EESj
Vol. 3, N° 1, 2019

Journal of Energy & Environmental Sciences

A publication of
CINCADER
Centre of Research and Training for Regional Development
Online at www.journals.cincader.org

ISSN 2523-0905

Contribution of the species *Pilea microphylia* in the thermal comfort of a house

[Contribución de la especie *Pilea microphylia* en el confort térmico de una casa]

Kevin Campos Poma[a], Jhonny Wilfredo Valverde Flores[a, *]

[a]Universidad César Vallejo, Peru.
jhoval1@yahoo.es

Resumen

La investigación presenta la influencia de la especie *Pilea microphylia* en el confort térmico de una casa. Las dimensiones del ensayo fueron 2,8 m x 3,8 m x 2,5 m. Las mediciones se realizaron en dos habitaciones, una habitación con un techo cubierto por la especie *Pilea microphylia* y otra habitación con un techo no cubierto. La experimentación se llevó a cabo durante los meses de octubre y noviembre de 2018. Los resultados muestran que la habitación con techo cubierto con la planta de *Pilea microphylia* mejoró el confort térmico de la habitación en la semana 5 (temperatura de 20.07 °C y humedad relativa del 75.75%), que con la habitación con techo descubierto (temperatura de 24.94 °C y humedad relativa 82.90%). Por lo tanto, se concluye que la especie *Pilea microphylia* mejora el confort térmico de la habitación con una variación de temperatura de 4.87 ° C y una atenuación de la humedad relativa en 7.15%.

Palabras clave: *Pilea microphylia*, comfort térmico, techo cubierto, techo no cubierto.

Abstract

The research presents the influence of the species *Pilea microphylia* on the thermal comfort of a house. The dimensions of the test were 2.8 m x 3.8 m x 2.5 m. The measurements were made in two rooms, a room with a roof covered by species *Pilea microphylia* and another room with a roof no covered. The experimentation was carried out during the months of October and November of 2018. The results show that the room with roof covered with the *Pilea microphylia* plant improved the thermal comfort of the room in week 5 (temperature of 20.07 °C and relative humidity 75.75%) than with the room with uncovered roof (temperature of 24.94 °C and relative humidity 82.90%). Therefore, it is concluded that the species *Pilea microphylia* improves the thermal comfort of the room with a temperature variation of 4.87 °C and an attenuation of the relative humidity in 7.15%.

Keywords: *Pilea microphylia*, thermal comfort, covered roof, no covered roof.

1. Introduction

One of the main risks for cities in the future is the manifestation of the decrease and the increase in temperatures caused by climate change creating a social, economic and environmental imbalance. With the use of extensive green roofs, the environmental temperature and the interior temperature of the houses can be reduced, as well as protecting the roof from solar radiation (Kidd, 2015). Trees and green areas, by evapotranspiration, cool the immediate environment, reduce greenhouse gases, minimize energy consumption among many other benefits, which allow the environment to cool significantly (Peck et al., 2013). Several researchers have evaluated the thermal comfort placing pots with the species *Cissus verticillata (L)* on zinc roof reducing the temperature to 4.5 °C on average (Beltran et al., 2014), the ambient temperature of 3 °C was

Please cite this article as: Campos K., Valverde J, Contribution of the species *Pilea microphylia* in the thermal comfort of a house, Journal of Energy & Environmental Sciences, vol. 3, no 1, 2019, pp. 1-11

EESj
Vol. 3, N° 1, 2019

Journal of Energy & Environmental Sciences

A publication of
CINCADER
Centre of Research and Training for Regional Development
Online at www.journals.cincader.org

ISSN 2523-0905

attenuated approximately and a 10% increase in relative humidity (Forero et al.,2011), sensors known as "Tag temp" were programmed and installed, decreasing the temperature of 10 °C from August to October (Yeomans et al., 2013).

Ecological roofs, known as green roofs, roof gardens or living ceilings, can be defined as roofs covered with vegetation and growing medium (Vijayaraghavan, 2016). Green roofs are capable of providing various benefits to urban areas in terms of aesthetics and environmental aspects (Pisello et al., 2015). Some of these benefits are the reduction of greenhouse gas emissions, air pollution, the effect of "Island of Urban Heat", the risks of flooding by retaining excess water and providing a better habitat for urban life and wildlife, green roofs are also capable of absorbing local noise pollution within urban areas (Theodoridou et al., 2017; Bevilacqua et al., 2015; Bevilacqua et al., 2016). Green roofs are generally classified as extensive, semi intensive and intensive (Blanusa et al., 2013; Matos et al., 2015) (see Table 1)

Table 1. Types of green roofs

Characteristics	Extensive	Semi-intensive	Intensive
Substrate thickness	Up to 10 cm	Between 10 and 20 cm	More than 20 cm
Passable Vegetable Coverage	No passable	Partially passable	Passable
Saturated weight	Between 50 and 150 kg/m^2	Between 150 and 250 kg/m^2	More than 250 kg/m^2
Plant diversity	Little	Half	High
Maintenance	Minimum	Variable	High
Type of vegetation	Small plants, creepers	Small shrubs, ornamental grasses	Shrubs and trees

Source: Blanusa et al. (2013).

