INFLUENCE OF MANAGEMENT OF THE ARBORICULTURE ON URBAN THERMAL COMFORT

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VELASCO, Giuliana Del Nero[1] ; LABAKI, Lucila Chebel[1]; COUTO, Hilton Thadeu Zarate do[2]
[1] State University of Campinas, UNICAMP, Brazil - giulivelasco@hotmail.com
[2] University of Sao Paulo, USP, Brazil

1. INTRODUCTION

The influence of vegetation on thermal comfort in open spaces has been widely studied, but there are still gaps in these studies in relation to street arboriculture, especially taking into account the differences in management. So the study of thermal comfort in different situations of street arboriculture in a city, becomes an important tool to support public policies aiming the quality of urban spaces, and to establish guidelines on the management of this vegetation.

Trees planted along streets and avenues are fundamental to ensure thermal comfort to urban residents, especially to those who live apart from parks and squares, in apartments without wooded gardens. This benefit is often jeopardized depending on the adopted management procedure for the trees, mainly when they undergo frequent pruning.

The aim of this study is to assess the effect of different pruning procedures on thermal comfort provided by the trees in the city of Piracicaba, São Paulo State, Brazil, analyzing the same species, *Tabebuia heterophylla*, in three distinct situations: drastic pruning (A1), "V" – shaped pruning (A2) and no pruning (A3), all located on the same street, in the same urban setting (Figure 1). A site under plain sunlight was chosen for control

