

Microclimate: Diurnal temperature variation inside crop canopy of Pearl millet

ABSTRACT

The microclimate was evaluated for the pearl millet crop at different height inside the crop canopy. Field experiments were conducted during *kharif* seasons of year 2018 and 2019 and temperature was measured at bottom, middle and top of the crop canopy at panicle initiation stage, boot stage, 50 per cent flowering, dough stage and physiological maturity stages from 09:00 in the morning to 05:00 in the evening. The temperature profiles indicates that lower temperature were recorded at the top of crop canopy as compare to bottom of crop canopy *i.e.* temperature inside the crop canopy was higher than at top of the crop canopy in all the treatments. Temperature profiles were lapse in all the treatments within the crop canopy in both the crop seasons. The maximum temperature was observed in afternoon hours and the minimum temperature was recorded in the morning hours.

Keywords: Temperature profiles, date of sowings and pearl millet hybrids

INTRODUCTION

Under hot dry conditions on infertile soils of low water holding ability where other cereal crops usually fail totally there pearl millet is grown as subsistence crop largely for its ability to produce grain in harsh conditions [3]. In pearl millet temperature requirements for growth and development depends on the varieties. Temperature ranges from 22 to 35 °C in optimum for growth of plant and among pearl millet genotypes averaging 34 °C is required for germination with upper limit lies between 47 and 52 °C and base temperature lies between 8 and 13.5 °C [4]. Temperature ranges from 31 to 35 °C is optimum for a virtuous photosynthetic response. High temperature accelerates the production rate of the leaves [5]. Yield and how tall a plant will grow can be affected by the sowing time. Most important and non-monetary input that affect the yield of the crop is sowing time and also considered as a critical input for higher yield. With optimum planting time establish healthy and vigorous plants and with delay in sowing time reduces the plant height and yield [2]. Sowing at optimum time improves the productivity by providing suitable environment at all the growth stages. Crop sown on proper date of sowing enjoy favorable climatic conditions in term of temperature and other climatic parameters during various crop growth stages which reflected into better growth and yield [1].

For choosing the proper sowing time various factors like agro-climatic situations and crop growing season and also in accordance to the variety were kept in considerations, so that the crop can get proper temperature and photoperiod during its different phenophases which is required by the crop for proper growth and better yield. Keeping the above facts in view, the present study on diurnal temperature variation inside crop canopy of Pearl millet was carried out.

MATERIAL AND METHODS

1. Location of experiment site

The field experimentation were conducted at research farm of Department of Agricultural Meteorology, CCS HAU, Hisar in the *Kharif* seasons of 2018 and 2019, located at latitude 29°10' N, longitude 75°46' E and altitude of 215.2 m over the mean sea level.

2. Climatic conditions of experimental site

The climate condition of Hisar over most of the year is of an obvious continental character. In summer climatic condition is very hot and markedly cold in winter. The maximum temperature lies above 45 °C usually common during summer, in winter, the minimum temperature below or near freezing point. The rainfall in the region is low and erratic, south-westerly wind prevailed during monsoon season brings rain. In monsoon period lasting from the middle of June to the end of September on which autumn crop and spring sowing depends and the other is the winter rains which occur from December to February, benefiting *Rabi* crop. Rainfall is meagre in Hisar.

3. Experimental details

The experiment was put in a split plot design and comprised of three date of sowings (main plot treatments) *viz.* D₁- 2nd fortnight of June, D₂- 1st fortnight of July, D₃- 2nd fortnight of July and four sub plot treatments comprising four varieties *viz.* V₁- HHB 67 Improved, V₂- HHB 197, V₃-HHB 272 and V₄-HHB 299 with three replications.

Micrometeorological observations for temperature

Micro-meteorological (temperature) observations was recorded in the experimental location during panicle initiation stage, boot stage, 50 per cent flowering, dough stage and physiological maturity stages at the time of clear sky at one hourly interval starting from 09:00 in the morning to 05:00 in the evening.

The temperature was measured at bottom, middle and top of the crop canopy panicle initiation stage, boot stage, 50 per cent flowering, dough stage and physiological maturity stages from 09:00 to 05:00 hours with the help of digital Psychrometer. Temperature profiles

were drawn at panicle initiation stage, boot stage, 50 per cent flowering, dough stage and physiological maturity stages.

RESULTS AND DISCUSSION

Temperature profile

The temperature profiles shown in Fig 1 to 10 indicate that lower temperature was recorded at the top of crop canopy as compare to bottom of crop canopy *i.e.* temperature inside the crop canopy was higher than at top of the crop canopy in all the treatments. Temperature profiles were lapse in all the treatments within the crop canopy. The maximum temperature was observed in afternoon hours and the minimum was in the morning.

At panicle initiation stage in crop season 2018 as depicted in Fig. 1, maximum temperature (41.7 °C) was recorded at the bottom of the crop canopy in the afternoon (02:00) with D₁ and minimum temperature (26.0 °C) was recorded at top of the crop canopy at 9 in the morning in D₃. While during crop season 2019 as depicted in Fig. 6, maximum temperature (42.6 °C) was recorded at the bottom of the crop canopy at 02:00 in the afternoon with D₃ and minimum temperature (24.6 °C) was recorded at top of the crop canopy at 09:00 in the morning in D₂. Among pearl millet hybrids, maximum temperature was recorded with V₄ in both the crop season at the bottom of the crop canopy at 02:00 in the afternoon (43.0 and 44.5 °C) in crop seasons 2018 and 2019, respectively. In both the crop seasons 2018 and 2019, Minimum temperature was recorded in V₁ at the bottom of the crop canopy at 09:00 and 10:00 in the morning with 25.5 °C and 25.2 °C in crop seasons 2018 and 2019, respectively.

At booting stage in both the crop seasons 2018 and 2019 as depicted in Fig. 2 and 7, maximum temperature was recorded at the bottom of the crop canopy at 02:00 in the afternoon in D₁ (42.6 °C) and D₃ (43.4 °C) in crop seasons 2018 and 2019, respectively and minimum temperature was recorded at 09:00 in the morning at top of the crop canopy in D₂ (20.6 °C) in 2018, while at top of the crop canopy in D₃ (21.3 °C) in 2019. In both the crop seasons 2018 and 2019, among pearl millet hybrids V₄ recorded maximum temperature (43.8 °C and 44.9 °C) at the bottom of the crop canopy at 02:00 in the afternoon in crop season 2018 and 2019, respectively and minimum was recorded in V₁ (20.1 °C) and (21.1 °C) at top of the crop canopy in crop seasons 2018 and 2019, respectively.

