The Pharma Innovation Journal 2023; 12(5): 980-984

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2023; 12(5): 980-984

www.thepharmajournal.com
Received: 14-02-2023
Accepted: 17-03-2023

KK Chauhan
Department of Agricultural Meteorology, B.A.C.A. College of Agriculture, Anand Agricultural University, Anand, Gujarat, India

MM Lunagaria
Department of Agricultural Meteorology, B.A.C.A. College of Agriculture, Anand Agricultural University, Anand, Gujarat, India

Corresponding Author:
KK Chauhan
Department of Agricultural Meteorology, B.A.C.A. College of Agriculture, Anand Agricultural University, Anand, Gujarat, India

Microclimate in the vertical profile of capsicum under open ventilated greenhouse

KK Chauhan and MM Lunagaria

Abstract
The differences of microclimatic parameters *viz*; Photosynthetically Active Radiation (PAR), Air temperature and Relative humidity (RH) in capsicum canopy at three heights for PAR (ground level, middle level and effective canopy height) and at two heights for air temperature and relative humidity (ground level, effective canopy height) and their comparison with the different vegetative phases were studied. The microclimatic data were obtained at the field experiment conducted at Horticulture farm of Department of Horticulture, BACA, Anand Agricultural University, Anand, Gujarat during October 2017 to March 2018 from the canopies of capsicum crop under open ventilated greenhouse. It was found, that capsicum canopy microclimate differed significantly at different height. The vertical profile of PAR shows that at the ground level, PAR was ranged from 27 µ mol m^{-2} s^{-1} to 52 µ mol m^{-}2 s^{-1}, and it gradually increased. There wasn't any significant difference in air temperature between top of the canopy and at ground level. This indicates that the crop has experienced uniform thermal condition at different part of the canopy. It was observed that relative humidity was higher at ground level as compared to canopy level due to lower air exchange at the ground level.

Keywords: Microclimate, capsicum, ventilated greenhouse, relative humidity

1. Introduction
A canopy's microclimate plays a key role in the ecosystem processes, however, the predictive understanding of the vertical and horizontal variability in the heterogeneous landscape is missing to a high extend in spite of the fact that it has been observed that organisms, species and communities have diverse reactions to hourly, daily, seasonal and long period temperatures (Vanwalleghem & Meentemeyer, 2009) [10]. Canopy's microclimate also have significant effects on plant growth and development Because different microclimatic parameters usually varies with area, it is hard to separate the influence of solar radiation and temperature on canopy development, and high radiation intensities and temperatures might affect the metabolites of Capsicum canopies. The vertical variability is particularly complex because the combination of physiographic (e.g. altitude) and ecological (e.g. vegetation structure) factors impacts energy and humidity fluxes (Chen *et al*., 1999) [1]. A significant amount of heat and water vapor enters the atmosphere as a result of the process of substance and energy exchange between the active surface and the lowest layers of atmosphere. As a result, a change of air temperature and humidity inside a canopy and immediately above it occurs. Following this pattern, every plant community creates its own microclimate and the climatic status of a canopy can be significantly influenced (Geiger, 1965) [2].
The aim of this work was to evaluate and describe the microclimatic characteristics of Capsicum canopy in relation to vertical variability of canopies by means of the linear regression analysis. An equally important objective was to display the Photosynthetically Active Radiation (PAR), air temperature and relative humidity (RH) values by graphical presentation.

2. Material and Method
The microclimatic data were obtained from field experiment of Anand Agricultural University at Horticulture farm of Department of Horticulture, BACA, Anand, Gujarat during October 2017 to March 2018 in the canopies of Rabi Capsicum (Capsicum annuum, GPS – Location: 22°31'48"N, 72°58'16"E). Capsicum was represented by the Indra variety. The experimental area is situated at the average altitude of 45.1 m above the sea level. Data recording for crop was carried out by means of a mobile equipped for Photosynthetically Active Radiation; it was measured with line quantum sensor (LI-191R; LI-COR, USA).

