Evaporation distribution in greenhouse using three evaporation heights

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Abstract

The management of irrigation water in a culture is fundamental, because it allows the rational use of this factor of production aiming to obtain the maximum output per unit of water applied. Allied to this technology, protected environment cultivation allows continuous production in periods which conditions in the field are usually unfavorable, enabling the supply of the domestic market in all seasons. In order to know the meteorological variables that most affect the production in this environment, it was made a research in the experimental area of the Department of Rural Engineering of the Universidade Estadual Paulista - UNESP, campus of Botucatu, to evaluate the spatialization of the protected environment by the distribution of minievaporimeters to verify the energy distribution in three heights, 40, 80 and 120 cm from the ground. The work was conducted in greenhouse, with guidance Northwest Southwest. It was performed the measuring of the evaporation of minievaporimeter weekly, for 6 months. The minievaporometer spatial distribution showed that the period of study of 07 May to July 16 of 2005 had an increased of the evaporation in the environment to 40 cm from the ground, that is, during the coldest months. The period from July 30 to September 16 of 2005 the greatest evaporation occurred at 80 cm from the ground. The minievaporimeters installed to 120 cm from the ground had values less than or equal, the other heights, regardless of the evaluation period. The Southwest face had higher evaporation for the entire study period. There was greater evaporation in the protected environment during the coldest months of the year for minievaporimeters which were close to the ground.

Key words: Balance of energy; agricultural climatology; evaporation.

Introduction

Everyday there is a need to increase the production of food in the world. With the use of technologies that enhance the production, the man can achieve high rates of productivity in almost all sectors of agriculture, as the expansion of agricultural areas and privilege is restricted to only some countries. The use of agricultural areas should be rational and in order to ensure the maintenance of man life on the planet. Many of these areas, with intensive use and getting inadequate management end up compromised and causing losses and damage, not only economic, to the producer, but also damage to the environment, making impossible the use of them.

In recent decades cultivation in the protected environment in Brazil presented significant growth, mainly for production of vegetables and flowers (ALVES; KLAR, 1996). Conside ring the importance of food crops, their cost of production and its high economic value, mainly in period between harvests, it is necessary to research in order to provide technology to increase productivity and reduce risks (FARIAS, 1993). Among the benefits of cultivation in protected environment, can be included the diversity increasing of agricultural products and stability of annual production, with optimization of land use. In places where the land is more valued and scarcer, the cultivation in greenhouses is a valuable strategy to increase productivity and absorb increasing agricultural production (SOUZA, 2003).

The protected environment makes it possible to explore the farm crops in times of unusual for the cultivation and consequently, can be achieved better economic returns due to product quality, and to the production occurs in period between harvests (NIED, 1999).

The meteorological variables inside of greenhouses have proven spatial variability, influencing the development of crops through effects on transpiration and photosynthesis (JUNIOR MENEZES, 1999). The control and monitoring of meteorological variables, especially the air temperature and humidity are important factors in control of plant diseases planted inside the greenhouses. Thus this work aimed to assess the spatial distribution of evaporation of water in the protected environment.

Material and methods

The work was conducted in the experimental area of the Department of Rural Engineering Agronomy Science Faculty, belonging to the Universidade Estadual Paulista, *Campus* of Botucatu - SP, whose geographical coordinates are 22° 51'03 "south latitude and 48° 25'37", west longitude, with average altitude of 786 meters.

The climate of the region is the Temperate Climate (Mesotermic), according to criteria adopted by Köppen. The region is wet, presenting rainfall of about 1516.8 mm and evapotranspiration annual average of 692 mm. The average annual temperature is 20.6°C on average maximum and minimum temperatures of 23.5 and 17.4°C respectively.

The study was conducted in a plastic greenhouse geographically oriented towards Northeast-Southwest. The greenhouse was the type plastic-covered tunnel in the form of an arc, presenting the following dimensions: width of 7m, length of 26m, height of the right foot of 1.85m and 3.35m center, covered along with polyethylene films thickness of 100 microns. In the sides and the funds were placed shading screens with 40% porosity. In the front part was the door that gave access to the interior of the greenhouse.