At 50 per cent flowering in both the crop seasons 2018 and 2019 as depicted in Fig. 3 and 8, maximum temperature was recorded at the bottom of the crop canopy at 02:00 in the afternoon in D₂ (44.0 °C) and D₃ (42.7 °C) in crop seasons 2018 and 2019, respectively and minimum temperature was recorded at the top of the crop canopy at 09:00 in the morning in

D₃ (22.1 °C) and D₂ (22.9 °C) in crop seasons 2018 and 2019, respectively. In both the crop seasons the maximum temperature (43.6 and 44.2 °C) was recorded in V₄ at bottom of the crop canopy at 02:00 in the afternoon in crop seasons 2018 and 2019, respectively while minimum was recorded at the top the crop canopy at 09:00 in the morning in V₂ (25.8 °C) and V₁ (23.4 °C) in crop seasons 2018 and 2019, respectively.

At dough stage in both the crop seasons 2018 and 2019 as depicted in Fig. 4 and 9, maximum temperature was recorded at the bottom of the crop canopy at 02:00 in the afternoon in D₂ (42.5 °C) and D₁ (42.5 °C) in crop seasons 2018 and 2019, respectively and minimum temperature was recorded at the top of the crop canopy at 05:00 in the afternoon in D₁ (23.9 °C) and D₃ (20.5 °C) in crop seasons 2018 and 2019, respectively. In both the crop season the maximum temperature (43.9 and 44.6 °C) was recorded in V₄ at bottom of the crop canopy at 02:00 in the afternoon in crop season 2018 and 2019, respectively while minimum was recorded at the top the crop canopy at 09:00 in the morning in V₁ (24.3 °C) in crop season 2018, while in crop season 2019 minimum temperature recorded at top of the crop canopy at 05:00 in the afternoon in V₁ (22.4 °C).

At physiological maturity in crop season 2018 as depicted in Fig. 5, D₁ recorded maximum temperature (41.8 °C) at bottom of the crop canopy at 02:00 in the afternoon and minimum temperature (23.2 °C) at top of the crop canopy at 9 in the morning, among pearl millet hybrids V₄ recorded maximum temperature (42.7 °C) at bottom of the crop canopy at 02:00 in the afternoon while minimum temperature (25.0 °C) was recorded in V₂ at top of the crop canopy at 09:00 in the morning. In crop season 2019 as depicted in Fig. 10, D₂ recorded maximum temperature (43.2 °C) at bottom of the crop canopy at 02:00 in the afternoon and minimum temperature (22.7 °C) at top of the crop canopy at 9 in the morning, among pearl millet hybrids V₄ recorded maximum temperature (45.1 °C) at bottom of the crop canopy at 02:00 in the afternoon while minimum temperature (23.3 °C) was recorded in V₁ at top of the crop canopy at 05:00 in the afternoon.

The prevailing temperature inside the crop canopy was higher at the bottom as compared to top of the crop canopy among in all treatments *i.e.* temperature profiles were lapse during the day inside the crop canopy. The maximum temperature was observed at 02:00 in the afternoon and the minimum was at 09:00 in the morning in both the crop seasons. This was due to the electrophile nature of the crop, facilitating the penetration of the radiation into the crop canopy which mainly consumed in heating the soil and adjacent air layers. Similar results were reported by [6].

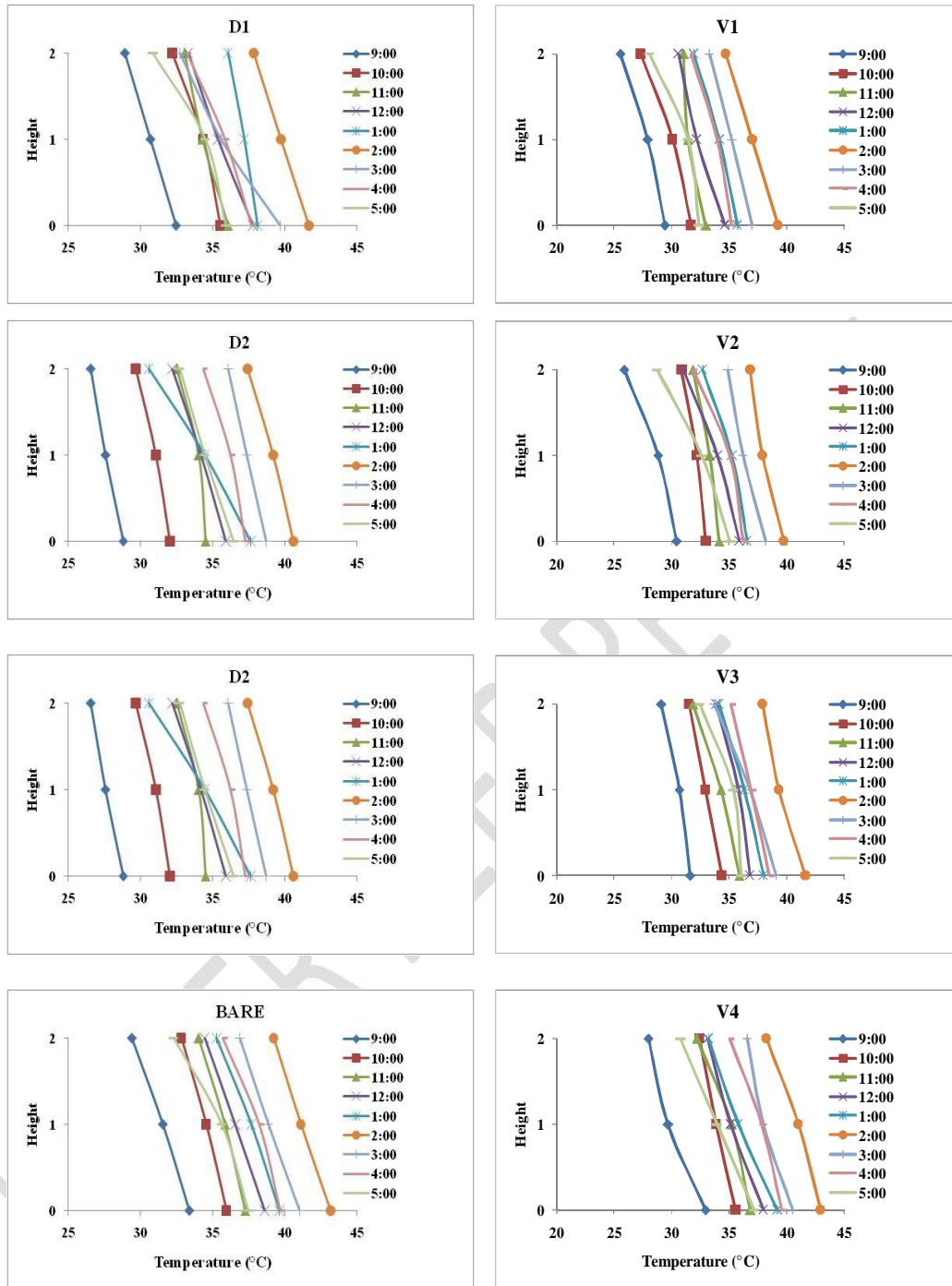
Conclusion

Temperature inside the crop canopy was higher as compared to top of the crop canopy. Temperature profiles were lapse throughout the day within the crop in all treatments in both the crop seasons.

