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Study of microclimatic conditions under different environments in wheat crop

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सार — गेहूँ की बेहतर पैदावार के लिए इसके सूक्ष्म जलवायु अध्ययन हेतु हरियाणा कृषि विश्वविद्यालय (एच० ए० यू०) के अनुसंधान फार्म में एक प्रयोग किया गया। फसल वितानों के पौधों की विभिन्न अवस्थाओं के दौरान तापमान, सापेक्ष आर्द्रता, पौधे का तापमान व आर्द्रता और पवन गति की रूपरेखा को मापा गया। विलंबित बुआई वाली फसल में बीज के उगने के समय अपेक्षाकृत उच्च वायु तापमान तथा न्यून मृदानमी देखी गई। धवलता अनुपात में 0.19 से 0.23 तक अंतर रहा। देर से की गई बुआई के साथ परीक्षण भार कम हुआ है। आंकड़ों को देखने से पता चलता है कि 31 अक्तूबर से 14 नवम्बर तक की अवधि में बोई गई फसल से, विभिन्न प्राकृतिक दशाओं के अनुकूल सूक्ष्म जलवायु परिस्थितियों में गेहूँ की बेहतर पैदावार प्राप्त हुई है।

ABSTRACT. An experiment was conducted to study the wheat microclimate for higher grain yield production at research farm of Hisar Agricultural University (HAU). Profiles of temperature, relative humidity, leaf temperature, leaf wetness, wind speed were measured in the crop canopies of different sowing treatments. Higher air temperatures and lower soil moisture were observed during reproductive phase under delayed sowings. Albedo varied between 0.19 and 0.23. Test weight decreased with delay in sowing time. Sowing of wheat between 31 October and 14 November produced statistically higher yield under favourable microclimate conditions at different phenophases.

Key words — Phenophase, Leaf area index (LAI), Sowing dates, Soil moisture, Air temperature, Yield.

1. Introduction

The microclimate of different crop canopies has been the subject of investigation during the last decade (Gillespie and King 1971, Legg and Long 1975, Johnson *et al.* 1976, Baldocchi *et al.* 1983 and Ram Niwas *et al.* 1989). Physical and dependent physiological variables provided the interaction between the crop with its surrounding environment. However, the separation of the complex physiological system of wheat crop into components which respond to discrete elements of the physical environment is not so simple. Often physiological variables are used alongwith weather variables to explain these interactions. When these interactions are visualized at organelle scale these are much more complicated because the physiological and morphological characteristics of plant tissues and their development take place with environmental interactions (Friend 1966, Woledge 1973).

Such studies will generate valuable information regarding the interaction of crop with its environment. Therefore, a field study was undertaken to quantify the crop microclimate to improve the yield potential.

2. Materials and methods

A field experiment was conducted at the experimental farm, Hisar (Lat. 29°10'N, Long. 75°46'E, 215.2 m asl) during the winter season of the year 1990-91. The wheat variety, WH-147, was sown under five different dates of sowing namely, 31 October (D_1), 14 and 29 November (D_2 and D_3), 14 and 29 December (D_4 and D_5). The plot size was 11.25×4 m. All the basic inputs and agronomic practices were followed as per the package of practices recommended for wheat crop by the University. Soil of the experimental plot was sandy loam. Five plants were tagged for recording detailed phenological observations in each plot. The experiment was conducted in randomized block design with five treatments and three replications. The day on which any of the three plants attained a phenophase, was recorded as the date of occurrence of that particular phenophase. Plants from 1.0 m^2 area were uprooted and leaves were separated for leaf area measurement using leaf area meter and finally LAI and dry matter was calculated at 15-day intervals. Yield and its attributes were recorded at maturity in all the treatments.

TABLE 1

Sensor	Data logger	Location
Wind speed sensor	ES-020	At 50% of crop height & at 2 m above crop canopy
Air temp. & R. H. sensors	ES-120	—do—
PAR sensor		1.0 m above crop canopy
Pyranometer		—do—
Albedometer	3023	—do—
Two Blackman soil moisture blocks in each plot	8 M-898 with ES-260	At 5 & 15 cm soil depth
Two thermister temp. probe	ES-060	Attached to two fully grown up leaves
Leaf wetness sensor	ES-460	—do—

An OMNIDATA automatic weather stations was installed in the wheat crop to record crop micro-climatological parametrs. Details of the different sensors and data logger used in the weather station are given in Table 1.

The two Blackman soil moisture blocks were installed at 5 and 15 cm of soil depth in each plot and these were not changed only the wires were disconnected.

The above parameters were recorded on each date of sowing by shifting the weather station on the consecutive days in each replication at particular phenophase. The occurrence of phenophases was different on different dates of sowing of wheat. The data-logger was programmed to record all meteorological variables and averaged over the day.

