

Genome Insider (Mini-)Episode 6. How Microbes Can Protect Plants in Drier Straits

ALISON: Hey! I'm Alison Takemura, and this is Genome Insider, a podcast of the US Department of Energy Joint Genome Institute or JGI.

We're bringing you a short story today, and it's coinciding with the release of a Nature Reviews Microbiology paper. The paper covers all of the complex but essential ways that microbes influence the health of plants. It's co-authored by Susannah Tringe, JGI's very own Deputy for User Programs, and one of our collaborators, microbiologist Pankaj Trivedi of Colorado State University in Fort Collins, CO.

Pankaj Trivedi, who developed two small consortia of drought-associated bacteria that have been observed in field experiments to make plants more robust to drought conditions. (Courtesy of Pankaj Trivedi)

Now, let me briefly introduce Pankaj. Earlier this year, he began collaborating with JGI through the Community Science Program to study the interplay between soil microbes and boreal forests. These forests, which include birch, pine, and aspen trees, ring the northern hemisphere and serve as a globally important carbon sink. But they're sensitive to a changing climate. Pankaj is studying their soil microbes to understand what might happen to these forests.

That story is just getting started, though, so when I interviewed Pankaj, he also had another plant-microbe story to share. Today, we're going to follow that story to soils at lower latitudes, where Pankaj is trying to harness the relationships between plants and microbes for agriculture.

PANKAJ: Can we understand those interaction, and use those interactions to, to kind of have more resilience in our agriculture systems?

ALISON: Especially when those systems suffer drought.

PANKAJ: Drought is one of the big climate calamities, you can say.

ALISON: According to recent research, the US Southwest, for example, is in the grip of a 20-year mega-drought, exacerbated by the climate crisis.

PANKAJ: So if you can understand those plant microbiome feedbacks, then there's a chance that we can engineer microbiome to provide more resilience to the plant systems against drought or any other stress conditions.

One of the EDGE field sites (Hays, Kansas) testing plants against drought conditions. This is one of the sites at which Pankaj Trivedi collected bacteria for his synthetic consortia. (Courtesy of Pankaj Trivedi)

ALISON: To test that hypothesis, Pankaj turned to EDGE, E-D-G-E, which stands for the

Extreme Drought in Grasslands Experiment. This experiment is spread out across 6 different grasslands in the central US. And it's where he and scientists from institutions around the country are studying plants that they subject to drought conditions, giving them just a third of the rainfall they would normally receive.

Pankaj sought out plants that were growing particularly well, despite the conditions, and from these plants, Pankaj and his team isolated microbial communities that they thought might be helping the plants to get through the dry times.

PANKAJ: The plants have a very conserved response to drought. And they will always attract a particular microbial community, which can support them to withstand this drought condition.

ALISON: Pankaj's team found that the microbial community can help the plant adapt in myriad ways. One is by keeping more moisture around the plant's roots, where the microbes form a thick biofilm.

The structures enclosing the plots are called "rainout shelters." They allow scientists to control the amount of precipitation falling on the plants in order to simulate drought conditions. (Courtesy of Pankaj Trivedi)

The community can also influence plant hormones, which speed up flowering, allowing the plant a better chance to seed the next generation. Pankaj is hoping to keep benefits like these using just a distilled form of the microbial community.

PANKAJ: Our idea is that we can reduce the complexity of the microbial ecosystems.

ALISON: And early results suggest that they can. The team used microfluidics to isolate and culture bacterial strains associated with drought-tolerant plants. And then they used machine learning to help select optimal combinations of those bacteria. Now, Pankaj's team has two simplified bacterial communities that, in a greenhouse and a few field sites in Colorado, can prime plants to deal with drought.

PANKAJ: So next step is to understand what we have right now. Is it good enough to go to different ecosystems and perform in the same level as what we are witnessing in a particular ecosystem such as Colorado?

Maize that has been grown in drought conditions (50 percent less water) grows better with a synthetic consortium of bacteria that Pankaj Trivedi and his team assembled (right) than maize grown without the consortium (left). (Courtesy of Pankaj Trivedi)

ALISON: If the microbial communities do help plants withstand drought, they could be a boon to parched agricultural fields. That goal has been a passion of Pankaj's ever since he was a boy in a rural village in the hill state of Uttarakhand, India.

It was there that his own family lost crops due to drought. The precariousness of farming is what actually got him thinking about the health of soils.

PANKAJ: And that's what I, I always thought about like, this thing like, what is there in the soil? So why we cannot grow more? What is the plant doing to the system? And, and my grandmother will always tell me, you know what, there are many things we cannot see. And I think she had a good idea about microbiome. (Laughter)

ALISON: Clearly, a woman ahead of her time.

This episode was directed and produced by me, Alison Takemura, with editorial and technical assistance from Massie Ballon and David Gilbert. Special thanks to our guest Pankaj Trivedi for sharing his research and tales of his grandmother's prescience. Find out more about plant microbiomes in Pankaj and Susannah's review paper; we'll include a link in the show notes on our website.

If you're interested in collaborating with JGI, check out: jgi.doe.gov forward slash user dash programs.

That's it for now; see you next time!