of 2016-17 and 2017-18 with Barley crop on a sandy loam soil, to evaluate the impact of microclimate on Barley (*Hordeum vulgare L.*) cultivars in terms of growth and development at different growth stages under four growing environmental conditions at Hisar. The main plot treatments consisted of four dates of sowing (D_1- 3rd November, D_2-18th November, D_3-3rd December and D_4- 19th December) and subplot treatments consisted four varieties (V_1- BH 393, V_2- BH 902, V_3- BH 946, V_4- 885) using split plot design. The recommended dose of urea (150 kg N ha^{-1}), DAP (65 kg P2O5 ha^{-1}) and zinc sulphate (25 kg ha^{-1}) were applied. Irrigation was applied at CRI stage to all treatments. Each irrigation was of 6 cm depth. One weeding cum hoeing was done 40 DAS with long tine hand hoe.

The following micro-meteorological observations were recorded in the experimental field during tillering, jointing, booting, anthesis, hard dough and physiological maturity stages with clear sky at hourly interval from 0900 to 1700 hours.

a) PAR observations
b) Canopy temperature
c) Diurnal Energy balance components
d) Temperature and humidity profile studies

The PAR was measured with the help of Point Quantum sensor (Model L1-190SB).Canopy temperature was measured by using Infra-red thermometer (Model AG-45, Telatemp Corp. and diurnal net radiation was measured at one meter above the canopy. The amount of solar radiation received by crop was measured with the help of pyranometer (Medoes and Co., Australia) connected to a digital multivoltmeter.Net radiation was measured at one meter height above crop canopy with net radiometer (Medoes and Co., Australia) connected to a digital multivoltmeter. Soil heat flux was measured with the help of soil heat flux plate (Medoes and Co., Australia) which were kept at 5 cm soil depth in cropped field. The dry and wet bulb temperatures were measured with the help of Assmann Psychrometer at ground level, 50 and 100 cm heights.The relative humidity was calculated using Psychrometric Tables. By using the corresponding hourly values the temperature and relative humidity profiles were drawn at different phenophases. The following study were statistically analyzed by using the technique of analysis of variance (ANOVA) as applicable to Split plot design (Gomez and Gomez, 1984). The significance of the treatment effects was determined using F-test at 5 % probability.

3. Results and Discussion

3.1 Micrometeorological studies

Photosynthetically active radiation (PAR, %)

Photosynthetically active radiation of solar radiation viz., reflected (R), absorbed (A) and transmitted (T) of barley crop recorded at different growth stages are presented in Table 1. Absorption of radiation increased from tillering to booting (vegetative phase) and then decreased from anthesis up to physiological maturity among different growing environments and varieties during both the crop seasons. Among the growing environments, early sown crop (D_1) had more absorption i.e. 96.2 % and 93.9 % whereas, among varieties, V_4 variety had highest absorption *i.e.* 95.0 % and 92.1 % at vegetative phase during crop season 2016-17 and 2017-18 respectively. The findings are in conformity with those observed by Mishra *et al.*, (2010), Bingham *et al.*, (2007) and Lal *et al.*, (1991). The absorption of radiation was more in 2016-17 than 2017-18. The reflection of radiation due to decrease in chlorophyll content in foliage of plants and senescence of leaves and transmission of radiation because of less ground cover by leaves at this phase was highest at physiological maturity during both the crop seasons. Over the bare field, the absorption was between 86.9 to 88.3% in 2016-17 and 85.4 to 90.3 % in 2017-18. The reflected radiation varied between 7.4 to 10.7 % and 9.6 to 10.6 % during crop season 2016-17 and 2017-18, respectively.