The thermal sensation is the result of the way in which the skin perceives the objects temperature and their surroundings, which does not faithfully reflect the actual temperature. The human body measures temperature even though its own temperature remains approximately constant (around 37 °C). Therefore, it does not reach thermal equilibrium with the environment or with the objects it touches (Nagase & Dunnett, 2014). The variations of heat that occur in the human body generate a difference in the thermal sensation, deviating from the real value of the temperature. As a result, exaggeratedly high or low temperature sensations occur (Vijayaraghavan, 2016).

The species *Pilea microphylia* is an endemic plant from Central and South America. It is a small herbaceous perennial plant, monoecious and very branched that can grow up to 40 cm in height with an adequate maintenance. The leaves are small, oval, almost round in different sizes and light green. It is widely used to decorate the edges of gardens, parks and even advertising. The *Pilea microphylia* is cultivated in full sunlight, since it likes warm climates, but it can also be planted in a semi-shade environment. Withstands low temperatures and behaves as an annual plant. The minimum recommended temperature is 15ºC. For its survival a fertile, loose and drained substrate must be used. The use of organic matter in the preparation of the substrate is recommended. It is recommended to water 2 to 3 times a week during the summer and 1 time a week during the winter and to let the substrate dry between waterings (Monro, 2001; Saha et al., 2017; Bhellum & Hamid, 2016).

With global climate change a looming reality, designing low energy buildings needs to consider capricious climate variations at play. In a warming world, heating energy demands should reduce while cooling energy demands rise. But the rise is more than likely to offset the reductions (Gupta et al., 2015; Isaac & Van Vuuren, 2009; Van Hooff et al., 2016). Buildings designed or retrofitted

EESj
Vol. 3, N° 1, 2019
Journal of Energy & Environmental Sciences
A publication of CINCADER
Centre of Research and Training for Regional Development
Online at www.journals.cincader.org

ISSN 2523-0905

for a cold winter and a mild summer will have rising complains of overheating as the summer becomes more warm than mild (Willand et al., 2016; Duran et al., 2015).

2. Materials and Methods

The research design is non-experimental and descriptive, explanatory.

2.1. Conditioning of the test place

A house that has two rooms was taken as a representative sample. A room with a roof covered with the species *Pilea microphylia* and another room with a roof not covered with the species *Pilea microphylia*. The two rooms have the same characteristics to perform the measurements (Table 2).

Table 2. Rooms characteristics for research

	Room with roof not covered (HNC)	Room with roof covered (HC)
Room size	2,8 m x 3,8 m	2,8 m x 3,8 m
Ceiling height	2,5 m	2,5 m
Green roof area	-	10,64 m^2
Roof type	Traditional	Ecological
Roof material	Concrete	Concrete
Roof slope	<1°	<1°

Figure 1 shows the steps to prepare the green roof: Delimitation of the room, installation of waterproofing membrane and drainage layer, installation of the filter layer, placement of the substrate, installation of the species *Pilea microphylia* and species irrigation *Pilea microphylia*

Figure 1. Steps to condition the green roof: (a) Delimitation of the room, (b) Installation of waterproofing membrane and drainage layer, (c) Installation of the filter layer, (d) placement of the substrate, (e) installation of the species *Pilea microphylia* and (f) Irrigation of the species *Pilea microphylia*.

EESj
Vol. 3, N° 1, 2019
Journal of Energy & Environmental Sciences
A publication of
CINCADER
Centre of Research and Training for Regional Development
Online at www.journals.cincader.org

ISSN 2523-0905

2.2. Thermal Comfort Measurement

Thermal comfort basically refers to the conditions of well-being of any individual, but from the point of view of their equilibrium relationship between the conditions of relative humidity and temperature in a certain place (Yovane, 2003).
The Humphreys-Nicol model was used for having a better precision according to the data that is used (Humphreys & Nicol, 2016).

$$Tn = 13{,}5\ ºC + 0{,}35\ (Tm) \quad (1)$$
$$Z = Tn \pm 1{,}5\ °C \quad (2)$$

Where:
Tn: Neutral temperature
Tm: Average Annual/monthly temperature
Zc: Comfort Zone

2.3. Measurement instrumentation

In order to evaluate the performance of the test rooms, as well as proceeding to the comparison between the test room with no covered roof and the test room without covered roof, it was necessary to install a measurement system in the test rooms. The measurement system can be divided in three base components:

- Air temperature and relative humidity sensor;
- Thermocouples were installed in the inside and outside surface of the wall (superficial temperature sensors) of the tow Test Cells;
- A pyronometer were installed in the outside surface to meter the total radiation product.

The species *Pilea microphylia* was examined through the growth of the plant.

3. Results

3.1. Characteristics of the species

The height of the 35 units of the species *Pilea microphylia* was measured. The measurements were made every 7 days for 5 weeks (Table 3).

