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Canopy temperature (^{0}C) above and below and Relative Water Content (%) of leaves as affected by various treatments for wheat (*Triticum aestivum* L.)

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Abstract
The present investigation entitled **"**Canopy temperature (ºC) above and below and Relative Water Content (%) of leaves as affected by various treatments for wheat (*Triticum aestivum* L.)**"** was conducted at Instructional Farm of Acharya Narendra Deva University of Agriculture and Technology Kumarganj, Ayodhya (U.P.) during rabi season of 2020-2021 and 2021-2022: to study the Canopy temperature (ºC) above and below canopy of wheat as affected by various treatments (2020-21 and 2021-22) Relative Water Content (%) of leaves for wheat as affected by various treatments (2020-21 and 2021-22). Canopy temperature (ºC) of wheat at top and bottom of the canopy as affected by different date of sowing /weather variability and varieties recorded at successive stages during both the years. RWC was significantly influenced due to varieties at all the stages. V_3 recorded significantly RWC at all the stages which was at par with V_2 and significant over V_3 treatment at all the stages during both the years of investigation. RWC was significantly influenced due to seed rates at all the stages except 45 DAS and 90 DAS. PBW-343 recorded significantly RWC at all the stages which was at par with HD-2824 and significant over HUW -234 at all the stages during both the years of investigation. Experiment was conducted at Students Instructional Farm, Acharya Narendra Deva University of Agriculture and Technology Kumarganj Ayodhya (U.P.), which is geographically situated between 26°.47'N latitude to 82°.12'E longitude and at an altitude of 113 m above mean sea level. Geographically, Ayodhya falls under semi-arid and sub-tropical climate of Indo-Gangatic plains having alluvial calcareous soil. The average annual precipitation is about 1001 mm of which 85-90 per cent received during monsoon period *i.e.* between June to September. The maximum temperature reaches to its peak (40-45°C) during May while the minimum temperature is quite low (12-15 °C) during December and January. The experiment was carried out in randomized block design with three dates of sowing (15th Nov 2020, 25th Nov 2020 and 05th Dec 2020) and (15th Nov 2021, 25th Nov 2021 and 05th Dec 2021) and three cultivars (HD-2824, PBW-343 and HUW-234) there replicated three time. The experimental field was divided into 27 plots. Each the plot has gross size of 5.0m x 4.0m and row to row space was maintained at 20 cm.

Keywords: Canopy temperature (^{0}C), Relative Water Content (%)

Introduction
Wheat (*Triticum aestivum* L.) 2n=42 is a member of the Poaceae family that originated in South West Asia. It is the most extensively produced field crop, and it thrives well in temperate as well as tropical and subtropical climates. Wheat plays a crucial role in India's food security. China has the highest land area dedicated to wheat production, followed by the United States. Globally, the total area under wheat production is 223.40 million hectares with a production of 778.60 million tones and a productivity of 3490 kg/ha. India has an area of 31.62 million hectares, a production of 109.52 million tones and a productivity of 3406 kg/ha. (Annonymous 2022). Wheat is the most important grain crop in India's Indo-Gangetic plains, including Punjab. Punjab contributes roughly 43 °C of wheat and 28 °C of rice to the central pool of food rains although covering only 1.54% of India's geographical territory (Annonymous 2015). Wheat, as a winter crop, is accustomed to lower temperatures and is consequently more negatively affected by hot temperatures than rice. Indian wheat yields are growing more vulnerable to low temperatures, particularly during the post-anthesis stage. The additional thermal restrictions in achieving high production include exposure to a constant minimum temperature of 12 °C for 6 days and terminal heat stress with a maximum temperature of 34 °C for 7 days during the post-anthesis stage. (Rao *et al.*, 2015) phenological development of wheat is advanced when temperatures are beyond average.

