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The shading quality of tree species and their influence on the microclimate of the immediate surroundings in urban environments

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ABSTRACT

The purpose of this paper was to assess the quality and impact of the shading offered by two types of shading trees *Samanea saman* (rain tree) and *Searsia Pendulina* (Wit Karee) of the environmental variables Dry Bulb Temperature (TBS) and Radiant Thermal Load (CTR) by selected species trees and increasing their relative air humidity (RH) on the climatic conditions of the University of Baghdad, and Baghdad Park in An Nasiriyah, Iraq. Data related to the variables described were collected by means of two sets of thermometers placed: the one in tree shade (5 m) and the second in trunk (full sun) at 10 m, from June to August 2020, for each single tree, for 3 days each hour from 10:00 am to 14:00 pm. The calculation of the percentage of the Relatively Variated Values, at 5 m and 10 m, with respect to the values obtained at 5 m for quantification of shading contribution to the attenuation and augmentation of environmental variables took place. The data were analysed by testing the following hypotheses: I TBS shade attenuation > TBS attenuation at 10 m (ii) shade CTR attenuation > CTR attenuation at 10 m and (iii) shade RH increased > RH increase at 10 m. Increased shade of TBS at 10 m. The results show the good impact on TBS and CTR mitigation and RH increases. *Searsia Pendulina* was the most prominent species that exhibited a general TBS attenuation range from 5% to 10%, rain tree and Karee in the UR variable with increments over 30% and Karee in the CTR shadow rates with attenuations in the order of 15%. The comparison of results in this sector with the criterion of comfort has proved the impact on improving the microclimate of the local environment of the researched arboreal species.

Keywords: Shading Quality, Baghdad, *Samanea saman, Searsia Pendulina,* environmental variables

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1. Introduction

Environmental comfort is linked to people's well-being and quality of life. Concern for this quality has grown in recent years as environmental awareness has grown, and it must be understood in its various aspects: thermal (temperature, relative humidity, solar radiation, winds), acoustic, visual (lighting), quality air (gases and suspended particles), and functionality, while keeping in mind that sensations vary from person to person. As a result, comfortable environmental conditions are those that provide well-being to the greatest number of people possible.

Solar radiation influences other environmental parameters that are responsible for thermal comfort or discomfort, either directly or indirectly. To reduce the negative effects of solar radiation, afforestation is the most natural method; however, it has received little technical attention. Different criteria are considered in urban afforestation planning, such as the shape and arrangement of the roots (so that pavements, foundations, and water and sewage networks are not harmed by its development), the height of the adult tree (so that the electrical network is preserved), aesthetics, and others [1]. However, urban thermal comfort has received little attention

in this study. Furthermore, as Zao et al. (2018) point out, the use of vegetation around buildings can provide a significant reduction in energy consumption for cooling-built environments.
It is worth noting that Chinese researchers [2] have produced little information on the impact of vegetation on the environmental comfort of urban spaces and built environments. It is well known that vegetation promotes positive effects; however, this information is frequently the result of empiricism, leaving applicable methodologies under various conditions lacking. Sattler (1991) and, more recently, the methodology proposed by Armson (2013) [4], Lin (2010) [7] evaluated, respectively, the attenuation of incident solar radiation by different tree species and the quantification of the improvement of thermal comfort in the built environment using vegetation around the buildings. It is worth noting that such studies were conducted in the bioclimatic conditions of Iraq southern and south-eastern regions, with tree species from these regions, leaving a significant gap in research under bioclimatic conditions and with tree species from Iraq, specifically the ecosystem. In this context, the current work is critical for the generation of information that will lead to the correct selection of native tree species in Iraq and the Baghdad ecosystem for use in urban afforestation, resulting in a practical and efficient solution. Low-cost results in thermal and environmental comfort. The present work has as general objective to study the contribution of shading by arboreal species native to Iraq, including native species from the Baghdad in the modification of environmental variables related to thermal comfort - temperature, relative humidity and radiant thermal load - and its influence on microclimate of its immediate surroundings, under the climatic conditions of the University of Baghdad and Baghdad Park in Nasiriya.