Table 3. Measurement of the height of each unit of the species *Pilea microphylia*

Species number	Week 1 (cm)	Week 2 (cm)	Week 3 (cm)	Week 4 (cm)	Week 5 (cm)
1	15.4	17.8	19.2	21.2	24.3
2	17.2	17.5	19.1	21.4	24.1
3	15.7	16.4	18.8	20.1	24.3
4	18.1	18.8	20.1	21.9	24.6
5	15.5	15.9	18.6	21.1	24.1
6	15.4	16.4	18.9	21.7	25.2
7	16.2	17.3	19.7	21.3	24.5
8	18.2	18.9	20.3	21.4	24.8
9	19.1	20.1	21.5	22.1	25.2
10	17.2	19.2	20.3	21.8	23.9
11	18.1	19.2	20.4	21.7	23.8
12	19.2	20.4	21.3	22.1	25.1
13	18.6	20.3	21.2	22.3	25.3
14	17.9	19.9	21.3	22.4	25.1

EESj
Vol. 3, N° 1, 2019

Journal of Energy & Environmental Sciences

A publication of
CINCADER
Centre of Research and Training for Regional Development
Online at www.journals.cincader.org

ISSN 2523-0905

15	19.2	20.5	21.7	23.2	25.7
16	18.5	20.3	21.9	22.9	24.1
17	16.9	19.8	20.8	22.1	24.6
18	19.7	20.5	21.1	22.8	24.9
19	18.7	20.8	21.5	22.4	24.8
20	17.9	19.9	21.7	23.1	25.2
21	19.4	20.8	21.9	22.9	24.9
22	18.7	20.1	21.1	22.8	25.1
23	17.8	20.2	21.4	22.1	24.5
24	19.2	20.8	21.8	22.7	24.3
25	17.5	19.8	21.1	22.3	24.9
26	16.4	18.8	20.7	22.1	24.7
27	18.1	19.1	20.4	21.8	24.8
28	18.3	19.8	20.8	21.9	24.1
29	18.4	19.9	20.7	21.8	23.6
30	19.1	20.4	21.4	22.4	24.8
31	19.2	20.4	21.1	22.9	24.5
32	17.2	19.8	21.2	22.2	24.1
33	17.6	20.4	21.5	21.9	23.6
34	16.8	19.8	20.8	22.1	24.7
35	17.8	19.9	20.9	21.8	22.9
Average (cm)	17.83	19.43	20.75	22.08	24.55

Figure 2, shows average height of the species *Pilea microphylia* on the roof of the room until week 5.

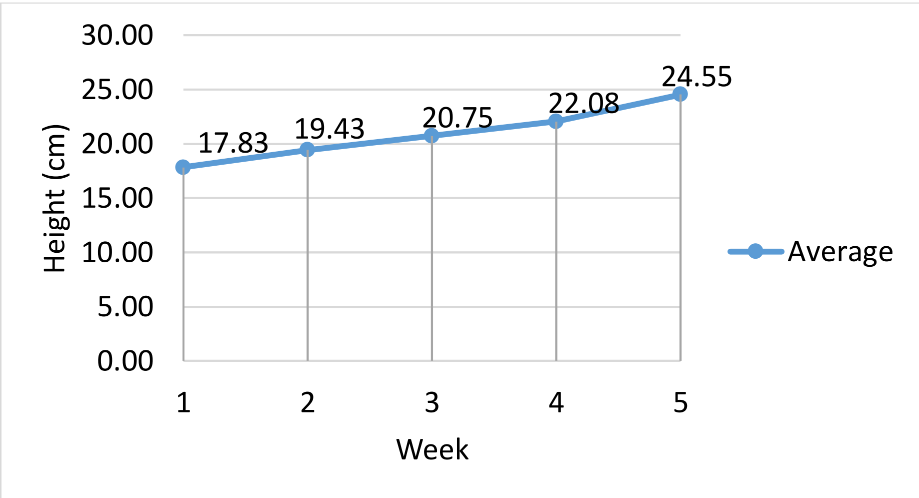

Figure 2. Average height of the species *Pilea microphylia* on the roof of the room

3.2. Characteristics of the roof not covered and covered with the species *Pilea microphylia*

The temperature of a room with a roof covered with the species *Pilea microphylia* and of the other room with a roof not covered with the species *Pilea microphylia* was measured. The minimum

EESj
Vol. 3, N° 1, 2019
Journal of Energy & Environmental Sciences
A publication of
CINCADER
Centre of Research and Training for Regional Development
Online at www.journals.cincader.org

ISSN 2523-0905

temperature was 22.3 °C at 1 hour of week 1. The maximum temperature was 26.4 °C between 13 hours and 14 hours of week 4 (Figure 3).