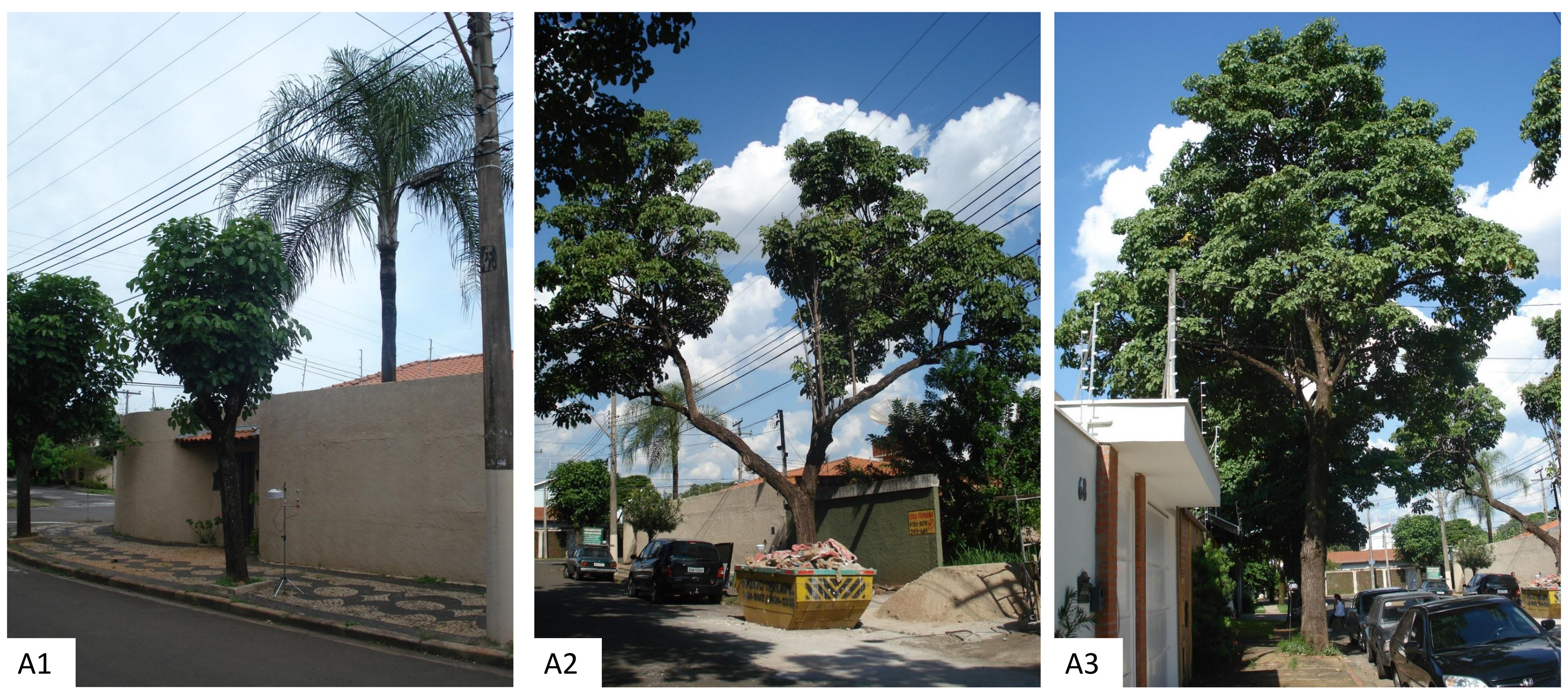

Figure 1 – Individuals *Tabebuia heterophylla* undergoing drastic pruning (A1), "V" – shaped pruning (A2) and no pruning (A3)

2. MATERIAL AND METHODS

We collected data on air temperature, relative humidity, globe temperature, wind speed, global solar radiation and calculated mean radiant temperature. Data were collected for five days in summer, from 06:00 am until 06:00 pm. We obtained Physiological Equivalent Temperatures (PET) index values using the model Rayman 2.1 and calibrations for data interpretation. The results show that the different types of pruning influence the thermal comfort. Higher PET index values were found in the control, followed by drastic pruning, V-shaped and no pruning.

3. RESULTS AND DISCUSSION

We can observe the statistical difference between treatments, between periods, as well as interaction between treatment and period, except for the variable "wind speed". Table 1 shows the analysis of the mean values obtained with the four treatments for the variables studied.

Table 1 –Comparison analysis between treatments for the variables: air temperature (Tar), relative humidity (RH), mean radiant temperature (Tmrt) and wind speed (VV)

Treatment	Tar	RH	Tmrt	VV
A 1	31.51a	59.65b	37.86b	0.34a
A 2	31.09b	59.71b	36.53c	0.31a
A 3	30.73c	63.96a	33.81d	0.27b
Control	31.08b	57.53c	41.86a	0.34a

Note: means followed by the same letter do not differ in the Tuckey test at 5% probability

In this general analysis, there was no statistical difference between A2 and control for the variable air temperature, as well as between A1 and A2 regarding air humidity. In the variable wind speed, the only treatment that showed difference from the others was A3, with lower wind speed than the other treatments. This is probably attributed to the wind speed reduction by the tree crown.

Based on the four simulations for each tree, we obtained the average PET indexes (five days, six period values). The results are shown in Figure 2.

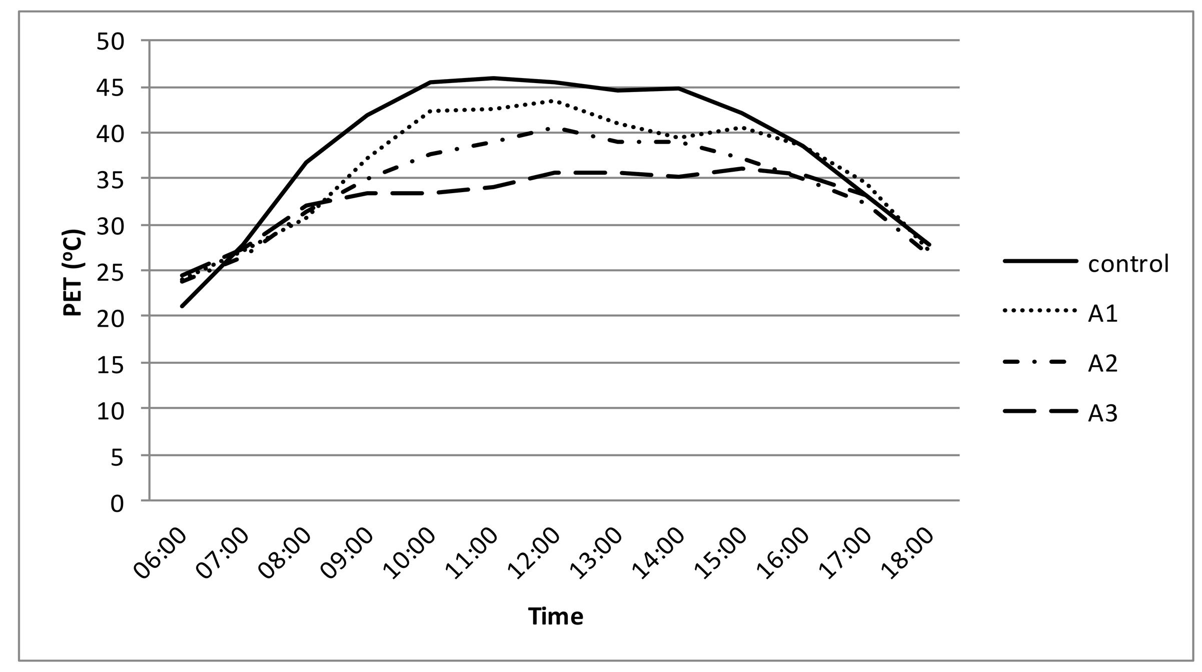

Figure 2: Mean daily PET for the four situations (Control, A1, A2, A3)