References

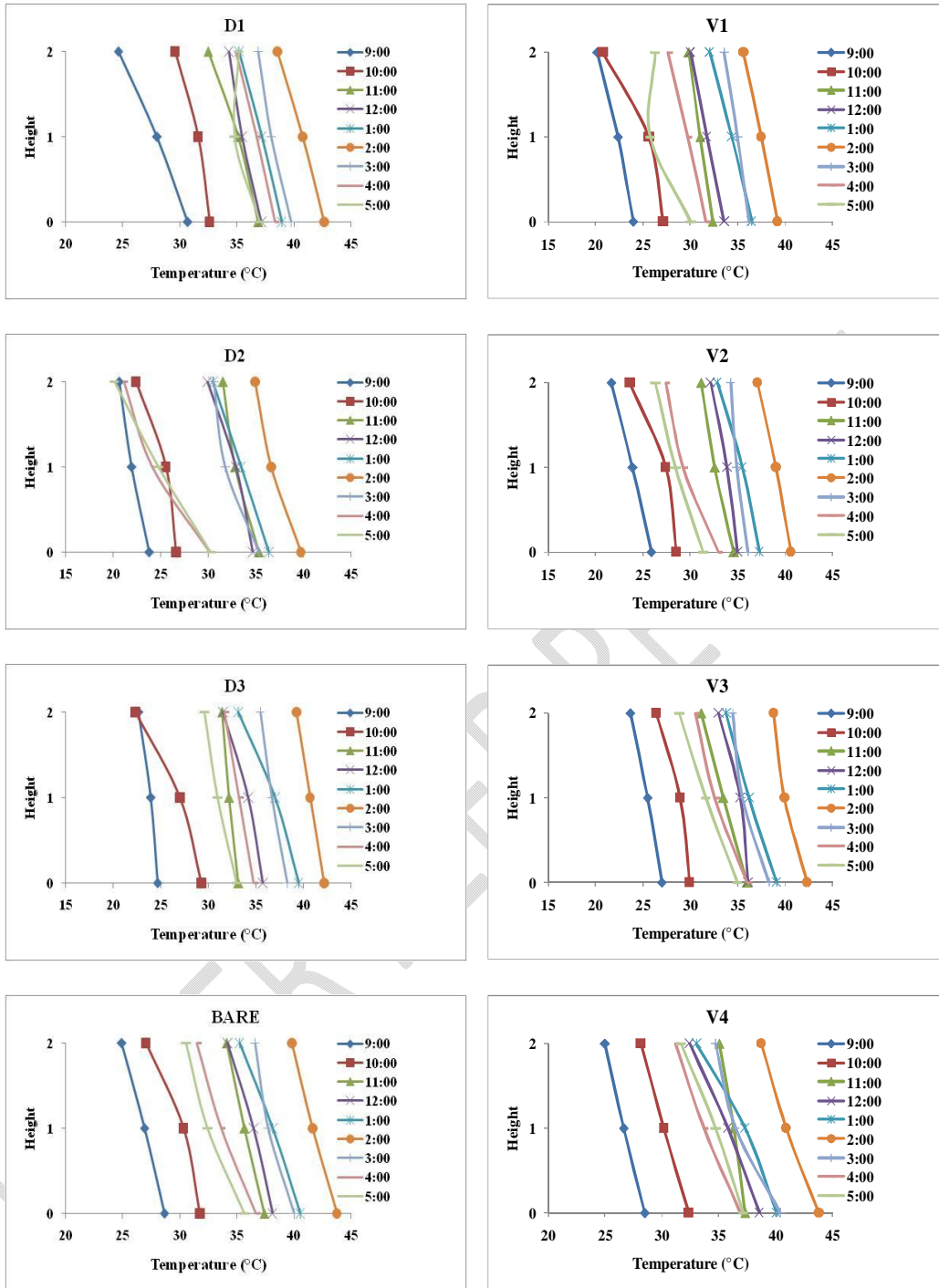
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Figures:



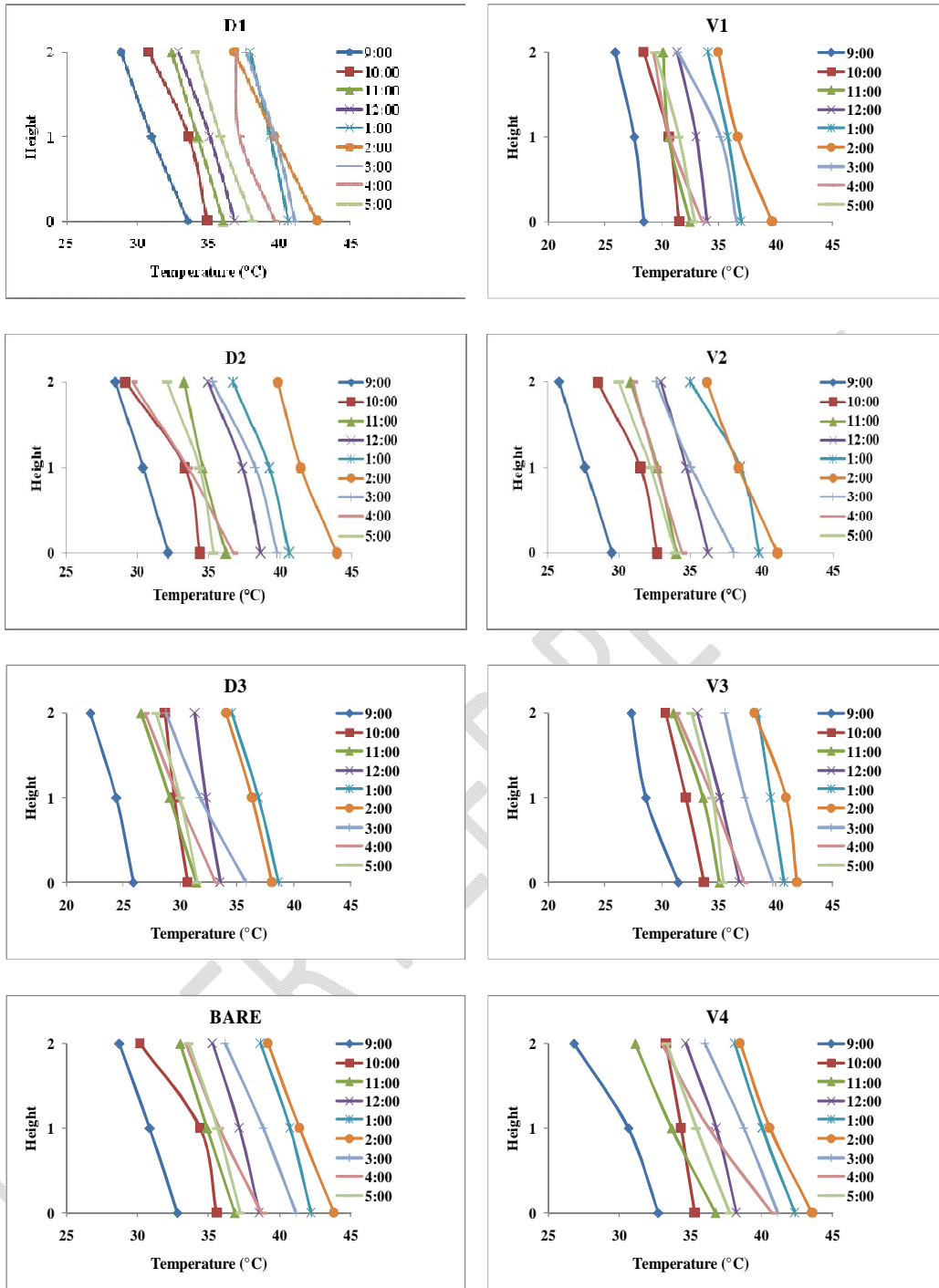
Where, 0=Bottom of canopy, 1=Middle of canopy, 2=Top of canopy D₁=Crop sown under 1st fortnight of June, D₂=Crop sown under 1st fortnight of July, D₃=Crop sown under 2nd fortnight of July, V₁= HHB 67 'Improved', V₂=HHB 197, V₃=HHB 272, V₄=HHB 299