The digital line Quantum sensor is a highly accurate and sensitive instrument and its data logger has special feature for accurate and speedily reading area and can allow user to take measurements at an optimum position so quantum sensor was placed at the position where measurement is required and the corresponding value of PAR in µ mol $m^{-}2\ s^{-1}$ was observed in data logger display. Air temperature and relative humidity was measured using Assaman psychrometer placed in the Canopies of Capsicum under Open ventilated greenhouse. The recorders were positioned at three levels for PAR (on the ground, middle level and at the effective height) and at two levels for Air Temperature and Humidity (on the ground and at the effective height) in order to cover the whole vertical profile. Sensors/Instruments positioned at the effective height were moved up as the crop was growing. The effective canopy height is the height corresponding to approximately 70% of the actual canopy height. PAR recorded inside the open ventilated greenhouse for vertical profile during 1240h to 1250h over canopy at grid points spaced at 4.75 m weekly interval. The observations at bottom and top of the canopy were being measured at 15 days interval for air temperature and relative humidity. For statistical processing, the data were adjusted into different vegetative phase intervals by arithmetic average and for the purpose of this paper; the data were evaluated by the linear regression analysis used for canopy variable impact analysis in dependence on the surrounding environment's (ambient) PAR, air temperature and relative humidity. For measurement of the microclimatic parameters for vertical profile, canopy of capsicum and layout of experimental field is show in Fig.1.