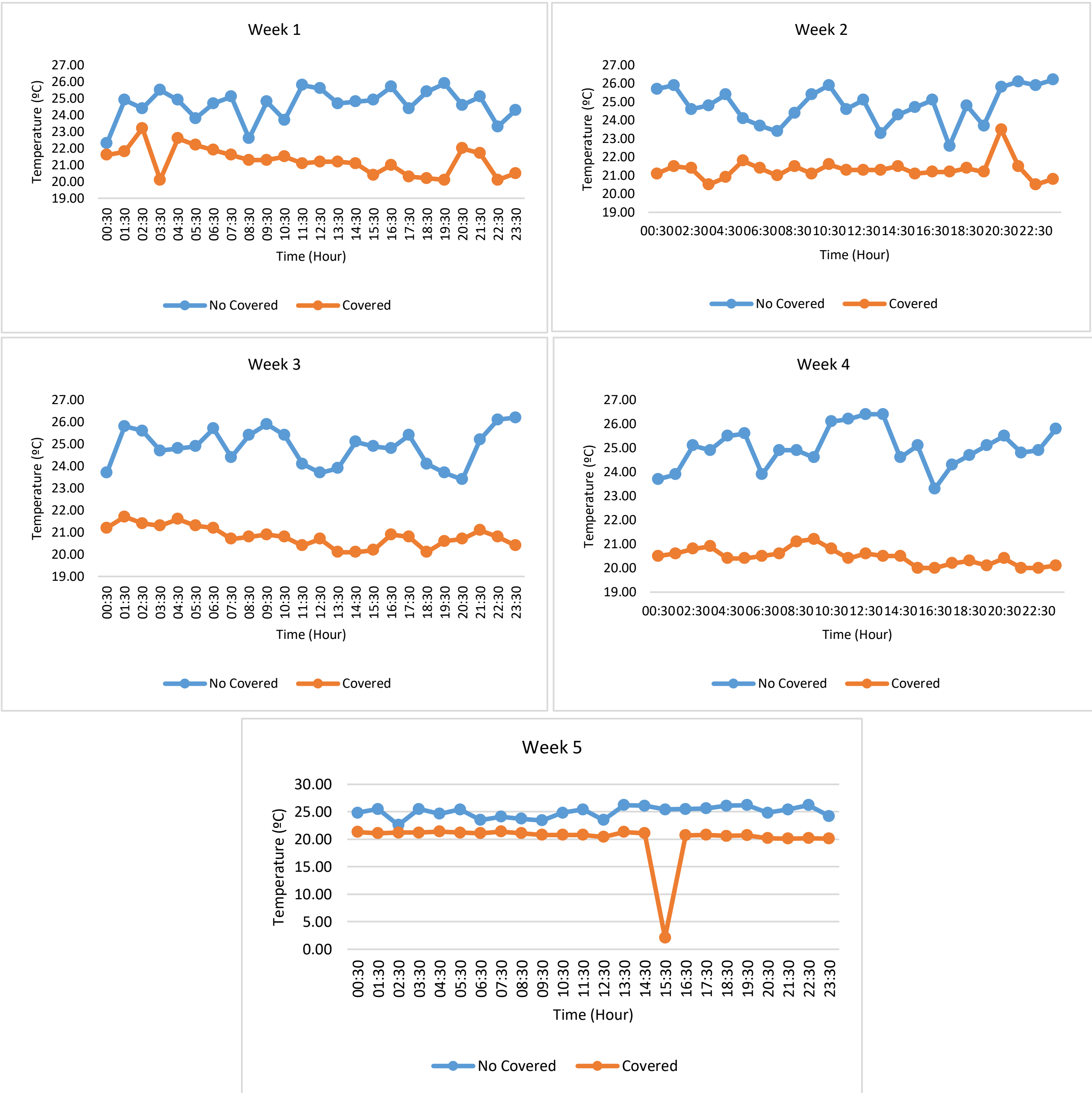

Figure 3. Variation of roof temperature not covered and covered with the species *Pilea microphylia* in each week

EESj
Vol. 3, N° 1, 2019

Journal of Energy & Environmental Sciences

A publication of
CINCADER
Centre of Research and Training for Regional Development
Online at www.journals.cincader.org

ISSN 2523-0905

The relative humidity of a room with a roof covered with the species *Pilea microphylia* and of the other room with a roof not covered with the species *Pilea microphylia* was measured. The minimum relative humidity was 80.30% at 0:30 hours in week 4, at 8:30 and 10:30 hours in week 2, at 18:30 hours in week 1 and 19:30 hours in week 4. The maximum relative humidity was 87.10% at 2:30 hours of week 1 (Figure 4).