Energy balance components

Among all treatments, the major portion of net radiation was utilized by latent heat of vaporization presented in Table 2 and 3. Among different growing environments, the net radiation was higher at anthesis in D_2 (426.4 Wm^{-2}) and D_3(480.8 W m^{-2}) while, late sown crop D_4(99.7 Wm^{-2} and 95.6 Wm^{-2}) was received higher values of soil heat flux at physiological maturity during 2016-17 and 2017-18 crop seasons. Sattar *et al.* (2003) has reported the similar result. The minimum value of soil heat flux was observed at anthesis and vegetative stages in D_1 and D_2 during crop season 2016-17 and 2017-18, respectively. Thereafter among energy balance components; soil heat flux was increased upto physiological maturity because of more LAI covered by barley crop at this phase. The latent heat of vaporization was higher at anthesis in D_2 (333.8 Wm^{-2}) and D_3 (313.1Wm^{-2}) due to maximum ground area covered by crop at anthesis and decrease in foliage covered by crop due to senescence at physiological maturity. The higher value of LE also reported by Das *et al.* (2005). The sensible heat flux was highest at physiological maturity in D_3 (107.9 Wm^{-2}) and D_4 (139.2 Wm^{-2}) during crop season 2016-17 and 2017-18, respectively, due to poor canopy development under delayed sowing with inferior growth results open canopy. The result has conformity with by Awal *et al.* (2006). Among varieties, the net radiation were higher at anthesis in V_1 (425.8 Wm^{-2}) and V_2 (523.5 Wm^{-2}). The soil heat flux was higher at physiological maturity in V_3 (77.7 Wm^{-2}) and V_1 (71.8 Wm^{-2}). The latent heat of vaporization was higher at anthesis in V_2 (339.5Wm^{-2}) and at vegetative stage in V_4(307.7 Wm^{-2}) during crop season 2016-17 and 2017-18, respectively. The sensible heat flux was highest at physiological maturity in V_2 (100.4 Wm^{-2}) and V_3(134.4 Wm^{-2}) during crop season 2016-17 and 2017-18.

On bare soil, the maximum net radiation was observed at anthesis; the higher soil heat flux was observed at physiological maturity; the maximum latent heat of vaporization was observed at vegetative phase and the higher sensible heat flux was observed at anthesis during first year crop season whereas, the highest sensible heat flux was recorded at physiological maturity during next crop season.

Table 1: Photosynthetically active radiation (PAR, %) on different sowing dates and varieties in Barley during 2016-17 and 2017-18

Phenophases																		
	2016-17									2017-18								
Treatments	**Vegetative**			**Anthesis**			**PM**			**Vegetative**			**Anthesis**			**PM**		
	R	**A**	**T**	**R**	**A**	**T**	**R**	**A**	**T**	**R**	**A**	**T**	**R**	**A**	**T**	**R**	**A**	**T**
D_1- 3rd Nov.	2.2	96.2	1.6	2.2	95.9	1.9	9.4	87.4	3.3	2.5	93.9	3.9	2.8	93.3	3.9	6.3	89.2	4.3
D_2-18th Nov.	2.9	95.4	2.5	2.7	95.6	2.3	9.8	86.4	3.7	3.4	90.4	5.1	3.3	91.9	4.5	6.6	88.0	5.1
D_3- 3rd Dec.	3.5	94.6	2.6	3.1	94.0	2.9	10.5	86.2	4.2	3.4	90.4	5.1	3.7	91.7	4.8	7.2	88.1	4.5
D_4- 19th Dec.	3.9	92.7	3.7	4.2	92.4	3.4	11.8	84.1	4.9	3.6	90.8	5.2	4.2	90.7	5.3	7.2	86.7	5.2
CD at 5%	**0.4**	**0.5**	**0.6**	**0.06**	**1.2**	**0.03**	**0.9**	**0.9**	**0.2**	**0.5**	**1.5**	**0.2**	**0.2**	**1.7**	**0.3**	**0.2**	**1.1**	**NS**
V_1- BH 393	3.0	94.6	2.4	3.0	94.4	2.6	10.3	86.1	4.0	3.0	91.6	5.0	3.4	91.9	4.7	6.8	88.7	5.0
V_2- BH 902	3.2	94.6	2.6	3.0	94.7	2.6	10.6	85.8	4.2	3.3	92.0	4.5	3.5	92.6	4.5	6.6	87.2	4.8
V_3- BH 946	3.3	94.7	2.4	3.1	94.6	2.7	10.2	86.3	4.1	3.1	91.9	4.8	3.7	91.3	4.5	6.9	87.7	4.8
V_4- BH 885	2.9	95.0	3.0	3.2	94.2	2.7	10.5	85.9	4.0	3.0	92.1	4.7	3.4	91.8	4.8	7.1	88.3	4.7
CD at 5%	**NS**	**NS**	**NS**	**0.05**	**NS**	**0.01**	**NS**	**NS**	**NS**	**NS**	**NS**	**0.3**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
Bare Soil	7.4	87.6	-	10.5	86.9	-	10.7	88.3	-	9.6	85.4	-	9.8	86.4	-	10.6	90.3	-