3. Results and discussion

The data on air temperature, relative humidity and wind speed are presented in Table 2. The seasonal temperature range (maximum and minimum mean air temperature during growing season) was recorded with a maximum value (15.81°C) in delayed sown wheat (D_5) followed by D_4 (13.35°C), D_3 (10.8°C), D_1 (8.13°C) and D_2 (7.0°C). The early sown wheat (D_1) experienced higher air temperatures during the initial growth stages as compared to later reproductive phenophase. However, with delay in sowings this trend was reversed. During germination period the mean air temperature was less in delayed sown wheat (D_5) by 10.9°C as compared to early sown wheat (D_1). However, during flowering to physiological maturity the mean air temperatures were higher in D_5 by 5 to 7°C as compared to those observed in D_1. A mean daily temperature of 15 to 20°C was optimum for growth and development of wheat crop, higher temperatures beyond 25°C, coupled with lower relative humidity values at maturity resulted in reduced yields (Mavi 1986).

The higher relative humidity values were recorded at germination stage in delayed sowings (D_4 and D_5) due to the inverse relationship between air temperature and relative humidity with the onset of north westerlies. It supports the results reported by Ram Niwas *et al.* (1989) in raya. The relative humidity values were recorded lower in wheat at milking and ripening stages under delayed sown conditions (D_5) by 9.23 and 11.03 percent respectively as compared to values observed in early sown wheat (D_1).

Higher wind speed was observed in late sown (D_4 and D_5) treatments than that of the early sown wheat crop (D_1) during later phenological stages due to the increased surface roughness created with the increase in crop height and leaf area index. Similar results were reported by Ram Niwas *et al.* (1989) in raya (*Brassica juncea* L.) under similar environmental conditions.

The leaf temperature, leaf wetness and soil moisture values, in wheat crop at different stages, are presented in Table 3. Wheat leaves were cooler than surrounding air temperature in all the sowing dates throughout the growing season due to non-stress conditions, when irrigations are given as per recommended irrigations for wheat crop. It confirms the findings of Ram Krishna *et al.* (1977) in pearl millet crop under arid environment. The difference in air and leaf temperature increased under delayed sowing conditions at the ripening stage due to increase of transpiration rate with increase of air temperature under late sown wheats.

Leaf wetness values during different wheat phenophases varied from 23 to 53 percent RD (relative dryness) irrespective of dates of sowings. The leaf surface had less water in delayed sown wheat (D_5) during reproductive phenophase as compared to other sowing dates. This is attributed to the lower humidity values experienced by wheat under late sown wheat (D_5) during the reproductive stage (Table 3).

The soil moisture tension increased with advancement of growth stages on all dates of sowing due

TABLE 2

Air temperature (T °C), relative humidity (RH, %) and wind speed (WS, m/sec) at different phenological stages inside the wheat canopy

Dates of sowing	Phenophases																							
	Germination			Crown root initiation (CRI)			Jointing			Heading			Flowering			Milking			Ripening			Harvest		
	T	RH	WS	T	RH	WS	T	RH	WS	T	RH	WS	T	RH	WS	T	RH	WS	T	RH	WS	T	RH	WS
D_1	21.7	48	0.84	20.2	55	0.83	17.8	63	1.07	13.0	68	1.04	14.1	66	1.01	15.9	68	1.17	18.7	64	1.21	21.1	63	1.10
D_2	20.3	63	0.81	16.9	63	2.12	15.4	65	1.14	15.1	62	1.03	15.3	71	1.38	20.2	61	1.49	21.1	60	1.02	21.0	58	1.34
D_3	14.7	52	0.66	14.6	63	1.30	16.8	66	1.22	16.3	64	1.17	16.7	68	1.34	21.5	59	0.96	21.4	62	1.11	25.4	57	1.67
D_4	14.6	63	1.30	11.7	62	1.11	12.8	65	1.11	17.3	72	1.28	19.3	67	1.41	22.7	61	1.43	24.0	61	1.47	25.1	52	1.88
D_5	10.7	64	1.02	13.4	63	1.07	17.5	72	1.11	18.0	70	2.09	20.9	66	1.52	25.2	58	1.54	24.1	53	1.41	26.5	52	2.42
S.E. (m)±	2.01	3.32	0.11	1.43	1.65	0.22	0.91	1.55	0.03	0.89	1.89	0.20	1.26	0.85	0.09	1.54	1.62	0.11	0.01	1.83	0.09	1.14	2.14	0.23
C.D. at 5%	6.55	10.83	0.36	4.66	5.38	0.72	2.97	5.05	0.10	2.90	6.16	0.65	4.11	2.77	0.29	5.02	5.28	0.36	3.29	5.97	0.29	3.71	6.98	0.75