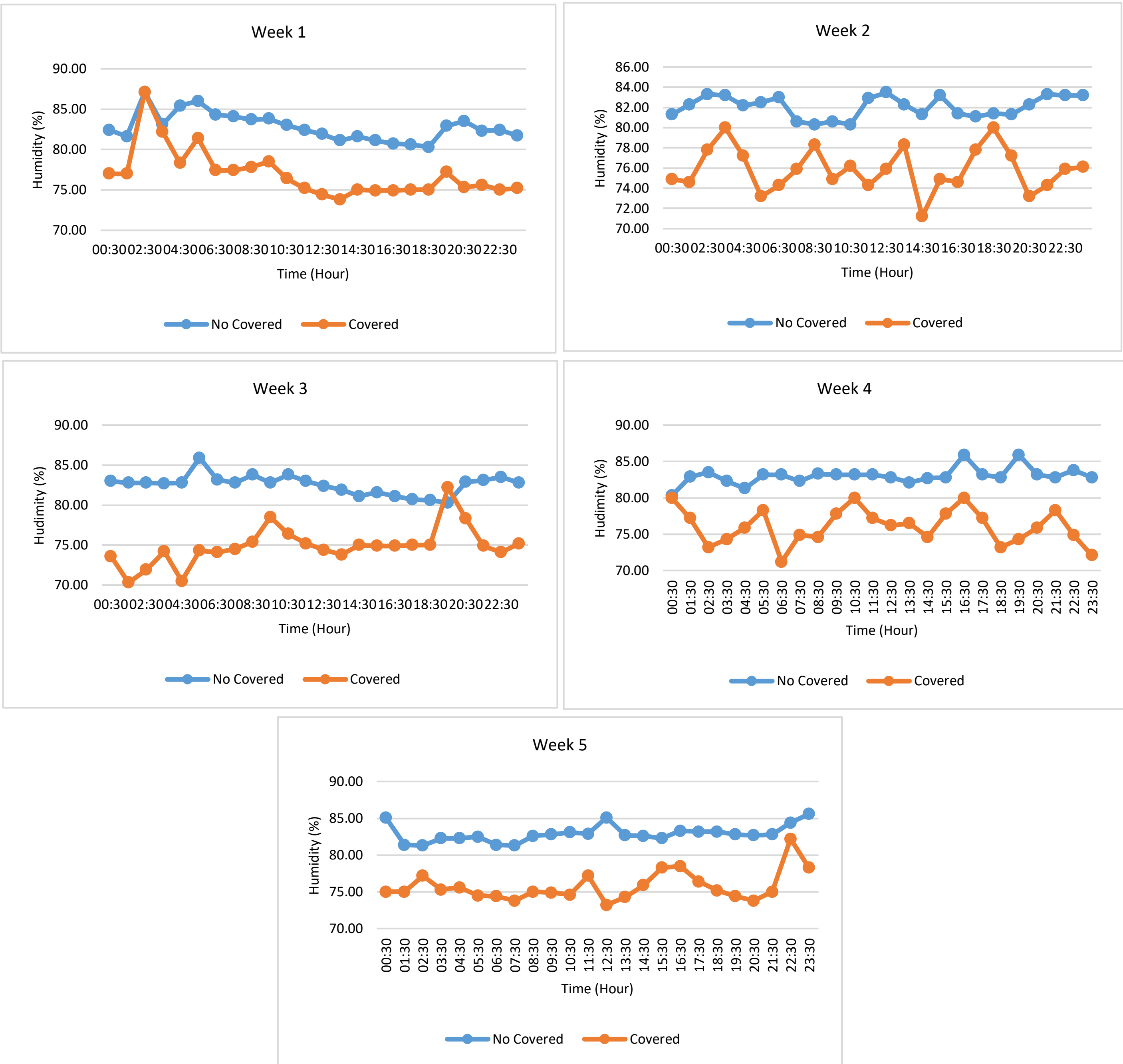

Figure 4. Variation of the relative humidity of the roof not covered and covered with the species *Pilea microphylia* in each week

EESj
Vol. 3, N° 1, 2019
Journal of Energy & Environmental Sciences
A publication of
CINCADER
Centre of Research and Training for Regional Development
Online at www.journals.cincader.org

ISSN 2523-0905

Figure 5 shows the Solar Radiation (W/m^2) of a room with a roof covered with the *Pilea microphylia* species was measured and the other room with a roof not covered with the species *Pilea microphylia*. The instrument called pyranometer was used for a period of 24 hours for 28 days in parallel in both rooms. The results that are detailed correspond to the 7th day of each week, titled as week 1 to week 5. The following figure shows that at midday, the highest solar radiation was 164.89 W/m^2 in week 5 in the room with ceiling covered with the species *Pilea microphylia* and the highest solar radiation was 742.35 W/m^2 in week 5 in the other room with roof not covered with the species *Pilea microphylia*.