R-Reflected PAR A-Absorbed PAR T-Transmitted PAR, NS = Treatment difference not significant

Table 2: Partitioning of net energy (Rn) in different energy balance components (Wm^{-2}) under different growing environments of barley varieties during 2016-17

Phenophases												
	2016-17											
Treatments	**Vegetative**				**Anthesis**				**PM**			
	Rn	**G**	**LE**	**A**	**Rn**	**G**	**LE**	**A**	**Rn**	**G**	**LE**	**A**
D_1- 3rd Nov.	410.9	22.0	310.9	78.0	410.2	15.8	308.1	86.3	396.2	58.5	247.8	89.9
D_2-18^{t}Nov.	414.1	20.4	331.6	62.1	426.4	22.8	333.8	69.8	420.8	46.5	275.0	99.3
D_3- 3rd Dec.	412.9	24.7	311.4	76.8	416.1	25.4	291.4	98.9	376.9	94.1	174.9	107.9
D_4-19thDec.	403.1	21.4	324.7	57.0	417.3	23.7	293.4	100.2	387.4	99.7	199.1	88.6
CD at 5%	**0.9**	**0.5**	**2.6**	**0.5**	**1.1**	**1.9**	**16.3**	**0.9**	**1.6**	**0.8**	**31.9**	**1.8**
V_1- BH 393	411.9	22.9	300.9	90.7	425.8	21.3	333.1	71.4	403.9	77.2	233.7	93.0
V_2- BH 902	414.6	21.0	308.5	84.7	417.3	22.7	339.5	55.1	380.6	70.0	210.2	100.4
V_3- BH 946	410.7	21.6	307.7	97.4	413.4	19.6	318.8	75.0	402.0	77.7	230.1	94.2
V_4- BH 885	415.2	22.2	310.0	82.3	384.7	25.0	287.2	72.5	394.9	74.0	222.8	98.1
CD at 5%	**1.9**	**NS**	**NS**	**1.4**	**1.9**	**NS**	**NS**	**1.4**	**1.4**	**0.6**	**15.1**	**1.4**
Bare Soil	432.9	89.4	274.4	69.1	440.7	84.3	235.6	120.8	384.8	91.7	221.3	71.8

Rn = Net radiation G = Soil heat flux LE = latent heat of vapour flux A = Sensible heat

Table 3: Partitioning of net energy (Rn) in different energy balance components (Wm^{-2}) under different growing environments of barley varieties during 2017-18

Phenophases												
	2017-18											
Treatments	**Vegetative**				**Anthesis**				**PM**			
	Rn	**G**	**LE**	**A**	**Rn**	**G**	**LE**	**A**	**Rn**	**G**	**LE**	**A**
D_1- 3rd Nov.	410.0	12.5	290.2	107.3	400.5	39.6	272.6	88.3	399.2	51.6	267.4	80.2
D_2-18^{t}Nov.	418.8	9.0	266.2	143.6	458.7	40.8	287.5	130.4	404.7	38.2	267.4	80.2
D_3- 3rd Dec.	415.3	12.9	295.9	106.5	480.8	49.5	313.1	118.2	374.7	95.4	175.0	104.3
D_4-19thDec.	410.7	11.0	301.7	98.0	381.9	56.7	192.0	133.2	393.6	95.6	158.8	139.2
CD at 5%	**1.4**	**0.2**	**1.2**	**0.6**	**0.8**	**1.3**	**1.8**	**NS**	**6.1**	**0.8**	**3.9**	**2.3**
V_1- BH 393	415.9	12.4	280.3	123.2	403.0	45.5	242.5	115.0	398.3	71.8	210.2	116.3
V_2- BH 902	413.7	9.2	285.8	118.7	523.5	45.3	362.8	115.4	387.9	71.2	211.1	105.6
V_3- BH 946	410.3	11.1	280.1	119.1	408.4	51.4	228.6	128.4	392.5	68.5	189.6	134.4
V_4- BH 885	414.9	12.8	307.7	94.4	387.2	44.4	231.4	111.4	393.4	69.2	213.7	110.5
CD at 5%	**0.9**	**0.3**	**1.6**	**0.7**	**1.0**	**0.8**	**1.3**	**NS**	**4.9**	**0.6**	**3.0**	**1.6**
Bare Soil	427.2	87.0	266.7	73.5	427.5	90.3	263.1	73.4	380.3	90.9	174.5	115.5