Have been installed 132 minievaporimeters, distant one another of 2.0m to 2.10m in longitudinal and transverse direction of the greenhouse, distributed in three levels of 0.40, 0.80 and 1.20m. The minievaporimeter consisted of a plastic container volume of 1.0L. In order to determine the water evaporated in minievaporimeters they were filled with 500 ml of water each, and once a week the water resulting in each minievaporimeter was measured and the bottle was again filled with 500 ml of water. For difference of water put every week, with the resulting water, was determined the weekly evaporation in the greenhouse. The readings were made every Saturday during the afternoon.

The data of air temperature and humidity were recorded in the greenhouse, using a Thermohigrograph, Dickson model, with accuracy of at least 95%, installed in appropriate metereological shelther and positioned near the center of the greenhouse, at a height of 1.5 m. The record of temperature and relative moisture in thermohigrograph was done continuously, 24 hours a day.

The "A" tank evaporation (CAE) was installed in the center of the greenhouse in front of the thermohigrograph. The data from external evaporation of the "A" tank evaporation (CAE) were obtained from the meteorological station of the Agronomy Science Faculty distant about 400 m from the site of the experiment. The reading of the evaporation of the tank was done with the help of a screw micron of precision of 0.2 mm and accompanied by a burette and a nylon yarn (dial-level).

The daily average values of temperature and relative moisture of the air in the field, observed during the assessment period are presented in Figure 1. The average monthly relative moisture during the first cycle was approximately 62.5%, 50% for the second cycle, 54% for the third cycle and 61% for the fourth cycle. The monthly average temperatures were 15.5, 18.2, 20.3 and 21.8°C for the first, second, third and fourth cycle respectively.

Distribution of evaporation in the protected environment Evaporation and distribution of energy within the plastic tunnels are difficult to be studied because there's not a practical and low-cost methodology already established. However, the use of minievaporimeters, evenly distributed inside the protected environment, or even in the field, was presented as a simple and very useful methodology in the study of energy distribution, as the evaporation can be converted into energy.

Analyzing the spatial distribution of evaporation in minievaporimeters in the period from May 7 to September 16, basically end of the fall and winter, it can be seen that there was a change in the evaporation of the environment as well as statistical differences between the averages at different hights of installation of minievaporimeters, as seen in figure 2. The minimum difference by significant test is presented in table 1.

Figure 1. Temperature and moisture media relative of the air on the field

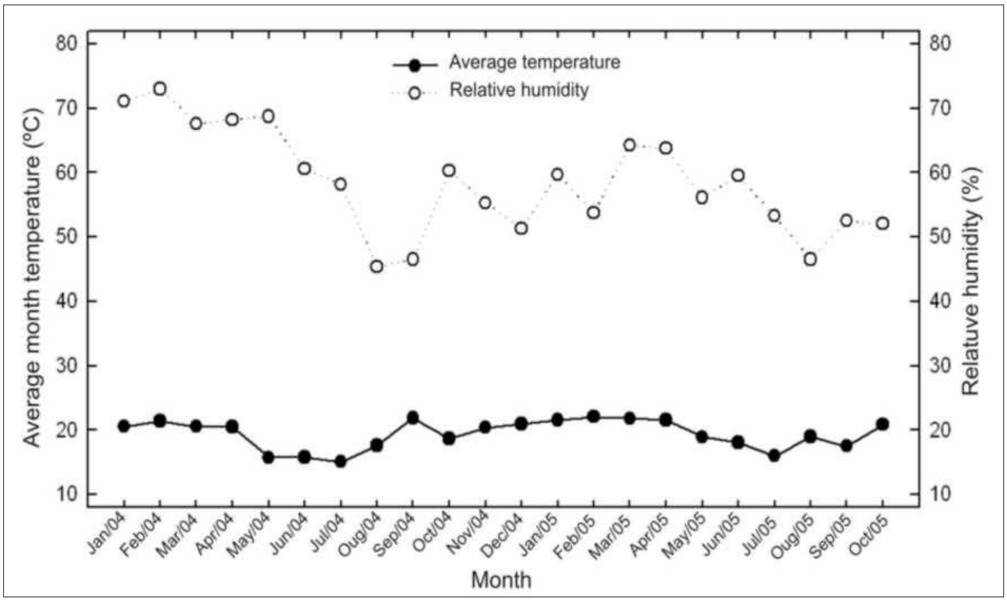

Figure 2. Weekly evaporation for the periods indicated, in three levels of installation, with significant differences in the test of Tukey to 5% probability of error

