There's no one-size-fits-all green roof, studies show

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Green roofs – rooftops covered with a layer of vegetation–are getting a lot of credit for providing environmental benefits. They have been found to reduce storm water runoff from buildings, conserve energy by moderating rooftop temperatures, restore fragile ecosystems and beautify urban spaces. From Toronto to New York, cities are investing billions in green infrastructure programs that rely on this kind of technology and ongoing research is helping refine its application.

Researchers are now looking at how the types of vegetation used in green roof affect their functioning. To date, many designers have used sedum–a genus of low-growing succulent plants that hold water in their leaves–to cover rooftops. Sedum, also known as stonecrop, is found

throughout the Northern Hemisphere, and has been favored for its hardiness, shallow root systems and low maintenance requirements.

However, two recent studies suggest that grasses or taller shrubs may actually be more effective than sedums at reducing storm water runoff, often a major selling point for green roofs. These studies suggest there is no one-size-fits-all green roof.

Stuart Gaffin, a climate scientist at Columbia University's Earth Institute who specializes in green roofs, says that this kind of study can help contractors and urban planners optimize green roof performance. "More research is always a good idea," he wrote in an email.

One of the studies compared different soil depths and plant types on an experimental green roof in northern Italy. Its authors found that "the use of succulent plants like sedum […] might not always represent the best choice to improve green roof technical functions."

A second study, conducted in the UK, also concluded that grasses were most effective at reducing water runoff, followed by forbs (herbaceous flowering plants like sunflowers) and, in last place, sedums.

According to Brad Rowe, a professor of horticulture at Michigan State University who did not participate in either study, these findings come as no surprise.

The more a plant transpires, releasing the water it absorbed back into the atmosphere, the more it mitigates water runoff, he explained. Sedums close their stomata (the microscopic pores on its leaves) to retain water and thus transpire very little. Even if they keep water in for a while, it is eventually released and adds to runoff.

The small size of sedums also puts them at a disadvantage compared to

taller or wider plants. “It makes sense. A plant whose biomass is up three feet rather than three inches will capture and retain more water even before it reaches the ground,” said Rowe, adding that he thought the findings in the UK studies were “spot on.”

According to Nigel Dunnett, an author of the UK study, previous research on the efficiency of green roofs had focused on their design and structural components, not on the type of plants used. Understanding the impact of vegetation type on the functioning of the system is important step for the field.

“There is a tendency in the green roof world to imply that all green roofs are the same, and deliver benefits in the same way,” he wrote in an email. By contrast, he said, his study showed that “vegetation choices can, to some extent, also influence green roof performance.”

Sergio Andri, co-author of the Italian study, also stressed that rooftop vegetation should reflect local growing conditions.

“If our aim is to build low-maintenance green roofs, we must imitate natural ecosystems,” he wrote, pointing out that sedum-type plants do not naturally grow in most parts of Italy. He believes that in temperate and Mediterranean climates, like the ones where his experiment was carried out, “the natural evolution will be to use more herbaceous plants and shrubs.”

Gaffin agrees that using local grasses can be an effective and low-maintenance way of covering a green roof. He and Columbia plant ecologist Matt Palmer have begun experimenting with such plants on New York City rooftops.

“We planted seeds from a native grassland ecosystem, the Hempstead plains [on Long Island], on the roof of a school in the Bronx, and they’re

thriving beautifully," he said. Using native plants for green roofs could have the additional benefit of restoring patches of fragile or disappearing ecosystems, he added.

But Gaffin cautioned against grass as a general trend, explaining that efficiency of green roofs depends on many things. "The type of plant used plays a role, but also the depth of the substrate used, and the structural design of the green roof," he said, pointing to a recent study by his team which showed that the use of pre-fabricated modules containing plants – favored because they are easy to install on any roof – retain storm water much less well than green roofs built from the floor up.

Neither would Gaffin write off sedum. "I like sedum. It's a very tough plant, usually a low-risk choice" for use on green roofs, he said.

As more and more cities are integrating green roofs into their planning, scientists are hard at work looking for ways to streamline the use of this technology while accounting for differing conditions and aims.

"There's water retention. There's energy. There's [the] urban heat island [effect]. There's aesthetics. When green roofs are designed to take all of these factors into account, that's when they're the most valuable," said Rowe. The problem, he said, is that it's "not always easy."

Provided by Columbia University