2. Methodology

To achieve the goals, the following steps were taken:
(i) Selection of tree species; (ii) Selection of measurement sites; (iii) Field measurements and (iv) Analysis of the results obtained.
Data collection was carried out in the urban area of the city of Baghdad, Iraq, in places where the surrounding characteristics of the arboreal individuals found. To quantify the effect of shading and the influence of trees at specified distances (1m and 5 m) in modifying environmental variables through collected data on Ambient Temperature (TBS), Relative Air Humidity and Load Radiant Thermal An adaptation of the methodology proposed by Armson (2013) and Abreu and Labaki (2007) was carried out. The analysis of the influence of tree species in improving the microclimate of the immediate surroundings was performed on Subtropical Urban Park and Vegetation in the Urban Environment.

2.1. Selection of species

In view of the proposed objectives, and the reality verified in the visits to the planning and execution agencies of the planting of urban afforestation in the city of Baghdad, the species studied were selected considering their origin, that is, native to Iraq, allied the characteristics of size, existence of leaves in the crown from August to October, possibility of adapting the species to urban environments and their ornamental qualities. Another determining factor for the selection referred to the availability of arboreal individuals whose surrounding conditions favored data collection. It was also considered that the arboreal individuals should be in the adult stage and with physical characteristics representative of the species. Therefore, two species were selected *viz Samanea saman* and *Searsia Pendulina* as in Figure 1.

Figure 1 (a). Samanea saman adult tree (b). Searsia Pendulina tree

2.2. Equipment

Measurements were performed using four sets of thermometers, each consisting of a black globe thermometer and a natural ventilation psychrometer to obtain the black globe temperature and relative humidity values, respectively. For ambient temperature measurements, dry bulb thermometers (scale from -10 °C to 50 °C) existing in natural ventilation psychrometers were used. For the measurements of the black globe temperature, dry bulb thermometers (scale -10 °C to 110 °C) inserted in black globes were used.

2.3. Data collection

Data collection was carried out in June to August of 2020, giving preference, therefore, to the critical periods of the year (hot and dry period) in relation to thermal discomfort. It is noteworthy that, for environmental adequacy and thermal comfort. A number of three days of data collection was adopted for each tree species. Each day, data were collected hourly from 10:00 am to 2:00 pm. The time-period was determined by the specificity of the work, whose objective was to quantify the individual's influence on the microclimate of their immediate surroundings. Thus, the periods of the day in which the shadow of each analyzed individual was effectively found under their crown and around their trunk were of interest. What does not happen in the times before and after the specified period. The equipment was arranged linearly, as shown in Figure 2, remaining in positions throughout the experiment:

- the First (EQ. 1) at 5 m from the tree trunk;
- the Second (EQ. 2) at 10 m from the tree trunk;

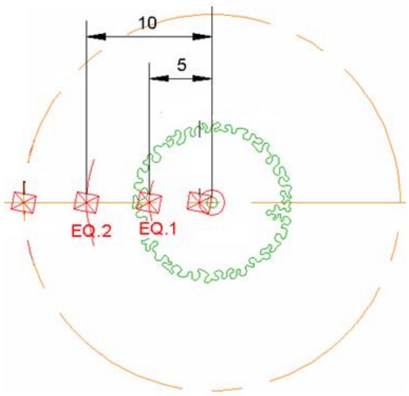

Figure 2. Schematic representation of the arrangement of equipment in relation to the arboreal individuals analyzed (distances in meters).

2.4. Methods of treatment and analysis of results

2.4.1. Dry Bulb Temperature – TBS

The interpretation and analysis of the temperatures of the dry bulb thermometers (room temperature) of the two pieces of equipment for each individual tree was based on tables and graphs, with the hypothesis for confirming the existence of the influence rays. As fixed parameters for the determination of percentage of TBS RV's, the values referring to equipment positioned 5 m from the trunk of each individual tree, considered in full sun in all cases, were adopted.