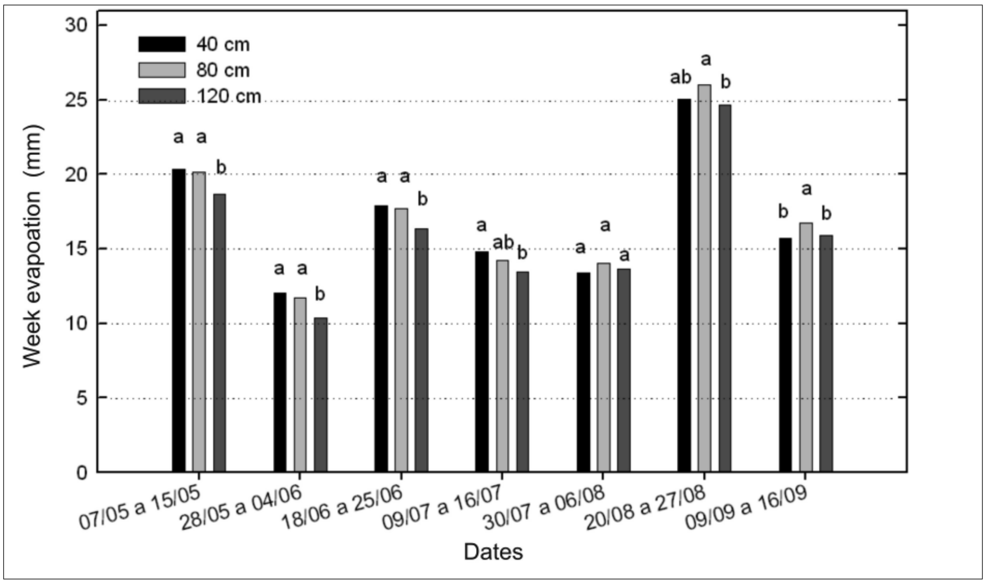

Table 1. Significant minimum difference by Tukey test

	period						
	May, 7 to 15.	**May, 28 to July, 4.**	**June, 18 to 25.**	**July , 9 to 16.**	**July, 30 to August, 6.**	**August, 20 to 27.**	**September, 9 to 16.**
DMS*	0.517	0.726	0.649	1.224	0.877	1.224	0.602

Significant minimum difference to 5% probability of error by Tukey test

For minievaporimeters installed at 40, 80 and 120cm from the ground, there was a weekly variation of 20.35, 20.50 and 18.66mm respectively for the week of 7 to May 15, giving greater evaporation by significant test Tukey, for the first two heights.

The evaporation for the week of May 28 to June 4 presented the following figures 12.05, 11.73 10.38mm for the heights 40, 80 and 120cm from the ground, respectively, presenting significant evaporation by Tukey test, for the first two heights, similar behavior to the weeks studied in May, but lower values of evaporation, caused mainly by low temperatures recorded in the period.

Evaporation for the week of June 18 to June 25, July 9 to July 16 and July 30 to August 6 showed similar values, a little higher in the first week mentioned, being close to 15mm per week, at different heights.

For the week of August 20 to August 27, near the spring, the values of evaporation increased, and were 26.01mm in height of 80cm, 25.04mm to 40cm, substantially equal by Tukey test, and 24.63 to 120mm, differing height of 80cm in height and 40cm similar.

As for the week of September 9 to September 16, with low temperatures, the evaporation of 80cm in height was increased significantly by Tukey test, with weekly average of 16.72mm, and 15.72 and 19.93mm to the heights of 40 and 120cm respectively, not differing the two means throught the same test.

The protected environment (plastic tunnel) was positioned towards Nortedeste-Southwest being approximately perpendicular to the apparent motion of the sun. It was observed that for practically every week observing the evaporation average, was higher in the face turned toward the Southwest.

Conclusion

The face Southwest of environment for the entire study period had higher evaporation in minievaporimeters. There was greater evaporation in the protected environment during the coldest months of the year for minievaporimeters which were close to the ground.

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