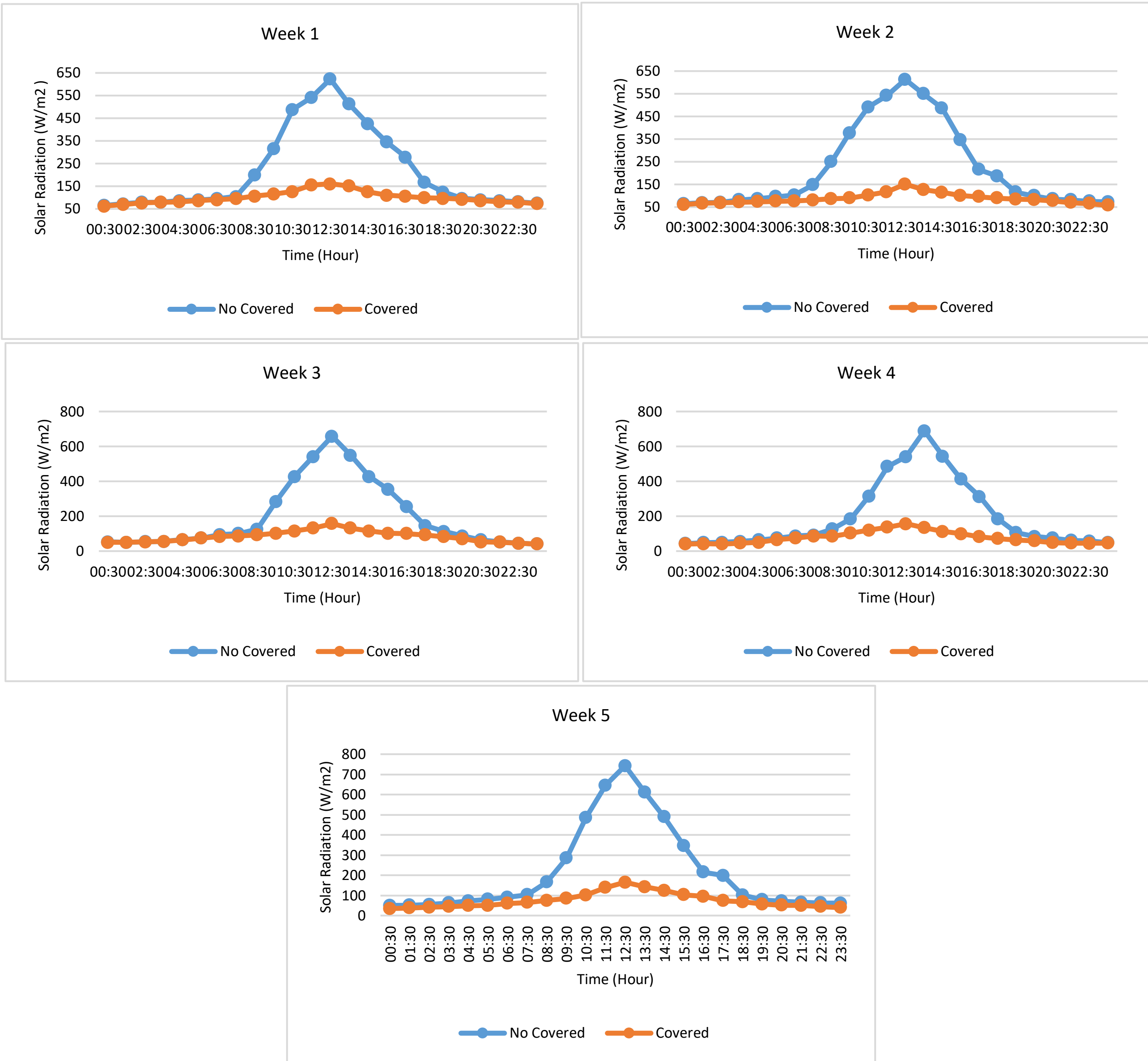

Figure 5. Variation of the solar radiation of the roof not covered and covered with the species *Pilea microphylia* in each week

EESj
Vol. 3, N° 1, 2019

Journal of Energy & Environmental Sciences

A publication of
CINCADER
Centre of Research and Training for Regional Development
Online at www.journals.cincader.org

ISSN 2523-0905

3.3. Determination of the comfort zone

Using the Humphreys-Nicol model (2016) we replace equations (1) and (2) and obtain the results in the following table:

Table 4. Determination of the comfort zone in the room with uncovered roof and covered with the species *Pilea microphylia*

Time	No Covered				Covered			
	Tm (ºC)	Tn= 13,5 ºC + 0,35 (Tm)	Zc (min) = Tn - 1,5 ºC	Zc (max) = Tn + 1,5 ºC	Tm (ºC)	Tn= 13,5 ºC + 0,35 (Tm)	Zc (min) = Tn - 1,5 ºC	Zc (max) = Tn + 1,5 ºC
Week 1	24.63	22.1205	20.6205	23.6205	21.25	20.9375	19.4375	22.4375
Week 2	24.81	22.1835	20.6835	23.6835	21.32	20.962	19.462	22.462
Week 3	24.87	22.2045	20.7045	23.7045	20.83	20.7905	19.2905	22.2905
Week 4	25.01	22.2535	20.7535	23.7535	20.45	20.6575	19.1575	22.1575
Week 5	24.94	22.229	20.729	23.729	20.07	20.5245	19.0245	22.0245
Average	24.852	22.1982	20.6982	23.6982	20.784	20.7744	19.2744	22.2744

Figure 6 shows the results of the measurement of the comfort zone in the room with a roof covered with the species *Pilea microphylia*, which is within the minimum and maximum comfort ranges, while the results obtained from the measurement of the area of comfort in the room with roof not covered, is not within the minimum and maximum comfort ranges.