Under Punjab conditions, a 1°C increase in temperature reduced wheat yield by 10 °C. (Hundal and Kaur 2007) [4] Climate change is evidently affecting every aspect of our lives. The impact on growth and development is palpable. The usage of water and the yield of main crops, such as wheat, are discussed. Because of the importance of agriculture to the global economy and the susceptibility of crop yields to climate conditions, the implications of climate change on agricultural output have received a lot of attention recently. Effect of Climate change on India can have far-reaching ramifications; India is the world's second-largest agricultural producer, and any changes in production due to climate change might have a significant impact on worldwide food imports and exports. Climate change is clearly having an impact on every part of our life. The impact on development and growth is evident. The impact of climate change on agricultural output has gotten a lot of attention recently because of the importance of agriculture to the global economy and the vulnerability of crop yields to climate conditions. The impacts of climate change on India could be far-reaching; India is the world's second-largest agricultural producer, and any changes in production caused by climate change could have a big impact on global food imports and exports.Wheat is the world's most widely grown food grain crop. It can be found growing in temperate, tropical, and subtropical climates. Wheat is India's second most significant primary food crop, after rice (Agrawal and Sinha, 1993). It has a wide range of adaptability and can even withstand extreme cold. Cool, wet weather during the vegetative phase, followed by dry, warm weather during the reproductive phase, produces the best quality wheat (Draganka *et al.,* 2004). Seasonal temperature is an essential climatic component that has a significant impact on rabi crop productivity. Seasonal temperature changes have an impact on the grain, mostly through phenological development processes. Winter crops are particularly vulnerable to high temperatures during reproductive phases, and distinct crops' responses to temperature change (increase) have been seen in varied production situations (Kaur and Hundal, 2007) [4].

Temperature and radiation are two of the most important environmental elements that influence wheat growth and development (Bal *et al.*, 2018). Causes the phenology and the yield of crops is changes. Seed production might be maximised by employing appropriate management strategies at various phenological stages in order to provide optimal meteorological conditions for crop growth. One of the most important staple foods is wheat. It occupies the biggest geographical area (more than 240 million acres) and ranks first in terms of production among all commercially cultivated crops in India. Global Warming is a key worry for humanity in the twenty-first century. The world's crop production is greatly influenced by the constantly shifting climate pattern. The impact of future climate change on agricultural production and food security is receiving a lot of attention these days (Lobell 2018). Wheat production has adapted to climate change through changes in planting dates, cultivars, and agronomic practises (Jalota *et al,* 2013; Tao *et al.,* 2015; and Pramod *et al.,* 2017). High temperatures hamper the growth of winter wheat during the post-heading stages (from anthesis to maturity), which are the hottest times of the growing season for this crop (Rao *et al.*, 2015). Grain filling length is shortened as a result of greater average temperature during this period (Zhao *et al.*, 2007; Lobell *et al.*, 2012; Garg *et al.*, 2013). Because of crop growth's great sensitivity to temperature, global warming has already posed a serious threat to winter wheat production around the world (Asseng *et al.*, 2015). Furthermore, the predicted warming trend in future climate scenarios suggests an increased risk of heat stress for winter wheat growth, particularly in regions where the environment is currently favourable (Ortiz *et al.*, 2008; Asseng *et al.*, 2015), emphasising the importance of understanding, estimating, and coping with heat stress impacts. Temperature changes have a wide range of effects on wheat growth and production (Sicbert and Ewert, 2014). Quantification of the actual impacts of unfavourable and extreme temperature conditions on crop growth under field conditions is also fraught with uncertainty, as farmers will adjust their crop varieties and management methods to cope with typical weather threats (Reidsma *et al.*, 2010; Farooq *et al.*, 2011; Tao *et al.*, 2015). In light of the foregoing, a study was conducted. Wheat crops are more adaptable and can withstand extreme cold, and the best quality wheat is produced when the weather is cool and damp during the vegetative phase and then dry and warm during the reproductive period (Draganka *et al.*, 2004). It's a plant for long days. For seed sowing and germination, a temperature of 20 ºC to 25 ºC is optimum. The ideal temperature for vegetative growth is between 16ºC and 22ºC. Wheat requires a mean maximum temperature of around 25ºC for at least 4-5 weeks during grain formation. Wheat thrives in climates with yearly rainfall ranging from 1200 to 1600 mm. When grown in low temperatures during the early stages of growth, winter wheat completes its life cycle the quickest, while high temperatures are necessary during the later stages of growth (Bobade, 2010). Wheat agriculture confronts several problems, with terminal heat stress being one of the most significant constraints restricting wheat yield in the country's eastern regions. According to studies, the ideal temperature for grain set and grain filling in wheat is between 19°C and 22 °C (Porter & Gawith, 1999). For wheat in the post-anthesis stage, the threshold temperature, or the value of daily mean temperature at which a discernible drop in growth begins, is 26 °C (Stone and Nicolas, 1994).