Rn = Net radiation G = Soil heat flux LE = latent heat of vapour flux A = Sensible heat

Canopy temperature (°C)

Among different growing environments, the higher canopy temperature (Tc) was observed at 1400 hour in D_4 date of sowing in range of 26.5-35.1°C and 24.1-32.5°C during crop season 2016-17 and 2017-18 at physiological maturity (Table 4) whereas; it was almost same at vegetative and anthesis stage during both the crop season. Similar result was reported by Ferguson *et al.* (1971).Among varieties, the higher Tc was observed at 1400 hour in V_2 cultivar, ranges of 19.1-28.4°C and 20.1-31.5°C at physiological maturity during crop season 2016-17 and 2017-18.

Table 4: Effect of different growing environments on canopy temperature variations from vegetative to physiological maturity phase over barley crop during 2016-17 and 2017-18

	Phenophases					
	2016-17			2017-18		
Treatments	**Vegetative**	**Anthesis**	**PM**	**Vegetative**	**Anthesis**	**PM**
D_1- 3rd Nov.	11.8-18.7	16.1-24.3	21.6-30.0	12.0-19.0	14.0-21.9	17.6-24.0
D_2-18th Nov.	15.7-23.3	17.4-26.7	22.1-26.2	12.8-24.0	13.6-22.9	17.9-26.5
D_3- 3rd Dec.	14.2-24.0	18.8-28.1	23.5-32.1	15.3-22.8	13.4-22.8	21.1-29.9
D_4- 19th Dec.	15.3-26.4	22.0-33.8	26.5-35.1	14.3-24.1	15.2-22.2	24.1-32.5
V_1- BH 393	13.6-25.0	12.7-21.2	21.5-26.9	14.1-22.6	14.5-23.2	21.8-26.9
V_2- BH 902	13.6-22.1	14.3-22.1	19.1-28.4	13.1-21.9	13.7-22.0	20.1-31.5
V_3- BH 946	13.9-23.8	14.2-22.5	20.2-27.2	13.8-23.3	13.5-22.5	20.0-26.9
V_4- BH 885	13.3-23.2	14.0-23.0	21.5-26.9	13.4-22.2	14.4-22.0	19.4-28.6

Range covers morning (0800 h) to evening (1700 h) observations at an hourly interval.

Temperature and humidity profile

The temperature profiles indicated that the temperature inside the canopy was lower than that recorded at top of the canopy in all the treatments *i.e.* temperature profiles were inverse throughout the day within the canopy. Over the top of the crop canopy the temperature profile was lapse. The maximum temperature was observed at noon hours and the minimum was at morning which was mostly iso-thermic with height at all growth stages during both crop seasons. The results found conformity with results were obtained by Sattar *et al*. (2003). The temperature varied between 14.0-28.4°C at vegetative, 15.1-30.3°C at anthesis and 13.4-44.8°C at physiological maturity phases in the cropped and bare soil, respectively among at varying dates of sowing and cultivars sown during both the crop seasons, respectively. The maximum value of temperature profile was recorded at physiological maturity during both crop seasons because of less ground area covered by the crop whereas, the higher temperature was recorded during crop season 2016-17 as compared to 2017-18 at all phenophases.

The humidity profiles was higher inside the crop canopy than above the canopy in all the treatments *i.e.* the relative humidity profiles were lapse inside the crop canopy throughout the day while profiles were near iso-humic at 9:00 hours at different growth stages during both crop seasons. The relative humidity decreased with height under all treatments at all phenophases. Similar results were reported by Roy *et al.* (2006). The relative humidity varied between 38.1-96.6% at vegetative, 45.0-88.6% at anthesis and 50.5-82.9% at physiological maturity phases in the cropped and bare soil, respectively among at varying dates of sowing and cultivars sown during both the crop seasons, respectively. The highest humidity was measured at vegetative phase among different growing environments and different barley cultivars, during both crop seasons. The maximum relative humidity during the day was observed at 9:00 hours. Due to higher in air temperature, the relative humidity was lowest at noon time. Invariably, the relative humidity profiles showed a reverse trend to that of temperature profiles in all dates of sowing throughout both the crop seasons. These results strengthen the existing psychometric law, which states that the temperature and relative humidity are negatively correlated.

The D_1sown crop was showed better phenology, growth, development and yield and yield attributes as compared to dates of sowing during both the crop season. This might be because of prevalence of favorable effect of temperature and humidity within the canopy.