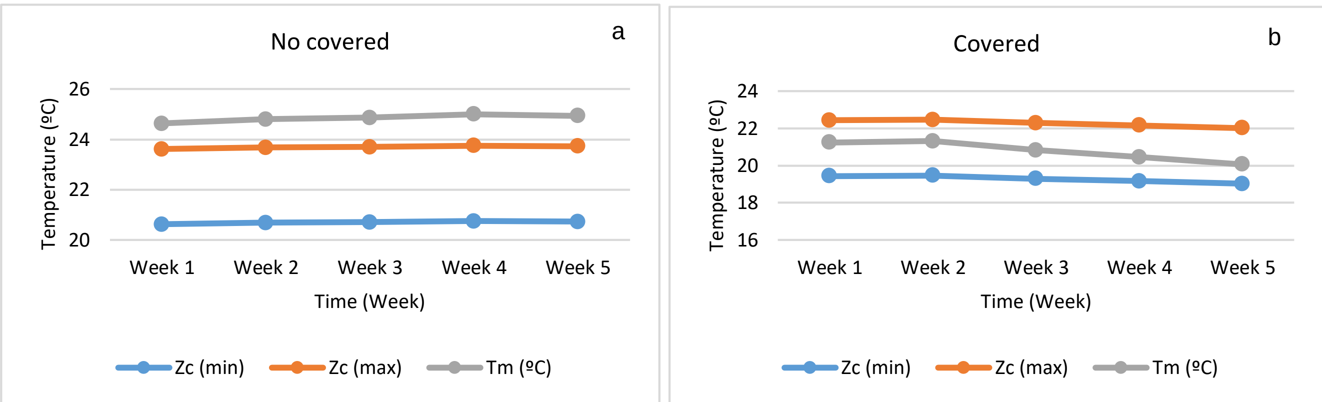

Figure 6. Comfort zone of the room: (a) with roof not covered with the species *Pilea microphylia* and (b) room with roof covered with the species *Pilea microphylia*.

EESj
Vol. 3, N° 1, 2019

Journal of Energy & Environmental Sciences

A publication of
CINCADER
Centre of Research and Training for Regional Development
Online at www.journals.cincader.org

ISSN 2523-0905

4. Conclusions

- The positive contribution results in better thermal comfort conditions of the internal spaces. With the implantation of the roof covered with the species Pilea microphylia, the average final temperature was reduced to 4.87 °C and an attenuation of the relative humidity of 7.15%, with this thermohydro-regulating technology improves the habitability conditions.
- The species Pilea microphylia adapted quickly to the conditions of the place reaching a height of 24.55 cm. contributing to improve thermal comfort. In addition, the relative humidity is controlled by the storage of water in its stems and by its large number of leaves.
- The physical characteristics of the substrate contribute to regulate thermal comfort because it is made up of fertile soil, compost and organic waste. In addition, the depth of the substrate (8cm) allowed the temperature of the substrate to be between 20 - 22 °C within the studied period, improving thermal comfort inside the room with a roof covered with the species Pilea microphylia.
- The average solar radiation in the roof covered with the species Pilea microphylia reached 75.10 W/m^2 and the average solar radiation in the roof not covered with the species Pilea microphylia reached 216.41 W/m^2, thus improving comfort thermal of the room.

References

Beltrán, A., Vargas, M., Pérez, A., García, A., & Cruz, J., 2014. Confort térmico de techos verdes con *Cissus verticillata* (Vitaceae) en viviendas rurales tropicales [Thermal comfort of green roofs with *Cissus verticillata* (Vitaceae) in tropical rural homes]. *Revista Mexicana de Ciencias Agrícolas. 9*, 1551-1560. http://www.redalyc.org/pdf/2631/263137781003.pdf

Bevilacqua, P., Mazzeo, D., Bruno, R., & Arcuri, N. 2016, Experimental investigation of the thermal performances of an extensive green roof in the Mediterranean area, *Energy and Buildings, 122*, 63-79. https://doi.org/10.1016/j.enbuild.2016.03.062

Bevilacqua, P., Coma, J., Pérez, G., Chocarro, C., Juárez, A., Solé, C., De Simone, M., & Cabeza, L. 2015, Plant cover and floristic composition effect on thermal behaviour of extensive green roofs, *Building and Environment, 92*, 305-316. https://doi.org/10.1016/j.buildenv.2015.04.026

Bhellum, B.L. & Hamid, S. 2016, *Pilea microphylla (L.) Liebm. (Urticaceae):* a naturalised taxon for the flora of Jammu and Kashmir State, India. *Curr. Trends Life Sci. 2,* 55-57. http://dx.doi.org/10.5281/zenodo.56050

Blanusa, T., Vaz, M., Fantozzi, F., Vysini, E., Li, Y., & Cameron, R. 2013, Alternatives to Sedum on green roofs: Can broad leaf perennial plants offer better 'cooling service'? *Building and Environment, 59,* 99-106. https://doi.org/10.1016/j.buildenv.2012.08.011

Duran, O., Taylor, S., & Lomas, K. 2015, The impact of refurbishment on thermal comfort in post-war office buildings, *Energy Procedia 78,* 877-882. https://doi.org/10.1016/j.egypro.2015.11.011

Forero, C., Castillo, D., & Alfonso, C. 2011, Mejora de las condiciones de habitabilidad y del cambio climático a partir de eco techos extensivos: Estudio de caso: barrio La Isla, Altos de Cazucá, Soacha, Cundinamarca [Improvement of living conditions and climate change based on extensive roof echoes: Case study: La Isla neighborhood, Altos de Cazucá, Soacha, Cundinamarca]. *Revista cuaderno de vivienda y urbanismo. 4*, 8. http://revistas.javeriana.edu.co/index.php/cvyu/article/viewFile/5578/442