The percentage values of the RV's were obtained through the shade 5 m / sun ratios, 10 m / sun, considering that the sun component was the standardization parameter for the percentage quantification the influence of the tree on its surroundings, according to equations 1 and 2:

$$VR_{TA} = \frac{TA_{Sun} \times TA_{shade} \times 100}{TA_{Sun}} \quad (1)$$

Where,

VR_{TA} = Relative Variation of Ambient Temperature (%);

TA_{sun} = Ambient temperature in the sun (°C) – equipment positioned 10 m from the trunk of the analyzed arboreal individual;

AT_{shade} = Ambient temperature in shade (°C) – equipment positioned at 5m from the trunk of the analyzed arboreal individual.

$$\mathrm{VR_{TA}} = \frac{\mathrm{TA}_{Sun} \times \mathrm{TA_{xm}} \times 100}{\mathrm{TA}_{Sun}} \quad (2)$$

Where,
VR_{TA} = Relative Variation of Ambient Temperature (%);
TAsun = Ambient temperature in the sun (°C) – equipment positioned 10 m from the trunk of the analyzed arboreal individual;
AT_{xm} = ambient temperature at 5m and 10m (°C) – equipment positioned 5 m from the trunk of the analyzed tree individual.

2.4.2. Relative air humidity - RH

The Relative Air Humidity (RH) values were determined using PLUS software – Psychrometric Look-up Substitute, developed by Albright (1990).
The percentage values of the RH's were obtained through the shade 5m/ sun ratios, 10 m / sun, considering that the sun component (equipment positioned at 5 m) was the standardization parameter for the percentage quantification of the influence of the tree on its surroundings, according to Equations 3 and 4:

$$\mathrm{VR_{RH}} = \frac{RH_{Shade} \times \mathrm{RH_{sun}} \times 100}{\mathrm{RH}_{Sun}} \quad (3)$$

Where,
VR_{RH} = Relative Air Humidity Variation (%);
RH shade = Relative Air Humidity in the shade (%) – equipment positioned 5 m from the trunk of the analyzed arboreal individual;
RH sun = Relative Air Humidity in the sun (%) – equipment positioned 10 m from the trunk of the analyzed arboreal individual;

$$\mathrm{VR_{RH}} = \frac{\mathrm{RH_{xm}} \times \times \mathrm{RH_{sun}} \times 100}{\mathrm{RH}_{Sun}} \quad (4)$$

Where,
VR_{RH} = Relative Air Humidity Variation (%);
RH shade = Relative Air Humidity in the shade (%) – equipment positioned 5 m from the trunk of the analyzed arboreal individual;
$\mathrm{RH_{xm}}$ = Relative Air Humidity in the sun (%) – equipment positioned 10 m from the trunk of the analyzed arboreal individual;

2.4.3. Radiant thermal load – CTR

As a mathematical parameter for the analysis of the effects of solar radiation under the influence of the arboreal individuals analyzed with the flowing equation 5 and 6

$CTR = \varepsilon\,(TRM)^4$ (Equation 5)

Where,
On what:
CTR = Radiant Thermal Load in W / m²
ε = Stefan-Boltzmann constant (5.67 x 10^{-8} K^4W/m^2)
TRM = Average Radiant Temperature (°C), according to equation 2
TRM = tg + $0.24v^{1/2}$ (tg – ts) (Equation 6)
TRM = mean radiant temperature (°C) tg = black globe temperature (°C)
ts = dry bulb temperature (°C) v = wind speed (m/s).

2.4.4. Influence of arboreal individuals on the microclimate of their immediate surroundings

The evaluation of the influence exerted by each individual tree on the microclimate of their immediate surroundings, with a view to verifying the effect of the tree on thermal comfort, was carried out considering the environmental variables dry bulb temperatures, relative air humidity and wind speed.