TABLE 3

Leaf temperature (TL, °C), leaf wetness (LW, %RD)) and soil moisture (SM, bars) in different dates of sowing at various phenophases

Dates of sowing	Phenophases																							
	Germination			CRI			Jointing			Heading			Flowering			Milking			Ripening			Harvest		
	TL	LW	SM	TL	LW	SM	TL	LW	SM	TL	LW	SM	TL	LW	SM	TL	LW	SM	TL	LW	SM	TL	LW	SM
D_1	—	—			—	—	12.1	31.8	—	12.2	47.7	0.47	12.6	39.7	0.49	15.2	43.8	0.57	17.3	48.9	1.27	17.8	44.2	6.3
D_2	—	—	—	—	—	—	12.0	37.2	0.51	14.2	46.3	0.70	15.2	46.4	0.58	19.5	49.2	0.78	19.2	41.7	3.60	—	42.2	7.6
D_3	—	—	—	14.2	39.0	0.51	15.4	48.8	0.46	13.4	44.6	0.56	15.0	48.0	0.54	19.2	47.4	0.77	19.0	40.7	4.12	20.3	39.7	7.6
D_4	—	—	0.46	11.4	52.8	0.47	11.9	40.0	0.50	16.6	40.2	0.55	16.4	45.4	0.63	20.0	50.2	2.86	19.1	41.5	4.14	20.2	41.7	9.2
D_5	—	—	0.47	11.7	44.0	0.47	15.8	36.9	0.57	17.6	46.8	0.83	20.5	50.2	0.99	—	41.4	12.54	—	26.3	13.14	—	22.5	13.9
S.E. (m)±	—	—	—	—	—	—	0.88	3.12	—	0.98	1.33	0.06	1.30	1.75	0.09	—	1.76	2.30	—	3.69	2.04	—	3.94	1.33
C.D. at 5%	—	—	—	—	—	—	2.87	10.17	—	3.20	4.34	0.20	4.24	5.71	0.29	—	5.74	7.50	—	12.03	6.65	—	12.85	4.34

TABLE 3

Maximum leaf area index (LAI), total dry matter production, 1000 seed weight and grain yield in different sowing dates of wheat

Dates of sowing	Maximum LAI	Total dry matter (q/ha)	1000 seed weight (g)	Grain yield (q/ha)
D_1	4.2	129.6	43.8	51.3
D_2	4.0	125.7	43.2	50.0
D_3	3.5	100.4	32.4	42.3
D_4	3.2.	96.9	30.1	41.0
D_5	2.9	80.0	26.2	35.9
S.E. (m)±	0.16	8.87	1.11	1.24
C.D. at 5%	0.52	28.92	3.62	4.04

to increased water use with canopy development. Lower soil moisture was observed during the reproductive stage in late sown conditions (D_4 and D_5) inspite of same irrigation levels. This was attributed to the higher air temperatures experienced by late sown crop, which may be due to the maximum water loss under prevailing environment.

Albedo values varied between 0.17 and 0.18 during germination time with bare soil in all treatments. Albedo increased with the emergence and development of crop canopy and the highest value (0.23) was observed in early sown treatments (D_1 and D_2) at the maximum leaf area index (LAI) stage. Albedo showed an increasing trend with the development of LAI, whereas after grain filling stage, a decreasing trend was observed in all treatments due to senescence of leaves as the crop approached maturity.

Maximum leaf area index, total dry matter accumulation, grain yield and test weight of wheat under different sowing dates are presented in Table 3. Highest leaf area index was observed in early sown conditions (D_1) and decreased with the delay in sowing dates. This may be due to the elongated vegetative phase in early sown conditions (D_1) and the duration of vegetative phase decreased with delay in sowing. The early sown crop (D_1) produced highest dry matter (129.6 q/ha) and decreased by 38 percent with delayed sown conditions (D_5) due to decrease in leaf area index for cumulative radiation interception for dry matter accumulation and higher air temperatures during ripening stage in late sown wheat (D_5). The 1000 seed weight also decreased with delay in sowing of wheat due to the increase in air temperature and decrease in soil moisture under delayed sowings during ripening stage (Table 4), which resulted in shrivelling of grains due to forced maturity. The grain yield produced was significantly higher in D_1 and D_2 as compared to other sowing dates, whereas grain yield production was statistically at par in D_1 and D_2. Singh *et al.* 1992, reproduced that delay in sowing of wheat beyond November 28 resulted in the significant decrease in yield.

4. Conclusion

Based on the above results it is concluded that miroclimatic conditions experienced by wheat crop sown from 31 October to 14 November provided favourable microclimatic conditions at different phenophases for attaining maximum yield of wheat.

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