Material and Methods

An experiment was conducted at Students Instructional Farm, Acharya Narendra Deva University of Agriculture and Technology Kumarganj Ayodhya (U.P.), India on the topic entitled **"**Canopy temperature (ºC) above and below and Relative Water Content (%) of leaves as affected by various treatments for wheat (*Triticum aestivum* L.)**"** The experimental site is located in the main campus of Acharya Narendra Deva University of Agriculture and Technology Kumarganj Ayodhya (U.P.), India. The geographically situated between 26°.47'N latitude to 82°.12'E longitude and at an altitude of 113 m above mean sea level. Geographically, Ayodhya falls under semi-arid and sub-tropical climate of Indo-Gangatic plains having alluvial calcareous soil. The average annual precipitation is about 1001 mm of which 85-90 per cent received during monsoon period *i.e.* between June to September. The maximum temperature reaches to its peak (40-45 °C) during May while the minimum temperature is quite low (12-15 °C) during December and January. The experiment was carried out in randomized block design with three dates of sowing (15th Nov 2020, 25th Nov 2020 and 05th Dec 2020) and (15th Nov 2021, 25th Nov 2021 and 05th Dec

2021) and three cultivars (HD-2824, PBW-343 and HUW-234) there replicated three time. The experimental field was divided into 27 plots. Each the plot has gross size of 5.0m x 4.0m and row to row space was maintained at 20 cm.

Result

Data pertaining to canopy temperature (°C) of wheat at top and bottom of the canopy as affected by different date of sowing /weather variability and varieties recorded at successive stages during both the years of investigation have been presented in the table-1 and 2. An examination 5of data presented in table-1 and 2 manifests the canopy temperature (°C) was significantly influenced due to varieties at all the stages. V_3 recorded significantly canopy temperature (°C) at all the stages which was at par with V_2 and significant over V_3 treatment at all the stages during both the years of investigation. As examination of data presented in table-1 and 2 manifests that canopy temperature (°C) was significantly influenced due to seed rates at all the stages except 45 DAS and 90 DAS. PBW-343 recorded significantly canopy temperature (°C) at all the stages which was at par with HD-2824 and significant over HUW-234 at all the stages during both the years of investigation.

Data pertaining to relative water content of wheat recorded at successive stages during both the years of investigation have been presented in the table-3 and 4. An examination of data presented in Table-5 manifests the RWC was significantly influenced due to varieties at all the stages. V_3 recorded significantly RWC at all the stages which was at par with V_2 and significant over V_3 treatment at all the stages during both the years of investigation.

As examination of data presented in Table 5 manifests that RWC was significantly influenced due to seed rates at all the stages except 45 DAS and 90 DAS. PBW-343 recorded significantly RWC at all the stages which was at par with HD-2824 and significant over HUW-234 at all the stages during both the years of investigation.

Table 1: Canopy temperature (°C) above and below canopy of wheat as affected by various treatments. (2020-2021)

Treatments	Days After Sowing											
	15 DAS		30 DAS		45 DAS		60 DAS		75 DAS		90 DAS	
	A	B	A	B	A	B	A	B	A	B	A	B
Date of sowing/ Weather variability												
15 Nov	25.41	25.33	19.30	19.28	13.78	13.77	17.78	17.65	24.47	23.65	25.80	24.54
25 Nov	25.35	25.32	19.44	19.43	13.65	13.56	17.89	16.45	24.45	23.45	25.46	24.34
05 Dec	25.26	25.23	19.31	19.21	13.76	13.74	17.60	17.43	24.34	23.43	25.67	24.56
Varieties												
HD-2824	25.43	25.21	19.65	19.34	13.46	13.36	17.65	17.23	24.67	23.23	24.78	24.76
PBW-343	25.45	25.40	19.76	19.23	13.87	13.56	17.45	17.44	24.86	23.34	25.54	24.90
HUW-234	25.34	25.12	19.87	19.30	13.76	13.54	17.67	17.33	24.45	23.56	25.67	24.87

A= Canopy Temp. above the canopy, B= Canopy Temp. below the canopy

Table 2: Canopy temperature (°C) above and below canopy of wheat as affected by various treatments. (2021-2022)

Treatments	Days After Sowing											
	15 DAS		30 DAS		45 DAS		60 DAS		75 DAS		90 DAS	
	A	B	A	B	A	B	A	B	A	B	A	B
Date of sowing/ Weather variability												
15 Nov	26.45	25.67	18.78	18.76	14.65	13.89	17.89	16.67	25.67	24.46	28.76	27.34
25 Nov	26.56	25.89	18.65	18.54	14.76	13.90	17.87	16.66	25.65	24.45	28.75	27.65
05 Dec	26.76	25.98	18.67	18.34	14.56	13.78	17.67	16.65	25.45	24.67	28.45	27.78
Varieties												
HD-2824	26.87	25.65	18.89	18.23	14.45	13.67	17.56	16.45	25.46	24.67	28.67	27.78
PBW-343	26.43	25.78	18.76	18.25	14.34	13.89	17.67	16.67	25.67	24.78	28.89	27.67
HUW-234	26.56	25.90	18.65	18.54	14.56	13.76	17.87	16.87	25.87	24.67	28.87	27.65