2.5. Experimental planning

The work was carried out completely randomized, with three replications corresponding to the days of collection of microclimatic variables as in Figure 3. To analyze the influence of each species separately, in relation to its immediate surroundings, an analysis of variance was performed to verify the influence of treatments on the response variables [3, 5, 6]. The treatments corresponded to the three positions of the equipment, that is, equipment in the shade, 5 m and 10 m from the trunk of each tree. The response variables analyzed corresponded to the mean values of Relative Variation for Dry Bulb Temperature (TBS), Relative Air Humidity (RH) and Radiant Thermal Load (CTR). Means were compared by Tukey test at 5% probability [6]. Statistical calculations were performed using the ESTAT software – Statistical Analysis.

Figure 3. (a) Natural ventilation psychrometer. Detail of the equipment height at 1.30 m, (b) Set of thermometers composed of the natural ventilation psychrometer and the dry bulb thermometer inserted in the black globe. (c) Portable digital anemometer

3. Results and discussion

3.1. The immediate surroundings

The analyzed trees are located on the street of Baghdad University, Baghdad and Park of Baghdad (Figure 4). The person has a wide crown at the bottom and a forming crown at the top. Its foliage is permeable to wind and sun radiation and has simple leaves in formation. Its immediate surroundings are characterized by the presence of grass covering the ground, asphalt pavement on the rolling track located approximately 5m from the trunk. There are buildings and paved parking lots, which, however, are outside the radius of influence considered for the study. The positioning of the equipment took place in the east-west direction, inclined approximately 15° in relation to it.

Figure 4. Street of Baghdad University, Baghdad and Baghdad Park

3.2. Analysis of results

Data for this individual were collected on the 16th (Day1), 17th (Day2) and 18th (Day3) of July 2020 which, in general, were characterized by open skies and light to moderate winds (Table 1).

Table 1. Hourly weather condition on the days analyzed for the arboreal individual of the species rain tree and Wit Karee

Time (Hours)	**DAYS ANALYZED**		
	Day 1	**Day 2**	**Day 3**
10	Open skies, moderate wind.	Open skies, light wind.	Open skies, moderate wind.
11	Open skies, light wind.	Open skies, light wind.	Open skies, light wind.
12	Open skies, light wind.	Open skies, light wind.	Open skies, moderate wind.
13	Open skies, moderate wind.	Open skies, light wind.	Open skies, light wind.
14	Open skies, strong wind.	Open skies, strong wind.	Open skies, light wind.

Data from the National Institute of Meteorology (Figure 5) for the month of July show that, for the days analyzed, the maximum daily temperatures ranged from 43.13°C to 44.05°C, the minimum from 28.64°C to 39.21°C , with the averages remaining between 35.91 °C and 36.63°C.

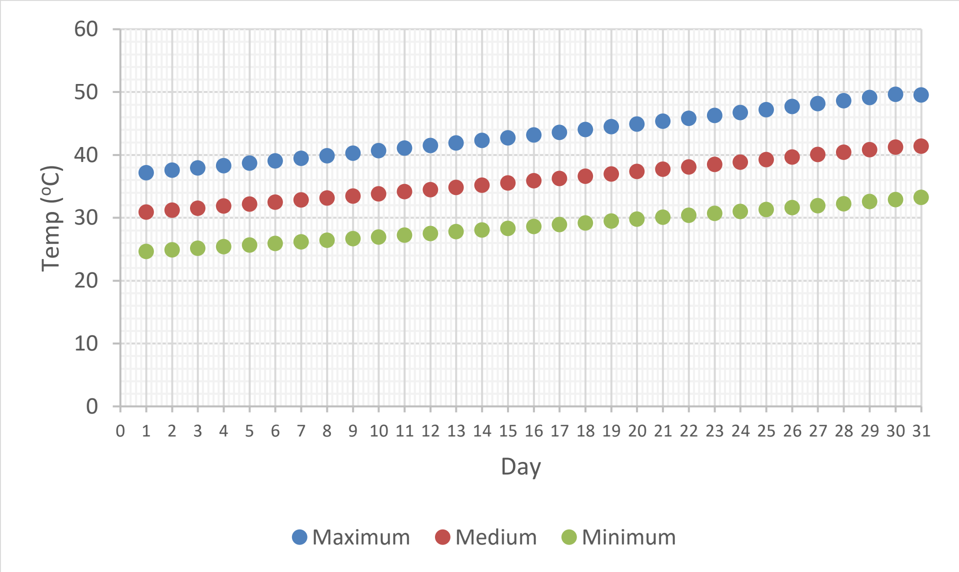

Figure 5. Maximum, average and minimum temperatures for 16th (Day1), 17th (Day2) and 18th (Day3) of July 2020