In most periods, the PET index values for the control site remained higher than for A1, A2 and A3. By comparing the trees, it is seen that the A3 showed the lowest PET indexes.

Based on the PET calibration proposed by Matzarakis and Mayer (1996), for each PET index obtained, we assigned a thermal sensation factor. This was applied to the four treatments during the five days, every 15 min. We obtained, therefore, the number of hours that the user would be under each thermal sensation, for the four treatments. Table 2 shows the results (average of five days).

In the calibration, we used three classes, namely: PET index values until 29ºC: comfortable (C); from 29 to 35ºC: slightly hot/uncomfortable (D) and above 35ºC: heat stress (S). Table 2 shows the results, in hours, for each thermal sensation, averaged for the five days.

Table 2 – period (in hours) and percentage (%) of each treatment in different thermal sensations

	A1		A2		A3		Control	
Thermal sensation	Hours	%	Hours	%	Hours	%	Hours	%
Comfortable	9h15min	15.41	10h 15min	17.08	8h 30min	14.17	9h 15min	15.42
Slightly hot	13h 45min	22.92	19h 30min	32.5	31h 30min	52.50	9h 30min	15.83
Heat stress	37h	61.67	30h 15min	50.42	20h	33.33	41h 15min	68.75

There was, thus, greater heat stress in the control site, followed by A1, A2 and A3. A user under the crown A3 would spend 33.3% of the time studied under heat stress conditions, whereas the same user under the crown of A1 would spend almost 62% of the time under such stress. The data show the strong influence of the tree crown on the generation of thermal comfort, as shown in Figure 3.

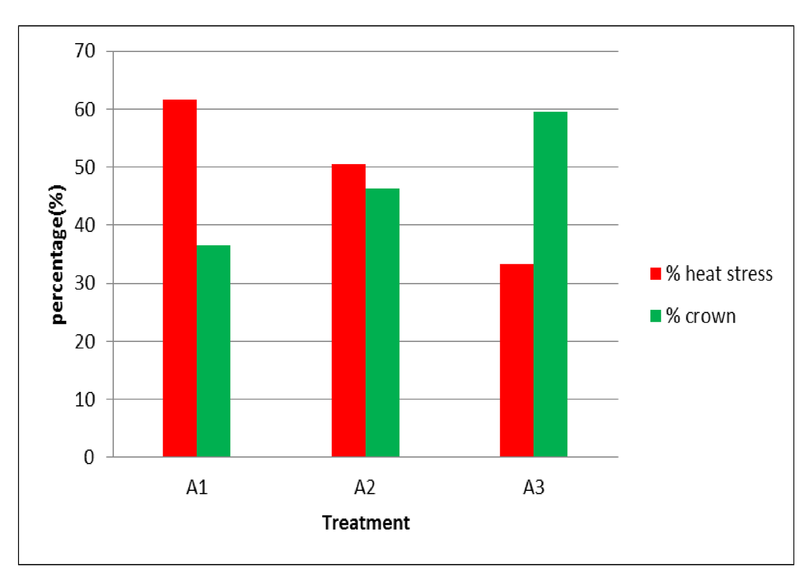

Figure 3: Relationship between percentage of tree crown and thermal sensation for the calibration of Matzarakis and Mayer, 1996.

The PET index value for A3 was 38.5ºC; for A1 the values reached 50.2ºC, and for A2, the maximum PET index value of 46.7ºC and the maximum values for the control was 51.9ºC.

4. CONCLUSION

The current work shows that different types of pruning influence urban thermal comfort, which is related to the tree crown: bigger crown,, better comfort. The mean radiant temperature values as well as the PET indexes show decreasing values, from heat stress to comfort, for the control, A1 (drastic pruning), A2 ("V" – shaped pruning) and A3 (no pruning) in most analyses.

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