Table 5: Diurnal temperature profile (°C) at different phenophases over barley canopy and bare soil

	Phenophases					
	2016-17			2017-18		
Treatments	**Ground level**	**50 cm**	**100 cm**	**Ground level**	**50 cm**	**100 cm**
Vegetative Stage						
D_1- 3rd Nov.	14.4-22.3	14.3-21.9	14.0-21.6	14.8-22.7	14.8-22.8	14.0-21.3
D_2-18th Nov.	16.9-24.7	16.7-24.7	16.9-23.9	15.9-27.5	15.6-27.2	15.1-25.9
D_3- 3rd Dec.	17.6-26.1	17.4-26.2	17.0-25.8	17.2-25.9	16.8-25.0	16.5-24.7
D_4- 19th Dec.	15.6-27.2	15.6-26.7	14.9-26.2	17.5-26.3	17.7-26.8	17.2-25.9
V_1- BH 393	15.9-25.0	15.6-23.8	14.8-26.9	16.1-25.5	16.3-25.7	15.8-25.9
V_2- BH 902	16.2-24.9	15.9-24.6	15.2-23.9	15.9-25.3	15.8-24.8	15.3-24.4
V_3- BH 946	16.1-25.7	16.0-24.8	15.1-23.8	16.6-26.0	16.0-25.4	16.8-24.6
V_4- BH 885	16.3-25.4	15.7-25.2	15.2-24.8	16.8-24.8	16.4-24.5	16.0-24.1
Bare Soil	15.8-28.4	16.3-27.2	15.5-27.8	16.5-26.9	18.5-28.4	16.5-26.5
Anthesis Stage						
D_1- 3rd Nov.	16.0-24.7	16.1-24.3	15.7-23.8	18.6-28.1	18.2-27.5	17.0-25.0
D_2-18th Nov.	16.3-24.8	15.7-25.8	14.8-24.8	16.1-24.6	15.7-25.6	15.1-25.2
D_3- 3rd Dec.	18.5-28.0	18.6-27.1	17.9-26.5	17.9-29.2	17.5-29.5	16.9-28.6
D_4- 19th Dec.	17.6-28.9	17.3-26.8	17.4-28.4	16.3-25.0	16.2-25.4	15.8-25.0
V_1- BH 393	17.0-27.3	16.7-26.6	16.0-25.9	17.0-27.1	16.8-26.8	16.1-26.8
V_2- BH 902	17.1-27.0	16.0-27.6	16.8-26.8	17.4-26.0	17.5-24.8	16.2-25.1

V_3- BH 946	17.2-25.9	17.0-25.6	16.5-25.1	16.9-27.4	16.6-27.1	15.9-27.4
V_4- BH 885	16.9-25.9	16.5-25.7	16.0-25.2	17.7-26.2	17.2-25.6	16.3-24.9
Bare Soil	17.4-29.6	17.1-28.5	16.7-28.9	18.4-29.9	17.3-30.3	16.8-29.7
Physiological Maturity						
D_1- 3rd Nov.	17.6-24.9	17.3-24.8	17.6-25.4	18.4-26.3	16.1-26.3	13.4-17.9
D_2-18th Nov.	18.9-27.9	18.4-27.4	17.3-25.7	18.2-25.6	16.3-21.6	15.9-22.8
D_3- 3rd Dec.	20.9-29.8	20.4-29.1	19.3-27.1	21.7-30.7	19.5-25.9	16.8-28.9
D_4- 19th Dec.	35.0-40.8	34.5-38.6	26.3-33.7	38.3-44.8	29.8-33.8	28.9-30.5
V_1- BH 393	20.1-31.8	19.1-30.7	18.6-29.4	20.5-32.5	18.0-26.9	17.7-25.8
V_2- BH 902	19.6-29.0	19.1-28.4	18.0-27.3	20.0-27.4	18.7-23.9	16.1-22.8
V_3- BH 946	20.9-29.8	22.2-25.8	19.0-26.0	20.1-30.8	19.0-25.7	18.6-25.9
V_4- BH 885	30.3-36.5	28.2-31.8	21.5-26.8	30.9-34.5	27.5-30.6	25.3-32.8
Bare Soil	28.6-37.5	27.6-38.1	22.8-30.8	27.4-35.9	24.9-34.6	23.9-32.3

Range covers morning (0800 h) to evening (1700 h) observations at an hourly interval.