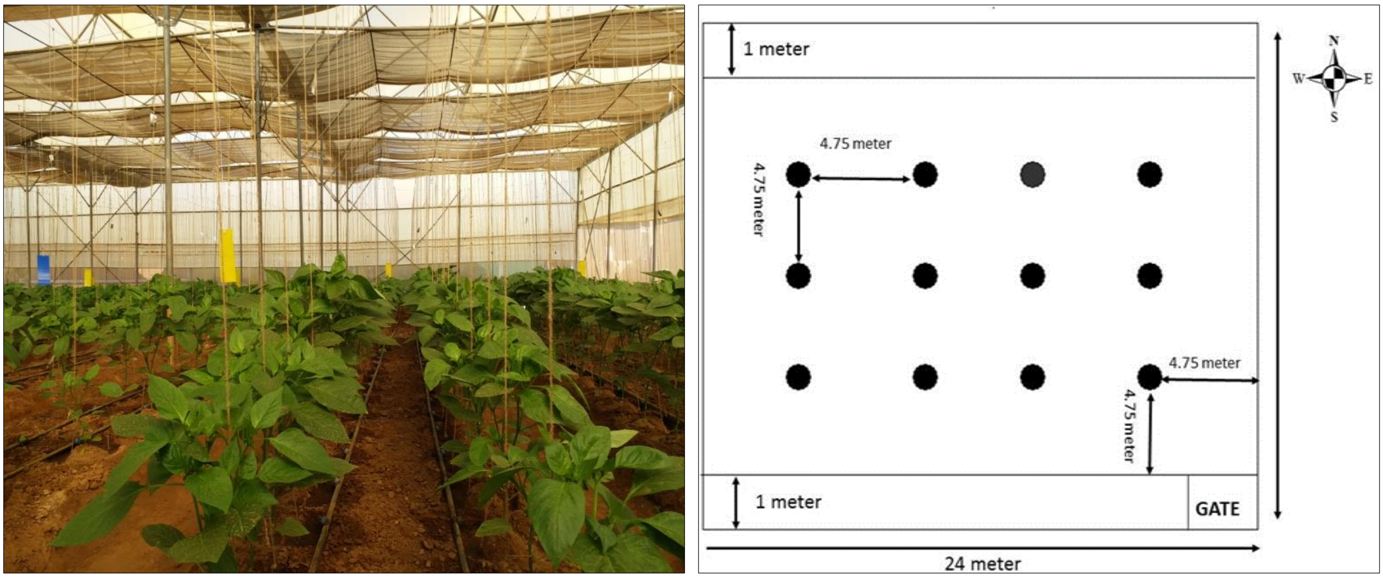

Fig 1: Canopy of capsicum and Layout of Experiment field

3. Results and Discussion

3.1 Vertical profiles of Microclimatic parameters under open ventilated greenhouse

3.1.1 *Photosynthetically Active Radiation*. The PAR level was measured at different crop height inside the open ventilated greenhouse. The observations were acquired after complete vegetative cover by crop canopies during the last week of January. The crop height ranged between 105 cm to 120 cm at the vertical profile study observations during January to march. PAR was measured within each canopy at canopy level, middle level, and ground level using line quantum sensor connected to data logger. Profile data presented in Figure 1 was acquired on 29th January, 16^{th} February, 5^{th} March and 20^{th} March for early vegetative phase, vegetative phase, reproductive phase and maturity phase respectively. The vertical profiles of PAR distribution with the plant height showed in Figure 2. At the early vegetative stage, PAR varied with crop height inside the greenhouse. At the ground level, PAR was ranged from 27 µ mol $m^{-2}\ s^{-1}$ to 52 µ mol $m^{-2}\ s^{-1}$, and it gradually increased. It might be due to plant got more exposure to prevalence of highly diffused PAR at ground level. At the middle of the canopy, PAR ranged from 49 µ mol $m^{-2}\ s^{-1}$ to 103 µ mol $m^{-2}\ s^{-1}$. Maximum PAR was observed at the top of plant canopy and its values ranging from 204 µ mol $m^{-2}\ s^{-1}$ to 402 µ mol $m^{-2}\ s^{-1}$. Thus PAR values shows extinction pattern with depth within canopy. Vegetative, Reproductive, and Maturity stages show identical pattern attennation. The values of the PAR under canopy were less varied during reproductive and physiological maturity due to dense and uniform canopy cover.

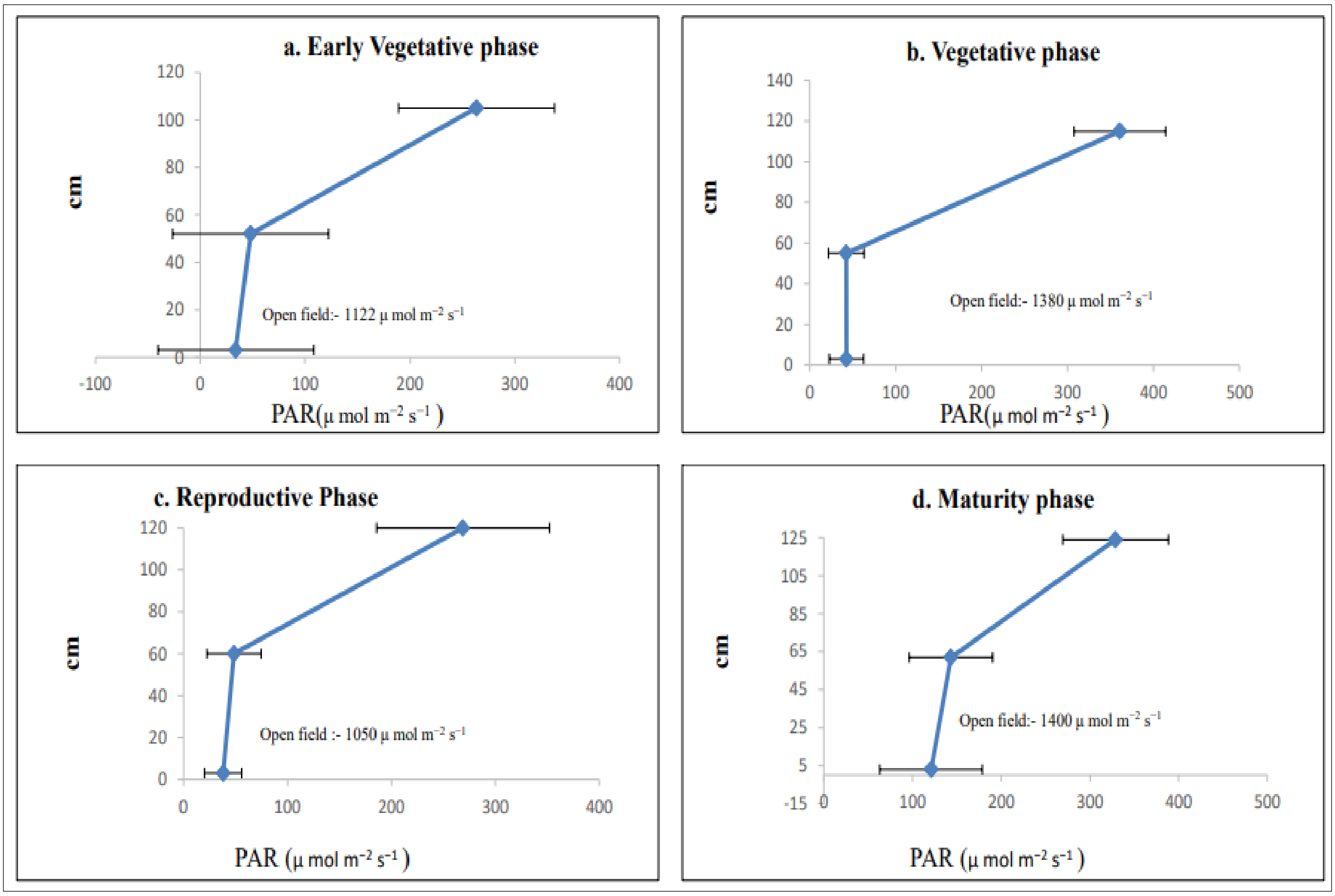

Fig 2: Vertical profile of photosynthetically active radiation (PAR)

3.1.2. Air Temperature

The observations of Air temperature in Capsicum canopies were recorded only for effective canopy height and ground level and depicted in Figure 3. There wasn't any significant difference in air temperature between top of the canopy and at ground level. This indicates that the crop has experienced uniform thermal condition at different part of the canopy.