The analyzed individual are an adult of the species Rain tree and Wit Karee. The person has a wide crown at the bottom and a forming crown at the top [7]. Its foliage is permeable to wind and sun radiation and has simple leaves in formation. The arithmetic means of the Dry Bulb Temperature (TBS), Relative Air Humidity (RH) and Radiant Thermal Load (CTR) values, obtained in the field for the three days analyzed for each time, in the form of tables are presented below.

Table 2. Average Dry Bulb Temperature Values obtained on the 16th (Day1), 17th (Day2) and 18th (Day3) of July 2020 for the species Rain tree and Wit Karee.

	Rain tree									
	DRY BULB TEMPERATURE (° C)					RELATIVE HUMIDITY (%)				
SHADOW DISTANCES	10 hours	11 hours	12 hours	13 hours	14 hours	10 hours	11 hours	12 hours	13 hours	14 hours
5 m	33.8	36	38	37.7	38	38.5	33.8	30.9	31.7	29.6
10 m	35.5	36	36.8	37.5	37.5	27.2	25.8	25.5	26.2	24.5

	Wit tree									
	DRY BULB TEMPERATURE (° C)					RELATIVE HUMIDITY (%)				
SHADOW DISTANCES	10 hours	11 hours	12 hours	13 hours	14 hours	10 hours	11 hours	12 hours	13 hours	14 hours
5 m	30.8	32.7	34.3	34.7	36.7	37.7	34.3	30	28.4	24.2
10 m	31.8	35.8	36.2	35.8	37.2	34.8	29.7	27.1	26.1	23.0

Comparing the Dry Bulb Temperature (TBS) data obtained in the field (Table 2), it can be seen that from 12h onwards, the TBS measured by the equipment in full sun (15 m) it reaches 43°C, or very close to this value, while the maximum for the days considered is around 44°C. Combining this value with the Relative Air Humidity (RH), ranging from 20% to 30% for the equipment in full sun, there is a significant difference of eight percentage points, which indicates the formation of a local microclimate, even this arboreal individual located on the edge of the city's urban area, away from the “heat island” characteristic of the urban environment. Comparing the data obtained in the field with those presented in Table 2, for wit tree, it can be seen that at 2 pm the TBS demonstrated by the equipment in full sun (10 m) comes close to 39 °C while the average of the maximum for the days considered was around 37°C. From the analysis of wit tree, it was found that, among the species studied, it was the one that clearly demonstrated the hypothesis of the individual's radius of influence and the shading provided on the environmental variables of its surroundings, according to the TBS and UR values.

The TBS results indicates that temperatures in the shade were always lower than in other situations – 5 m and 10 m. The set of values presented by the equipment demonstrate the hypothesis of the tree radius of influence on its immediate surroundings, even with close values, at distances 5 m and 10 m with alternation between the values of 5 m and 10 m from the 11 am. In the same way as the RH, the Radiant Thermal Load (CTR) was shown to be greater at 5 m than at 10 m (sun), which would also partially refute the initial hypothesis.

Table 3. Average Wind Velocity Values (m.s-1) Black Globe Temperature (°C), Average Radiant Temperature (°C) and Radiant Thermal Load (W m-²) on the 16th (Day1), 17th (Day2) and 18th (Day3) of July 2020 for the species Rain tree and Wit Karee.