Table 6: Diurnal relative humidity profile (%) at different phenophases over barley canopy and bare soil

Phenophases						
	2016-17			2017-18		
Treatments	**Ground level**	**50 cm**	**100 cm**	**Ground level**	**50 cm**	**100 cm**
Vegetative Stage						
D_1- 3rd Nov.	54.6-96.3	51.8-93.8	48.9-91.2	54.9-96.6	52.0-94.1	49.2-93.6
D_2-18th Nov.	50.1-67.0	49.0-65.0	49.2-67.0	44.6-88.7	43.3-87.4	42.6-86.7
D_3- 3rd Dec.	39.9-80.0	38.9-79.1	38.1-78.3	50.5-67.4	49.4-65.4	48.2-64.2
D_4- 19th Dec.	44.3-88.5	43.0-87.1	42.1-86.2	40.1-80.0	39.0-79.2	38.4-78.6
V_1- BH 393	45.2-87.1	44.7-80.2	43.2-78.6	48.1-82.5	45.7-79.7	44.5-78.6
V_2- BH 902	47.8-81.4	45.5-79.9	43.8-78.2	45.3-84.2	43.1-82.0	42.6-80.5
V_3- BH 946	48.3-84.3	44.8-80.6	46.6-82.4	48.1-82.7	45.9-81.3	42.6-80.3
V_4- BH 885	47.5-85.3	44.7-82.0	46.1-83.0	50.3-83.4	46.6-81.9	38.4-78.6
Bare Soil	53.4-88.4	43.7-91.7	45.5-90.7	52.3-94.5	48.5-94.8	45.2-88.4
Anthesis Stage						
D_1- 3rd Nov.	47.9-70.8	46.6-67.8	45.0-66.3	56.5-83.0	55.6-82.2	54.1-80.7
D_2-18th Nov.	54.0-78.2	52.6-75.4	49.7-72.5	54.1-78.4	52.8-75.5	52.2-73.9
D_3- 3rd Dec.	56.5-88.6	54.7-81.3	53.8-80.4	49.4-79.6	48.6-78.8	47.2-76.7
D_4- 19th Dec.	49.0-79.3	47.9-77.8	46.2-75.9	48.1-69.0	46.9-67.8	45.6-66.9
V_1- BH 393	52.9-79.3	51.6-77.4	50.7-76.3	54.3-77.5	59.3-75.3	58.4-74.2
V_2- BH 902	54.2-76.4	52.7-75.3	52.6-73.0	52.3-80.1	50.0-77.1	49.1-76.4
V_3- BH 946	50.2-77.2	49.1-74.9	48.3-73.8	48.7-74.7	47.2-72.0	45.9-71.7
V_4- BH 885	50.1-76.3	48.2-74.6	47.4-72.8	53.0-77.7	50.9-76.9	50.5-75.4
Bare Soil	57.2-85.1	54.6-83.2	48.2-78.6	48.7-80.5	54.2-84.5	51.2-79.5
Physiological Maturity						
D_1- 3rd Nov.	70.2-82.9	68.0-83.0	65.8-80.8	70.6-86.2	68.3-83.9	67.6-82.6
D_2-18th Nov.	56.5-78.2	55.4-77.3	53.2-75.2	59.0-80.8	55.9-77.7	54.9-76.9
D_3- 3rd Dec.	53.7-75.5	52.7-74.6	50.5-72.4	56.5-78.3	54.5-76.3	53.5-75.4
D_4- 19th Dec.	51.9-66.3	57.6-66.7	55.0-63.8	55.0-70.2	52.7-67.1	52.0-66.2
V_1- BH 393	60.1-77.1	58.9-76.5	56.6-74.2	59.6-79.2	56.6-76.2	55.4-75.5
V_2- BH 902	61.8-80.9	57.5-73.3	55.3-71.2	64.9-82.1	61.9-79.1	60.6-77.8
V_3- BH 946	61.2-81.5	55.1-75.5	52.8-73.2	59.1-79.2	56.1-78.6	55.8-74.9
V_4- BH 885	56.2-77.0	55.7-75.2	53.5-73.1	58.5-75.6	55.9-73.6	54.6-71.8
Bare Soil	65.2-84.6	61.4-76.5	62.3-78.5	59.6-85.2	58.7-86.8	66.3-78.5

Range covers morning (0800 h) to evening (1700 h) observations at an hourly interval.

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