A= Canopy Temp. above the canopy, B= Canopy Temp. below the canopy (RWC) Relative Water Content (%)

Table 3: Relative Water Content (%) of leaves for wheat as affected by various treatments (2020-2021)

Treatments	Days After Sowing					
	15 DAS	30 DAS	45 DAS	60 DAS	75 DAS	90 DAS
Date of sowing/ Weather variability						
15 Nov	87.6	84.4	88.10	77.8	67.9	68.19
25 Nov	86.5	84.3	86.78	75.3	66.0	65.11
05 Dec	86.2	84.2	86.12	74.4	65.9	60.43
S.Em±	0.7	0.4	0.67	0.4	0.6	0.74
CD (P=0.05)	NS	2.1	NS	1.3	NS	2.16
Varieties						
HD-2824	84.3	84.3	80.13	79.17	68.1	66.00
PBW-343	84.4	84.4	80.21	80.97	71.8	67.61
HUW-234	84.2	84.2	80.10	78.10	65.1	65.95
S.Em±	0.5	0.5	0.49	0.49	0.7	0.64
CD (P=0.05)	2.1	2.1	NS	1.43	2.1	NS

Table 4: Relative Water Content (%) of leaves for wheat as affected by various treatments (2021-2022)

Treatments	Days After Sowing					
	15 DAS	30 DAS	45 DAS	60 DAS	75 DAS	90 DAS
Date of sowing/ Weather variability						
15 Nov	84.4	87.6	87.64	77.8	67.61	67.7
25 Nov	84.3	86.5	86.53	75.3	66.0	66.0
05 Dec	84.2	86.2	86.29	74.4	65.45	65.9
S.Em±	0.4	0.7	0.75	0.4	0.64	0.6
CD (P=0.05)	2.1	NS	NS	1.3	NS	NS
Varieties						
HD-2824	88.9	88.9	84.34	75.32	73.26	68.1
PBW-343	91.2	91.2	84.40	77.88	75.45	71.8
HUW-234	84.0	84.0	84.21	74.42	72.08	65.1
S.Em±	0.8	0.8	0.48	0.47	0.39	0.7
CD (P=0.05)	2.5	2.5	NS	1.39	1.14	2.1

Table 5: Yield of wheat crops as affected by different treatments

Treatments	Grain yield (q ha^{-1})		Straw yield (q ha^{-1})		Biological yield (q ha^{-1})		Harvest Index (%)	
Year	2020-21	2021-22	2020-21	2021-22	2020-21	2021-22	2020-21	2021-22
Date of sowing / Weather variability								
15 Nov	46.07	46.77	61.82	62.67	107.89	109.43	42.70	42.73
25 Nov	44.13	44.77	59.33	60.08	103.47	104.84	42.65	42.70
05 Dec	36.83	37.35	49.78	50.31	86.61	87.66	42.52	42.61
S.Em±	1.10	1.12	1.12	1.45	2.15	2.51	0.99	1.05
CD (P=0.05)	3.31	3.34	3.35	4.36	6.45	7.52	NS	NS
Varieties								
HD-2824	39.27	42.53	56.52	57.20	98.45	99.73	42.62	42.67
PBW-343	45.83	46.52	61.57	62.35	107.40	108.87	42.67	42.72
HUW-234	14.93	39.83	52.85	53.51	92.12	93.34	42.59	42.65
S.Em±	1.10	1.12	1.12	1.45	2.15	2.51	0.99	1.05
CD (P=0.05)	3.31	3.34	3.35	4.36	6.45	7.52	NS	NS

Conclusion

It is concluded that the canopy temperature (ºC) of wheat at top and bottom of the canopy as affected by different date of sowing /weather variability and varieties recorded at successive stages during both the years. RWC was significantly influenced due to varieties at all the stages. V_3 recorded significantly RWC at all the stages which was at par with V_2 and significant over V_3 treatment at all the stages during both the years of investigation. RWC was significantly influenced due to seed rates at all the stages except 45 DAS and 90 DAS. PBW-343 recorded significantly RWC at all the stages which was at par with HD-2824 and significant over HUW-234 at all the stages during both the years of investigation.

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