Fig. 1: Temperature profile at panicle initiation stage under different growing environments and varieties of pearl millet crop and bare soil during 2018



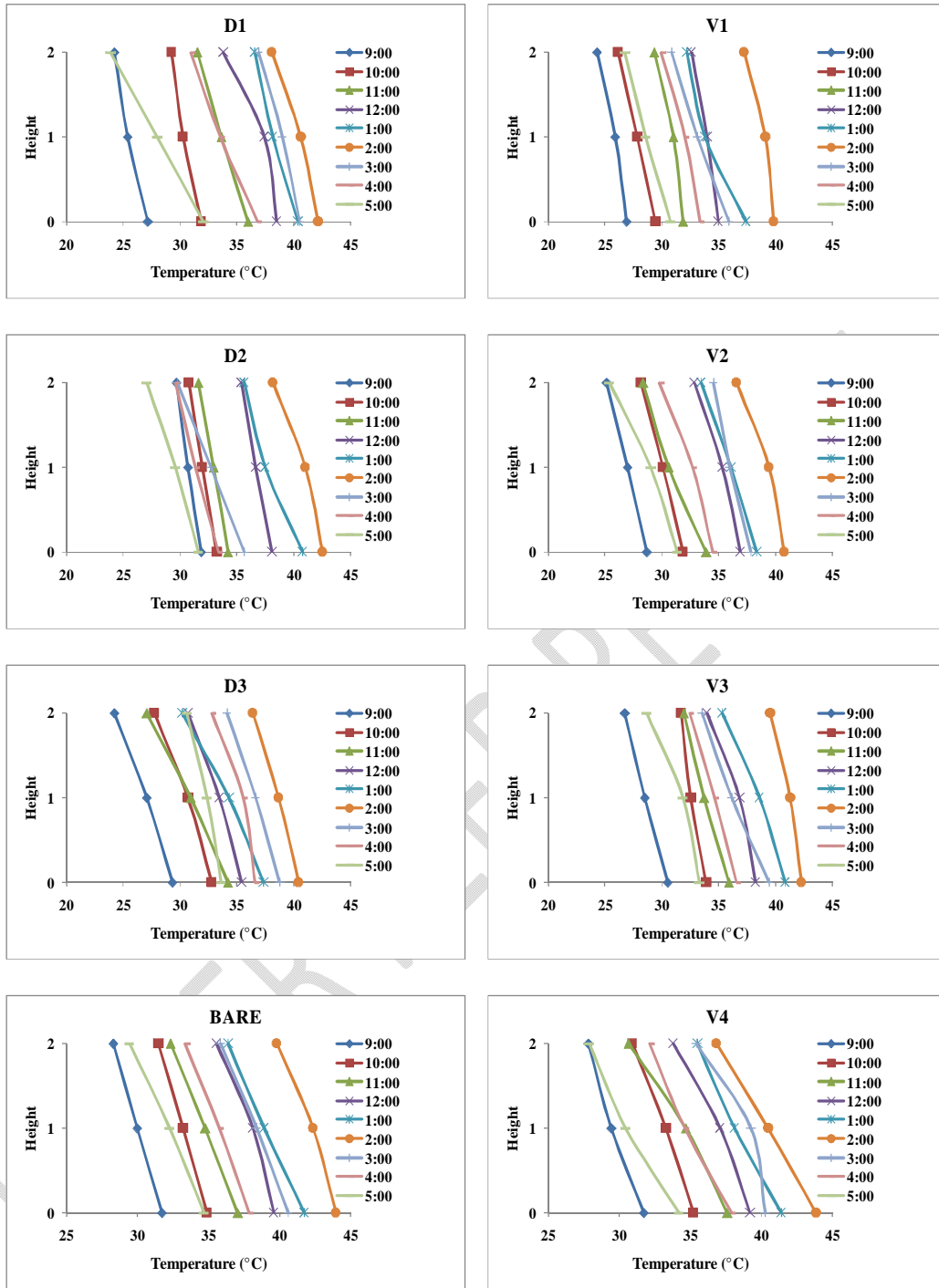
Where, 0=Bottom of canopy, 1=Middle of canopy, 2=Top of canopy D₁=Crop sown under 1st fortnight of June, D₂=Crop sown under 1st fortnight of July, D₃=Crop sown under 2nd fortnight of July, V₁= HHB 67 'Improved', V₂=HHB 197, V₃=HHB 272, V₄=HHB 299

Fig. 2: Temperature profile at booting stage under different growing environments and varieties of pearl millet crop and bare soil during 2018