	Rain Tree														
	10 hours			11 hours			12 hours			13 hours			14 hours		
VARIABLES SHADE	Vel. Wind = 5.0 m s-1			Vel. Wind = 3.9 m s-1			Vel. Wind = 4.0 m s-1			Vel. Wind = 4.0 m s-1			Vel. Wind = 8.9 m s-1		
	TG (°C)	TRM (°C)	CTR (W m⁻²)	TG (°C)	TRM (°C)	CTR (W m⁻²)	TG (°C)	TRM (°C)	CTR (W m⁻²)	TG (°C)	TRM (°C)	CTR (W m⁻²)	TG (°C)	TRM (°C)	CTR (W m⁻²)
5 m	34.7	35.1	511	39.3	40.9	550.6	42.7	44.9	578.8	46.3	50.6	621.9	45.7	51	625.4
10 m	41	43.9	571.9	42	44.9	578.8	45	49.1	610.8	48.7	54.1	649.1	48.8	56.9	671.5
	Wit karee														
VARIABLES	10 hours			11 hours			12 hours			13 hours			14 hours		
SHADE	Vel. Wind = 0.7 m s-1			Vel. Wind = 2.0 m s-1			Vel. Wind = 0.5 m s-1			Vel. Wind = 1.9 m s-1			Vel. Wind = 2.6 m s-1		
5 m	32	32.2	491.9	33.7	34	503.7	36.3	36.7	521.4	45.7	48.9	608.7	45	48.4	605.9
10 m	34.2	34.6	507.6	43.3	45.9	586.3	47.5	49.3	612.2	48	51.5	628.7	46.3	49.9	617.5

The results of the calculation of the Relative Variation for the environmental variables Dry Bulb Temperature, Relative Air Humidity, and Radiant Thermal Load, using as fixed parameters the values obtained in the equipment, were analysed to verify the attenuation of incident solar radiation provided by the shading of the Rain tree of the studied species. The values referring to the attenuation promoted by the individual tree, in the case of the dry bulb temperature and the radiant thermal load, and the increase in the relative humidity of the air, are represented in Tables 4.

Table 4. Means of Relative Variations (RV) of Dry Bulb Temperature (TBS) obtained on 16th (Day1), 17th (Day2) and 18th (Day3) of July 2020 for the individual of the species Rain tree and Wit Karee.

	Rain tree					Wit Karee				
SHADOW POSITIONS	RELATIVE VARIATIONS TBS (%) - Attenuation					RELATIVE VARIATIONS TBS (%) - Attenuation				
	10h	11h	12h	13h	14h	10h	11h	12h	13h	14h
5 m	7.3	1.4	3.4	1.7	3	13.6	12.5	7.6	6.7	4.8
10 m	2.7	1.4	6.4	2.2	4.3	10.7	4	2.7	3.6	3.5

The means in the columns did not show statistical differences ($p < 0.05$) according to the Tukey test, when comparing the positions.

Relative Variations corroborate the TBS results, showing a significant percentage in the shadow position, in the order of 20%, at 10:00 am and 12:00 pm and between 10% and 15% at 11:00 am, 1:00 pm and 2:00 pm (Table 4). The analysis of the 5 m and 10 m positions shows, statistically, the lower attenuation of TBS in relation to the shadow. Therefore, it can be seen that this arboreal individual contributes to the attenuation of TBS as a consequence of the attenuation of the incidence of solar radiation by shading [8]. The increase in Relative Air Humidity is clearly perceived by the analysis of the shadow position, whose greatest increase occurred at 12:00, reaching 36 percentage points, that is, the studied tree greatly contributed to the improvement of this environmental variable. At other times, the increase varied between 15% and 25% for this ratio. The 5 m position presents a smaller increase in RH, however it still demonstrates the influence of the rain tree at this distance. When considering the 10 m position, one notices the fact previously perceived in the analysis, in which the RH at 5 m is lower than at the sun (10 m). Therefore, for this relationship there was no increase in RH at 5 m, but a reduction, which contradicts the hypothesis that at a distance of 10 m this environmental component should be greater than at 10 m.

Also noteworthy is the behavior of the shadow positions, 5 m and 10 m from each other, which although the variations verified at 10 am and 5 pm did not show statistically significant differences, it gives evidence of the hypothesis of the individual's radius of influence and the shading provided by this in TBS component. Over the period analyzed (from 10 am to 2 pm) the absolute values of the attenuations presented a sequence in which: shadow attenuation ≥ 5 m attenuation > 10 m attenuation.