3.1.3 Relative Humidity

The observations of relative humidity in Capsicum canopies were recorded only for effective canopy height and ground level and depicted in Figure 4. Near Capsicum canopies humidity varied significantly from those of outside environments. The relative humidity was usually higher at the ground level. Inside the greenhouse, it was observed that relative humidity was higher within the plant canopy and found minimum at the top of the plant. It may be due to better gas exchange at the top of plant. At the early vegetative stage, it was found that relative humidity below and above the canopy was 17% and 10% higher than ambient air humidity respectively. At the time of reproductive and maturity phase, there were a less differences between outside and inside relative humidity (i.e. 2% to 6%). Higher relative humidity under canopy indicates that the canopy influences the microclimate of the adjoining atmosphere. The higher humidity observed at ground level due to lower temperature and less ventilation compared to canopy level. Up to the moment of complete canopy closure, the Capsicum vegetation was not able to affect the microclimate inside the canopies and immediately above them. Omid and Shafaei (2005) [4] studied the variation of temperature and relative humidity inside and open conditions, and observed the indirect relationship between temperature and humidity.

Increasing in temperature leads to decreasing of relative humidity inside the greenhouse. Relative humidity found higher during the early vegetative phase, vegetative phase and reproductive phase as compared to harvesting phase due to increasing of temperature from early vegetative phase to maturity time respectively, the growth and development during the higher relative humidity is good as compared to lower humidity during the month of summer season.