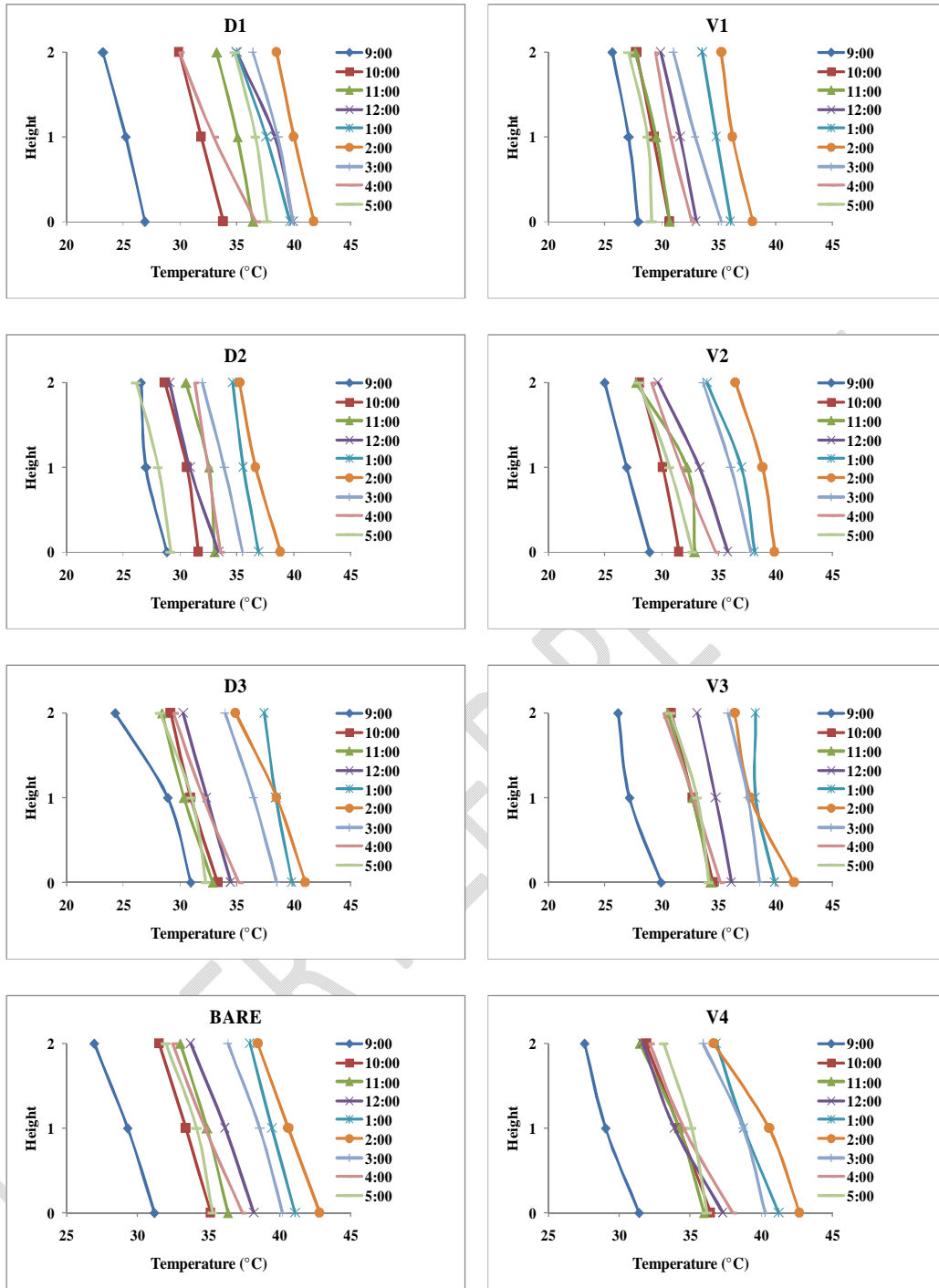
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Fig. 3: Temperature profile at 50 per cent flowering stage under different growing environments and varieties of pearl millet crop and bare soil during 2018



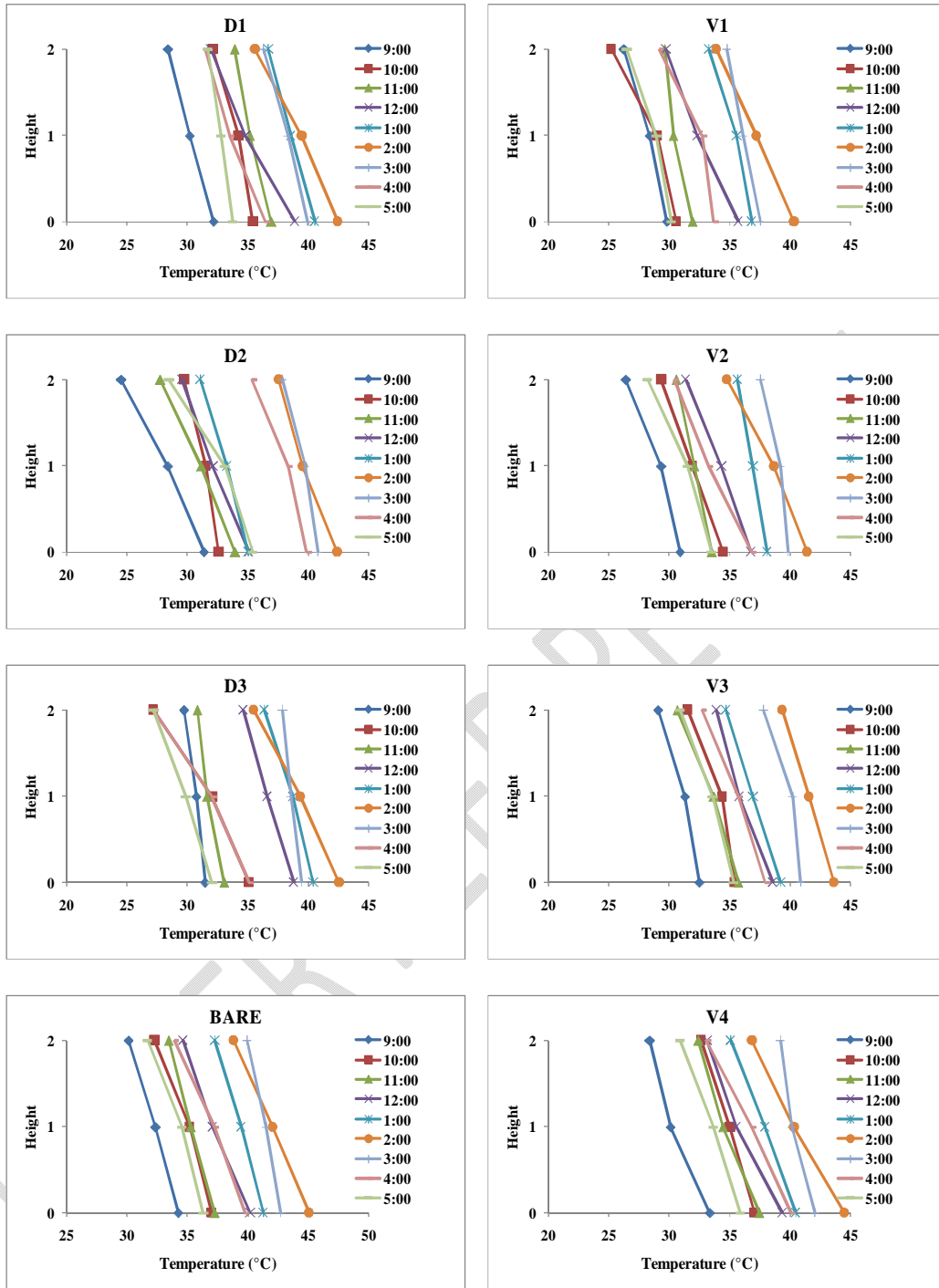
Where, 0=Bottom of canopy, 1=Middle of canopy, 2=Top of canopy D₁=Crop sown under 1st fortnight of June, D₂=Crop sown under 1st fortnight of July, D₃=Crop sown under 2nd fortnight of July, V₁= HHB 67 'Improved', V₂=HHB 197, V₃=HHB 272, V₄=HHB 299