The attenuation of the Radiant Thermal Charge (CTR) is clearly perceived in the shadow position, being greater, precisely at the times when the increase in TBS was recorded, that is, from 11 am, which confirms the influence of shading on the attenuation of incident solar radiation (Table 5). The 5 m position also demonstrates the influence of the tree, to a lesser extent, of the tree, as percentage attenuations are registered, however little significant.

For the 10 m position, it is concluded that there was no attenuation of the CTR, but an increase in the CTR for this distance, a fact that corroborates the previous analyses, that is, the values found at a distance of 10 m from the tree at first, they refute the hypothesis of influence rays at distances determined from their trunk. However, if the values found at this distance (10 m) are disregarded, the influence of the individual tree on the microclimatic variables is evident considering the determined radius [7-8].

Table 5. Means of Relative Variations (RV) of Radiant Thermal Charge (CTR) obtained on 16th (Day1), 17th (Day2) and 18th (Day3) of July 2020 for the individual rain tree species.

POSITIONS	Rain tree					Wit Karee				
	RELATIVE VARIATIONS CTR (%) - Attenuation					RELATIVE VARIATIONS CTR (%) - Attenuation				
	10h	11h	12h	13h	14h	10h	11h	12h	13h	14h
SHADOW	7.7	9.1	10.7	10.7	8.8	11.9	15.1	15.6	15.8	13.3
5 m	6.2	1.3	2.3	0.3	1.2	12.4	15.1	14.8	3.2	1.9
10 m	-5	-3.8	-3.1	-4	-6.1	9.6	1.2	0	0	-0.1

The means in the columns did not show statistical differences ($p < 0.05$) according to the Tukey test, when comparing the positions.

From Table 5, the influence exerted by the tree can be seen, mainly in the aspects related to shading, in the attenuation of the CTR. At 10 am, due to the positioning of the equipment in relation to the tree and the apparent movement of the sun, the equipment positioned in the shade and at 5 m were fully shaded and the equipment at 10 m was partially shaded, thus confirming the influence on attenuation of the solar radiation incident on this variable. For the two situations, at this time, there was attenuation of the CTR, that is, 11.9%, 12.4% and 9.6%, respectively, even though there were no statistically significant variations.
Considering the Relative Variation parameters – attenuations for TBS and CTR and increment for RH – for the shadow positions and 5 m, the results presented by Wit Karee analyzed demonstrate that shading provides improvements in the attenuation of solar radiation and, consequently, of the environmental variables involved in this study.

4. Conclusions

The results obtained in the development of this study confirmed that the general objective, that is, the verification of the contribution of shading by tree species native to Iraq in the modification of environmental variables related to thermal comfort and its influence on the microclimate of its immediate surroundings, in the climatic conditions of city of Baghdad, Iraq, was reached because the proposed methodology proved to be adequate.
Among the specific propositions it was possible:

- Quantify the attenuation of ambient temperatures (represented by TBS) and of the Radiant Thermal Load, as well as the increase in the relative humidity of the air, provided by the different arboreal individuals studied, demonstrating that there were expressive attenuations and that, at different distances, there is a staggering gradual contribution of the tree, which decreases with increasing distance from the trunk;
- Compare the microclimatic data obtained (TBS, RH and wind speed) with the thermal comfort criteria obtained and verify that there is the contribution of arboreal individuals to achieve better levels of thermal comfort in urban environments;
- Quantify the positive effects on TBS and CTR attenuation and RH increase. The species that stood out were *Samanea saman (*rain tree*)* and *Searsia Pendulina* (Wit Karee) that presented general averages of TBS attenuation between 5% and 10%, rain tree and Wit Karee in the UR variable providing increments greater than 30%.
- Demonstrate the influence of the studied tree species in improving the microclimate of their immediate surroundings by comparing the results obtained in the field with the adopted comfort criterion.
- Conclude positively on the methodology adopted for the proposed and carried out verifications.

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