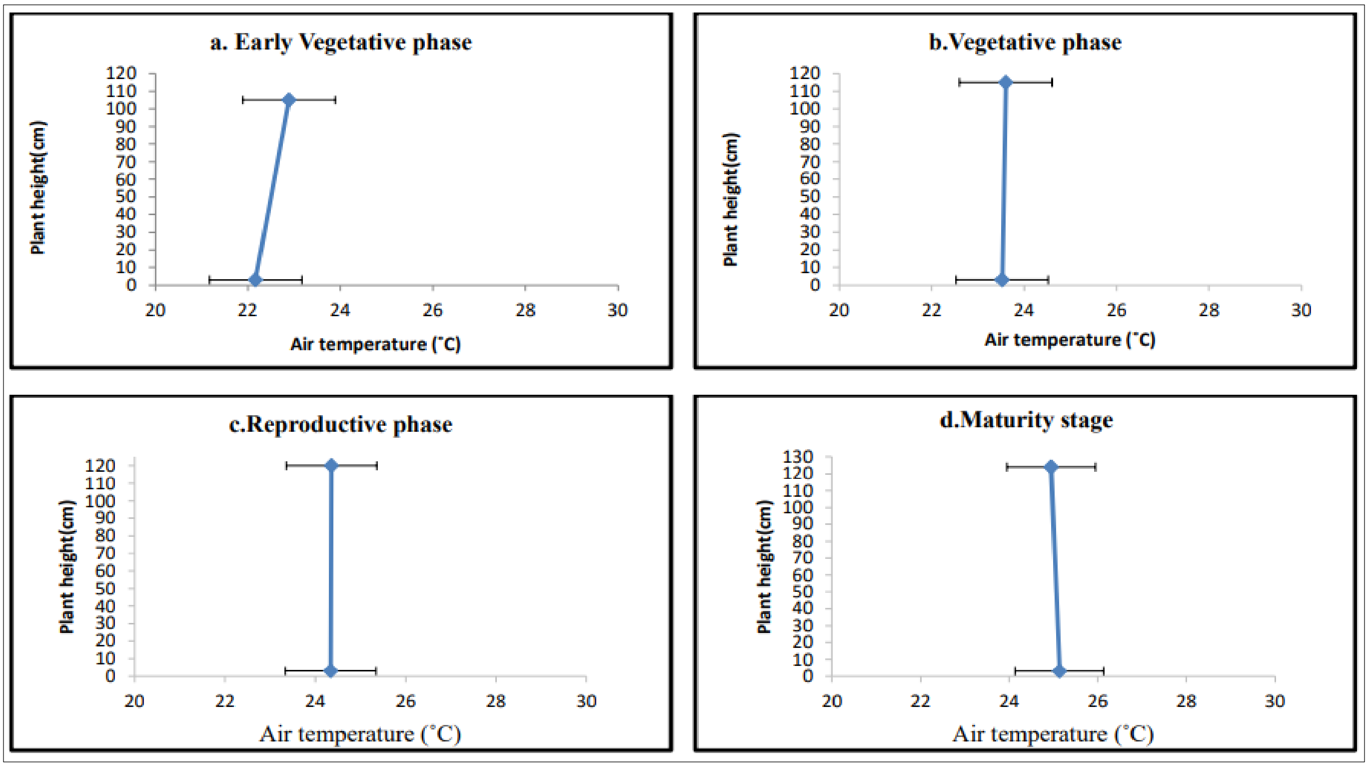

Fig 3: Vertical profile of air temperature in capsicum canopy

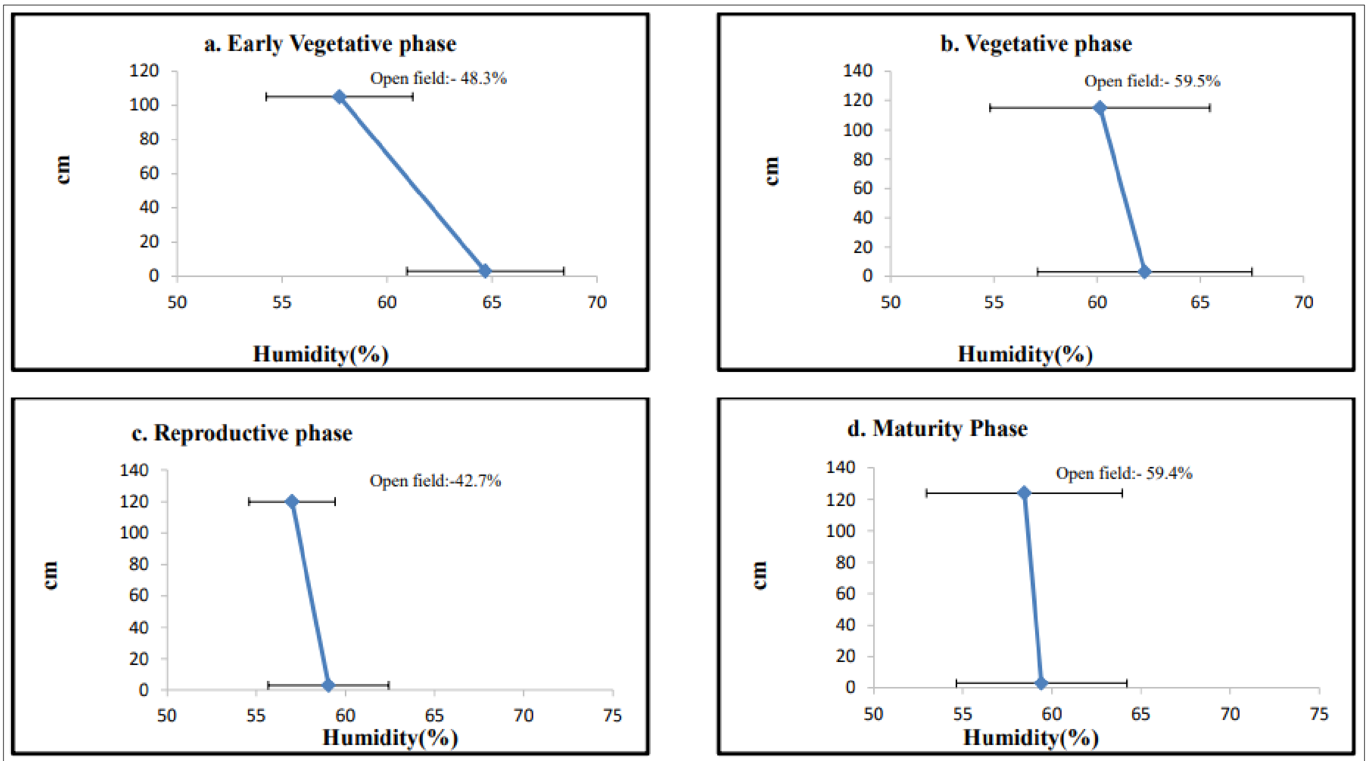

Fig 4: Vertical profile of relative humidity in capsicum canopy

4. Summary

The differences of photosynthetically active radiation, air temperature and relative humidity in capsicum canopies at three heights (ground level, middle level, and effective canopy height), and their comparison with the ambient values were studied at different vegetative stages. The average weekly photosynthetically active radiation, air temperature and humidity intervals were statistically processed by the linear regression analysis in order to predict the values of canopies´ temperature and humidity in dependence microclimatic variation inside open ventilated greenhouse. The results show that the capsicum canopies have microclimates that are rather different vertical variation at three heights. The vertical profile of PAR shows that at the ground level, PAR was ranged from 27 µ mol m^{-2} s^{-1} to 52 µ mol m^{-2} s^{-1}, and it gradually increased. It was due to only diffused PAR reached at bottom of canopy depth after attenuation and scattering. At the middle of the canopy, PAR ranged from 49 μ mol m^{-2} s^{-1} to 103 μ mol m^{-2} s $^{-1}$. Maximum PAR was observed at the top of plant canopy and its values ranging from 204 μ mol m^{-2} s^{-1} to 402 μ mol m^{-2} s^{-1}. Thus PAR values shows extinction pattern with depth within canopy. Vegetative, Reproductive, and Maturity stages show identical pattern of attenuation. The values of the PAR under canopy were less varied during reproductive and physiological maturity due to dense and uniform canopy cover. Air temperature and Relative humidity also measured at ground and canopy level inside the greenhouse. There wasn't any significant difference in air temperature between top of the canopy and at ground level. This indicates that the crop has experienced uniform thermal condition at different part of the canopy. It was observed that relative humidity was higher at ground level as compared to canopy level due to lower air exchange at the ground level. At the early vegetative stage, relative humidity below and above the canopy was 17% and 10% higher than ambient air humidity respectively. At reproductive and maturity phase, there were a less differences between outside and inside relative humidity (i.e. 2% to 6%).