Fig. 4: Temperature profile at dough stage under different growing environments and varieties of pearl millet crop and bare soil during 2018



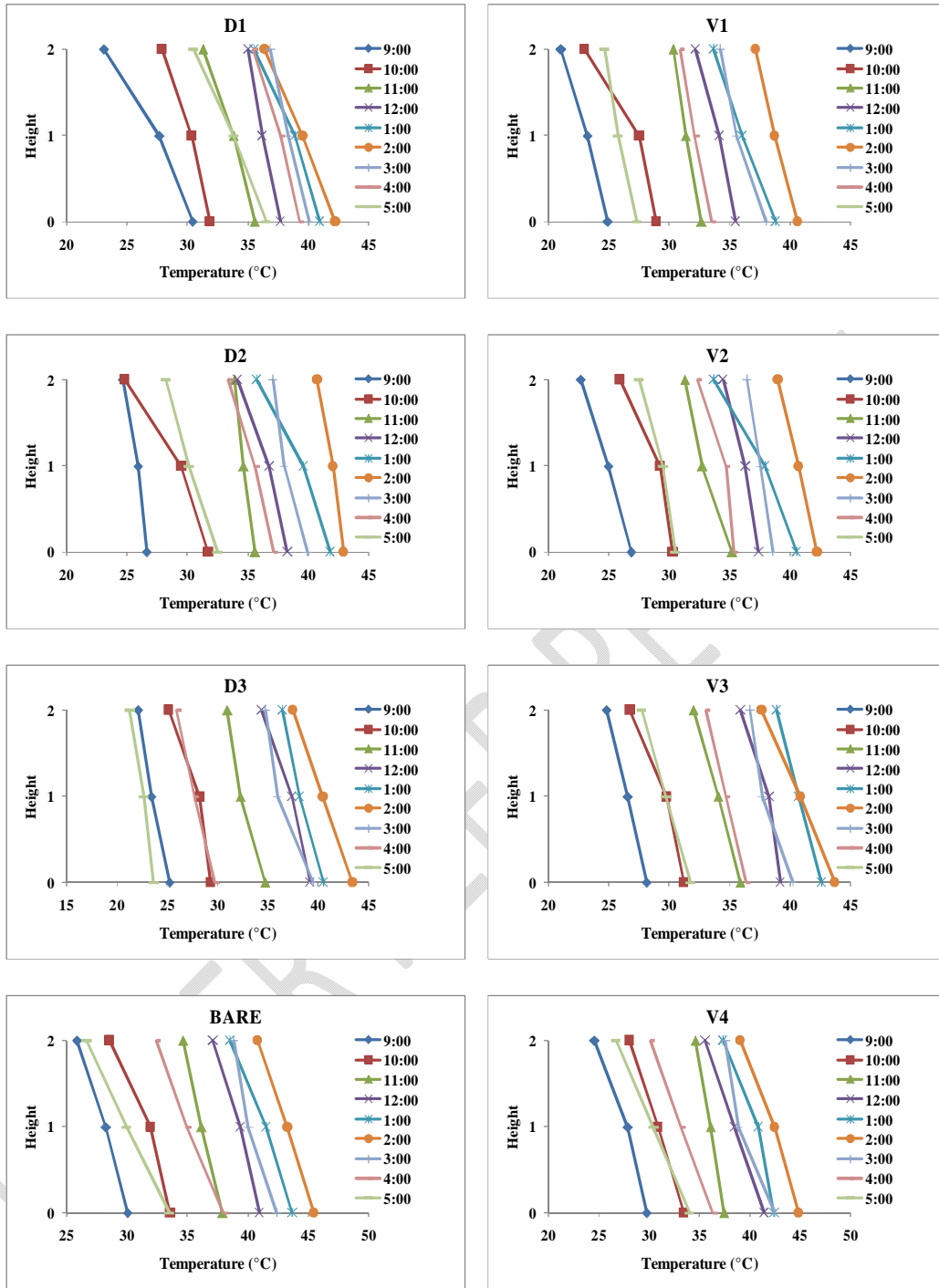
Where, 0=Bottom of canopy, 1=Middle of canopy, 2=Top of canopy D₁=Crop sown under 1st fortnight of June, D₂=Crop sown under 1st fortnight of July, D₃=Crop sown under 2nd fortnight of July, V₁= HHB 67 'Improved', V₂=HHB 197, V₃=HHB 272, V₄=HHB 299

Fig. 5: Temperature profile at physiological maturity stage under different growing environments and varieties of pearl millet crop and bare soil during 2018