Gupta, R., Gregg, M., & Williams, K. 2015, Cooling the UK housing stock post-2050s, *Build. Serv. Eng. Res. Technol. 36*, 196-220. https://doi.org/10.1177/0143624414566242

Humphreys, M. & Nicol, F. 2016, Outdoor temperature and indoor thermal comfort-raising the precision of the relationship for the 1998 database of field studies, *ASHRAE Transactions, 106*, 485-492. https://search.proquest.com/openview/2eacd513c1506a88e259382792338483/1?pq-origsite=gscholar&cbl=34619

EESj
Vol. 3, N° 1, 2019

Journal of Energy & Environmental Sciences

A publication of
CINCADER
Centre of Research and Training for Regional Development
Online at www.journals.cincader.org

ISSN 2523-0905

Isaac, M., & Van Vuuren, D.P. 2009, Modeling global residential sector energy demand for heating and air conditioning in the context of climate change, *Energ Policy, 37,* 507-521. https://doi.org/10.1016/j.enpol.2008.09.051

Kidd, J. 2015. Optimum green roof for Brisbane. BSc dissertation for the University of Brisbane, Australia.

Matos, C., Flores-Colen, I., & Coelho, A. 2015, Green roofs in Mediterranean areas - Survey and maintenance planning, *Building and Environment, 94,* 131-143. https://doi.org/10.1016/j.buildenv.2015.07.029

Monro, A.K. 2001, Synopsis of Mesoamerican Pilea (Urticaceae), including eighteen typifications and a key to the species. *Bull. Nat. Hist. Mus. London, Bot. 31,* 9-25. https://www.biodiversitylibrary.org/page/2239176#page/2/mode/1up

Nagase, A., & Dunnett, N. 2014, Drought tolerance in different vegetation types for extensive green roofs: Effects of watering and diversity. *Landscape and Urban Planning, 97*, 318-327. https://doi.org/10.1016/j.landurbplan.2010.07.005

Peck, S., Callaghan C., Kuhn M. & Bass B. 2013. Greenbacks from green roofs: Forging a new industry in Canada. Status report on benefits, barriers and opportunities for green roof and vertical garden technology diffusion. Canadá. https://www.nps.gov/tps/sustainability/greendocs/peck-sm.pdf

Pisello, A.L., Piselli, C., & Cotana, F. 2015, Thermal-physics and energy performance of an innovative green roof system: The Cool-Green Roof, *Solar Energy, 116*, 337-356. https://doi.org/10.1016/j.solener.2015.03.049

Saha, D., Marble, S.C., Stewart, C., & Chandler, A. 2017, Preemergence and Postemergence Control of Artilleryweed (Pilea microphylla) in Container Nurseries and Landscapes. *Weed Technol. 31*, 574-581. https://doi.org/10.1017/wet.2017.29

Theodoridou, I., Karteris, M., Mallinis, G., Tsiros, E., & Karteris, A. 2017, Assessing the Benefits from Retrofitting Green Roofs in Mediterranean, Using Environmental Modelling, GIS and Very High Spatial Resolution Remote Sensing Data: The Example of Thessaloniki, Greece, *Procedia Environmental Sciences, 38,* 530-537. https://doi.org/10.1016/j.proenv.2017.03.117

Van Hooff, T., Blocken, B., Timmermans, H., & Hensen, J. 2016, Analysis of the predicted effect of passive climate adaptation measures on energy demand for cooling and heating in a residential building, *Energy, 94*, 811-820. https://doi.org/10.1016/j.energy.2015.11.036

Vijayaraghavan, K. 2016, Green roofs: a critical review on the role of components, benefits, limitations and trends. *Renew Sustain Energy Rev, 57*, 740–752. https://doi.org/10.1016/j.rser.2015.12.119

Willand, N., Ridley,I., & Pears, A. 2016, Relationship of thermal performance rating, summer indoor temperatures and cooling energy use in 107 homes in Melbourne, Australia, *Energ Build. 113*, 159-168. https://doi.org/10.1016/j.enbuild.2015.12.032

Yeomans, F., Alamada, D., & Martínez, R. 2013. Evaluación de los Efectos de Techo Verde en el Nivel de Confort Térmico en Vivienda de Interés Social [Evaluation of Green Roof Effects in the Thermal Comfort Level in Social Interest Housing], Cancún: México. http://www.laccei.org/LACCEI2013-Cancun/RefereedPapers/RP298.pdf

Yovane, K.S. 2003. Reacondicionamiento bioclimático de viviendas de segunda residencia en clima mediterráneo [Bioclimatic reconditioning of second homes in Mediterranean climate] (Doctoral thesis), Universidad Politécnica de Cataluña. Barcelona, España. https://www.tdx.cat/bitstream/handle/10803/6113/01PARTE1.pdf?sequence=3&isAllowed=y