5. Acknowledgments
This study has been supported by the Department of Agricultural Meteorology and Department of Horticulture, B.A college of Agriculture, Anand Agricultural University, Anand.

6. References
1. Chen J, Saunders SC, Crow TR, Naiman RJ, Brosofske KD, Mroz GD, *et al*. Microclimate in forest ecosystem and landscape ecology: variations in local climate can be used to monitor and compare the effects of different management regimes. Bio Science. 1999;49(4):288-297.
2. Geiger R. The climate near the ground. Cambridge. Harvard Uni. 1965.
3. Krédl Z, Středa T, Pokorný R, Kmoch M, Brotan J. Microclimate in the vertical profile of wheat, rape and maize canopies. Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis. 2012;60(1):79-90.
4. Omid M, Shafaei A. Temperature and relative humidity changes inside greenhouse. International Agrophysics. 2005;19:153-158.
5. Parvej MR, Khan MAH, Awal MA. Phenological development and production potentials of Tomato under polyhouse climate, J Agric. Sci. 2010;5(1):19-31.
6. Pearson S, Hadley P, Wheldon AE. A model of the effect of day and night temperature on the height of chrysanthemum. Acta Horticulturae, 1995.
7. Ryu MJ, Ryu DK, Chung SO, Hur YK, Hur SO, Hong SJ, *et al*. Spatial, vertical, and temporal variability of ambient environments in strawberry and tomato greenhouses in winter. J Biosyst. Eng. 2014;39(1):47-56.
8. Suseela P, Rangaswami MV. Variation of relative humidity inside the greenhouse with height, ventilation and ambient climatic parameters. Karnataka. J. Agric. Sci., 2012, 25(1).
9. Teitel M, Ziskind G, Liran O, Dubovsky V, Letan R. Effect of wind direction on greenhouse ventilation rate, airflow patterns and temperature distributions. Biosyst. Eng. 2008;101(3):351-369.
10. Vanwalleghem T, Meentemeyer RK. Predicting forest microclimate in heterogeneous landscapes. Ecosystems. 2009;12(7):1158-1172.
11. Zhao Y, Teitel M, Barak M. SE—Structures and Environment: Vertical temperature and humidity gradients in a naturally ventilated greenhouse. J. Agric. Eng. Res. 2001;78(4):431-436.
12. Zorzeto TQ, Leal PAM, Nunes EF. Homogeneity of Temperature and Relative Humidity of Air in Greenhouse. Environ. 2014a;1(9):12.