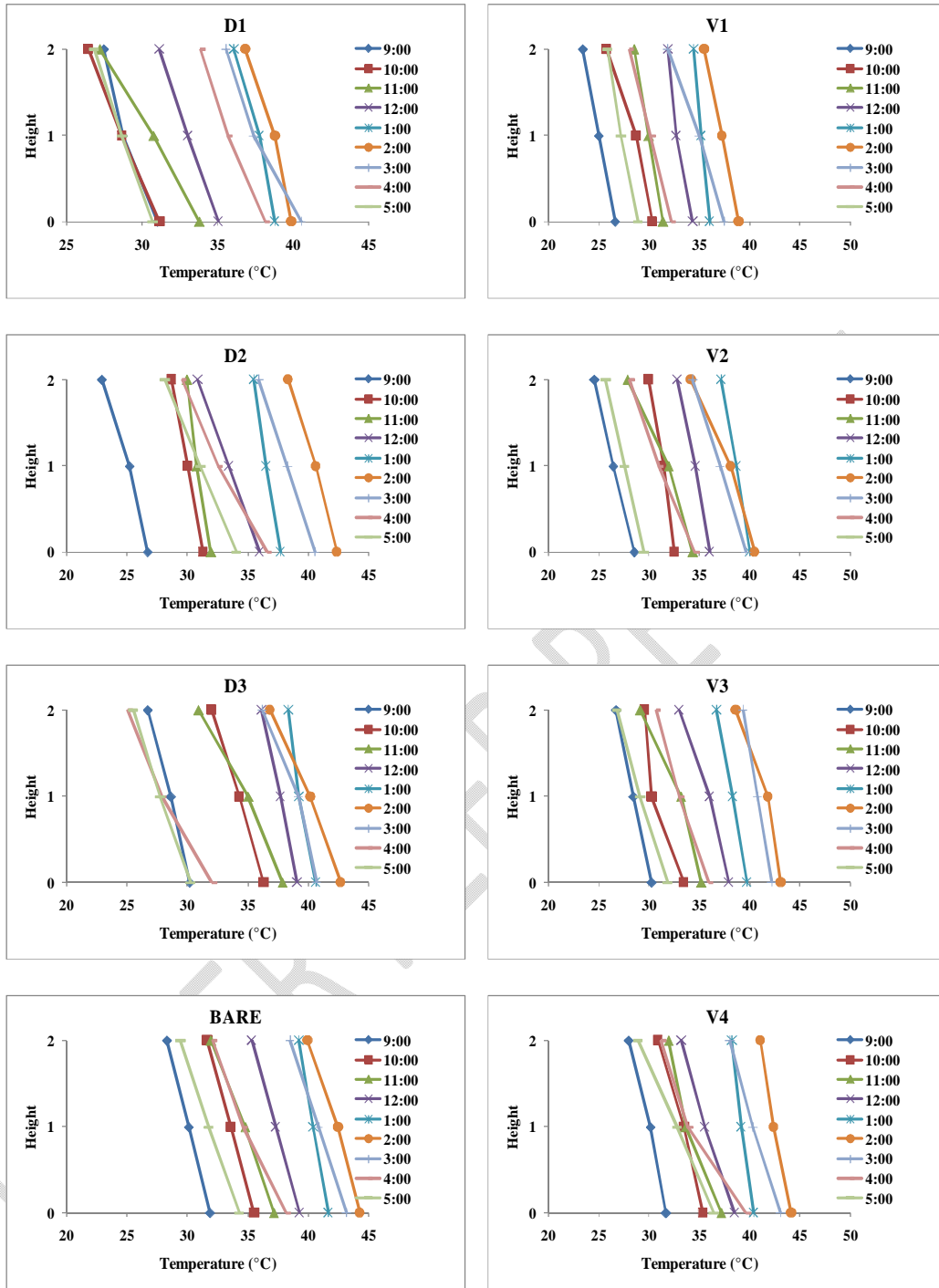
Where, 0=Bottom of canopy, 1=Middle of canopy, 2=Top of canopy D₁=Crop sown under 1st fortnight of June, D₂=Crop sown under 1st fortnight of July, D₃=Crop sown under 2nd fortnight of July, V₁= HHB 67 'Improved', V₂=HHB 197, V₃=HHB 272, V₄=HHB 299

Fig. 6: Temperature profile at panicle initiation stage under different growing environments and varieties of pearl millet crop and bare soil during 2019



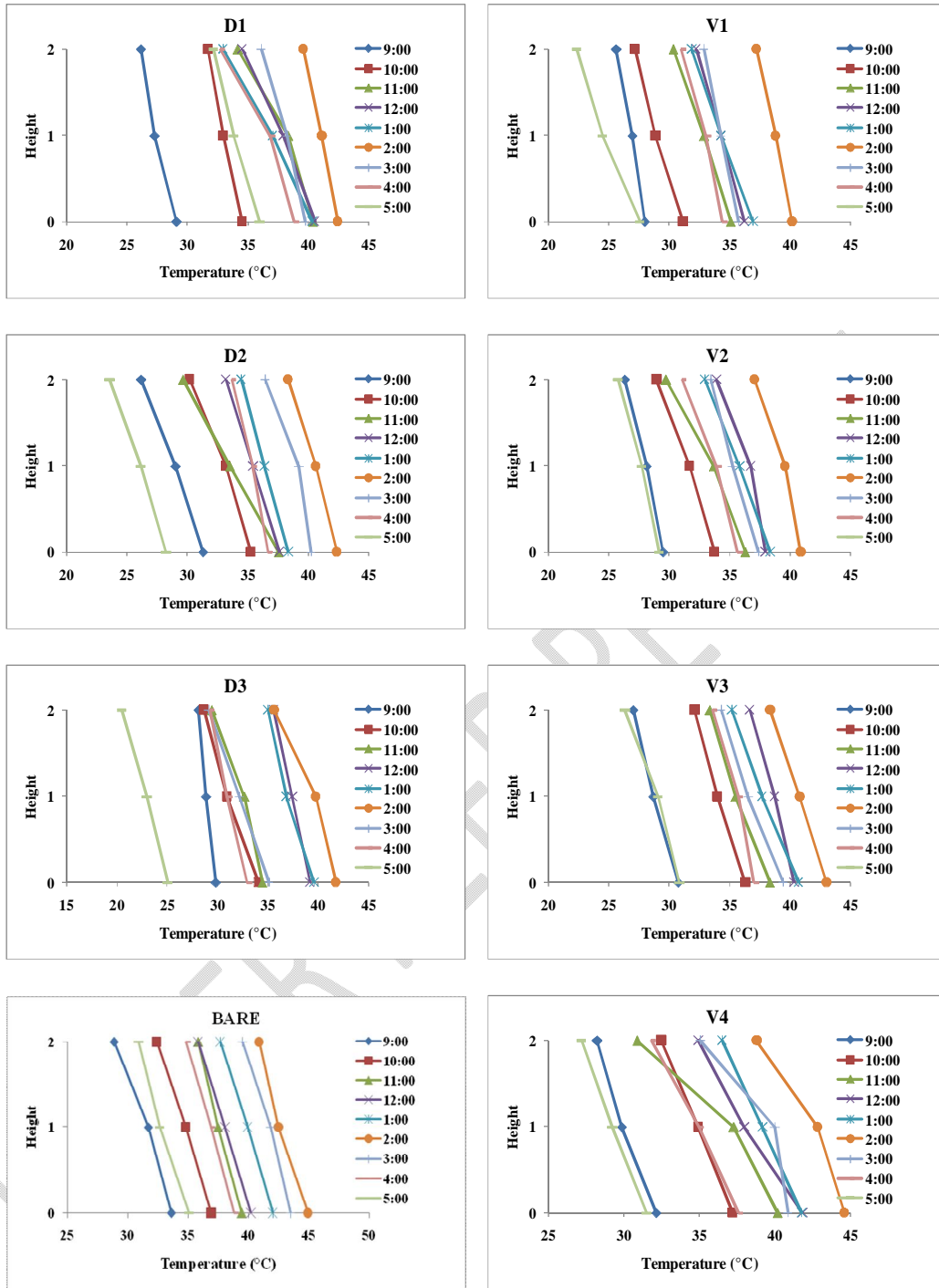
Where, 0=Bottom of canopy, 1=Middle of canopy, 2=Top of canopy D₁=Crop sown under 1st fortnight of June, D₂=Crop sown under 1st fortnight of July, D₃=Crop sown under 2nd fortnight of July, V₁= HHB 67 'Improved', V₂=HHB 197, V₃=HHB 272, V₄=HHB 299

