Trees with grassy areas soften summer heat

April 23 2018

One location was the Lehrer-Wirth-Strasse in Munich, where measuring instruments were attached to Robinia below the foliage. Credit: F. Rahman/ TUM

Trees cool their environment, and so-called "heat islands" like Munich benefit from it. However, the degree of cooling depends greatly on the tree species and the local conditions. In a recent study, scientists at the Technical University of Munich (TUM) compared two species of urban trees.

It is cooler under black locust trees, especially on hot summer days. This has significant implications for landscape architecture and urban planning. "Tree species such as the black locust that consume little water can provide a higher cooling effect if they are planted on grass lawns," said Dr. Mohammad Rahman from TUM. "The surrounding soil remains moister thanks to the trees, the grass dissipates additional heat through the evaporation of water and thus reduces the temperature near the ground." This is an important finding obtained by the team led by Humboldt research fellow Rahman.

A look under the treetops

Trees are considered to be nature's air conditioners, making them the most practical way of alleviating the heat in cities such as Munich. The Bavarian capital is the third-largest and the most densely populated city in Germany. It has an air temperature up to six degrees Celsius warmer than its rural surroundings. A team from the Chair for Strategic Landscape Planning and Management and the Chair of Forest Growth and Yield Science at TUM has now used combined sensor and storage devices (data loggers) to investigate how the microclimate develops below urban treetops in particular.

This was carried out on summer days with varying temperatures at different locations in Munich—close to the East Station of Munich and Messestadt Riem. With the little-leaved linden, the 2016 tree of the year, and the black locust—also known as false acacia—they selected two popular but contrasting urban tree species to analyze the complex interplay of location factors, current weather conditions, and tree type. In light of climate change, the focus was on the cooling effect on very hot days.

Black locusts need less water—and are therefore better suited for cities

The analysis becomes clearer by comparison: The output of a mechanical air conditioner is between one and 10 kilowatts (kW); that of a linden tree is up to 2.3 kW. The trees' cooling capacity is fed by various processes such as the dense treetops that provide shade and the fact that the leaf surfaces reflect the short-wave rays of the sun and also use them for transpiration.

These cooling mechanisms are common in all plants including grass. However, with bigger and denser canopies, along with higher water loss from the stomata of their leaves, linden trees use a large percentage of the intercepted radiation to vaporize water, hence cooling the surrounding micro-climate better.

However, there are several differences to the luxuriantly blooming black locust: Its crown is less dense, the leaf surface is smaller, and hence the transpiration is lower. That makes the linden tree more effective when it comes to cooling on mild summer days. However, the black locust needs less water than the linden tree, which takes more water out of the soil during the high heat, especially in combination with grassy lawns. Therefore, additional cooling from the grass surfaces under black locust

trees seems more effective. In the future, less water-demanding tree species need to be found. On the other hand, for paved surfaces, better cooling from the dense shade of linden trees are more effective.

Mohammad Rahman says, "On very hot days, city dwellers have a cooler time on grass lawns under trees with a less dense crown and a lower water requirement."

More information: Mohammad A. Rahman et al, Vertical air temperature gradients under the shade of two contrasting urban tree species during different types of summer days, *Science of The Total Environment* (2018). DOI: 10.1016/j.scitotenv.2018.03.168

Provided by Technical University Munich