Fig. 7: Temperature profile at booting stage under different growing environments and varieties of pearl millet crop and bare soil during 2019



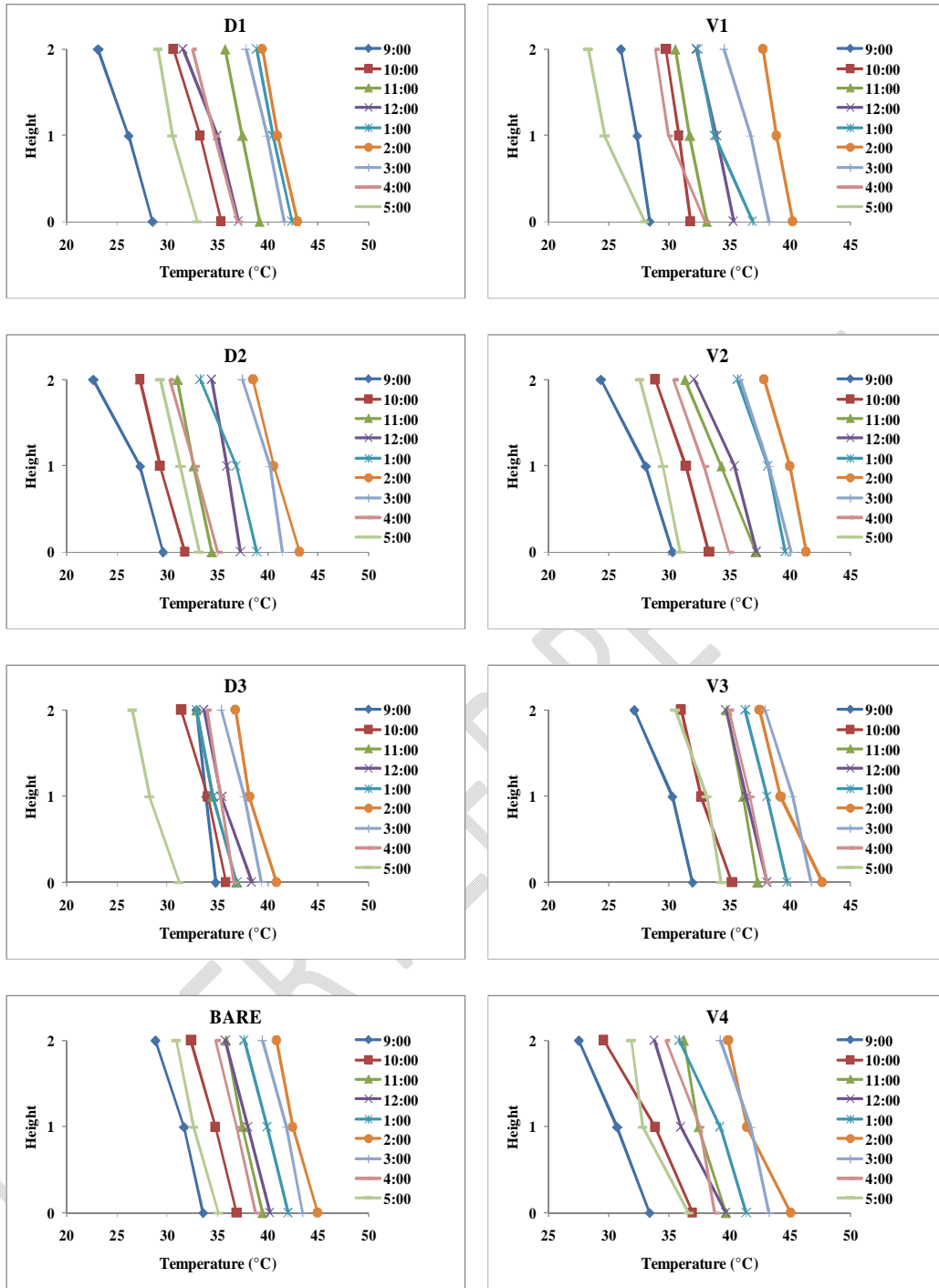
Where, 0=Bottom of canopy, 1=Middle of canopy, 2=Top of canopy D₁=Crop sown under 1st fortnight of June, D₂=Crop sown under 1st fortnight of July, D₃=Crop sown under 2nd fortnight of July, V₁= HHB 67 'Improved', V₂=HHB 197, V₃=HHB 272, V₄=HHB 299

Fig. 8: Temperature profile at 50 per cent flowering stage under different growing environments and varieties of pearl millet crop and bare soil during 2019



Where, 0=Bottom of canopy, 1=Middle of canopy, 2=Top of canopy D₁=Crop sown under 1st fortnight of June, D₂=Crop sown under 1st fortnight of July, D₃=Crop sown under 2nd fortnight of July, V₁= HHB 67 'Improved', V₂=HHB 197, V₃=HHB 272, V₄=HHB 299

Fig. 9: Temperature profile at dough stage under different growing environments and varieties of pearl millet crop and bare soil during 2019



Where, 0=Bottom of canopy, 1=Middle of canopy, 2=Top of canopy D₁=Crop sown under 1st fortnight of June, D₂=Crop sown under 1st fortnight of July, D₃=Crop sown under 2nd fortnight of July, V₁= HHB 67 'Improved', V₂=HHB 197, V₃=HHB 272, V₄=HHB 299

Fig. 10: Temperature profile at physiological maturity stage under different growing environments and varieties of pearl millet crop and bare soil during 2019