Residues of glyphosate-based herbicides in soil found to negatively affect plant-beneficial microbes

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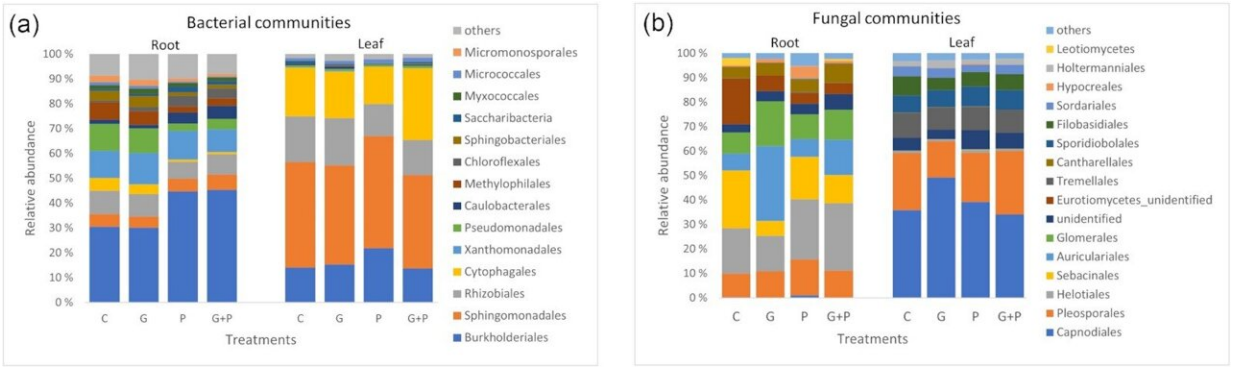

Order-level taxonomic distribution of endophytic microbial communities in the roots and leaves of garden strawberry (Fragaria × ananassa). Bacterial communities (a) and fungal communities (b) in the control (C), GBH (G), phosphate fertilizer (P), and GBH with phosphate fertilizer (G + P) treatment groups. Highly abundant orders are presented in the figure, and minor taxa are grouped together as "Others." Credit: *Journal of Applied Microbiology* (2023). DOI: 10.1093/jambio/lxad006

Researchers at the University of Turku, Finland, found that even very low levels of glyphosate-based herbicide residues have a negative effect on endophytic microbes associated with garden strawberry.

In a field study, researchers at the University of Turku, Finland,

followed the standard agricultural practices of herbicide application and investigated the impact of glyphosate residues in soil on the endophytic microbial communities of garden strawberry. The findings were published in the *Journal of Applied Microbiology*.

Samples collected from strawberry plants that had been growing in the experimental field showed that even though the overall composition of a microbial community and the growth of garden strawberries were unaffected, certain endophytic microbes known for their plant-beneficial functions were relatively less abundant in the strawberry plants that had been exposed to herbicide residues in soil.

"These plant-beneficial microbes are endophytic meaning that they live within leaves and roots of plants. They include bacteria, and fungi, and they form microbial communities within plants. These microbial communities promote nutrition, disease resistance and stress tolerance of their host plants. So, these endophytic microbes are essential partners of plants, as plants depend on them for health and survival," explains Dr. Suni Mathew from the University of Turku Department of Biology.

Glyphosate-based herbicides are used to kill weeds in agricultural fields before sowing and are claimed to degrade quickly in the soil, so that agricultural crops planted after the two-week safety period are not exposed to the chemical. However, other studies have shown that this is not the case and low residues of glyphosate are found in the soil even after two weeks.

In this study, the herbicide plots of experimental field were sprayed with the standard dose of glyphosate-based herbicide (glyphosate concentration: 450 g L^{-1}, CAS: 3864-194-0, application rate: 6.4 L ha^{-1}) and control plots with tap water. After spraying, the researchers observed the two-week long safety period before planting the strawberry plantlets.

Researchers are only starting to understand the importance of endophytic microbes to plant health

The effect of glyphosate is based on inhibition of the "shikimate pathway," a metabolic pathway for the synthesis of amino acids that is found in plants but not in animals. However, this pathway is present also in many microbes.

"It is often overlooked that the shikimate pathway is present in microbes as well. We know already that glyphosate-based herbicides and their residues can affect some free-living microbes in soil. Altogether, we are only starting to understand the importance of endophytic microbes to plant health. Thus, it is important to study whether these microbes are affected by glyphosate residues. The next question is whether the glyphosate residues that imposed changes in endophytic microbes are also affecting plant nutrition, health and disease-resistance, among other things," says Dr. Mathew.

The study also utilized a new bioinformatics approach for finding whether the changes in microbial communities are linked to their sensitivity to glyphosate. The results showed that the microbial community in the roots of the plants in the herbicide plots had more potentially glyphosate-resistant bacteria than the roots of the plants in the control plots. This shift in bacterial community favoring potentially glyphosate-resistant bacteria could cause a decline in microbial diversity.

"Our study shows how even very low residues of agrochemicals can affect plant-associated microbes. Changes in the abundance of certain plant-beneficial endophytic microbes and the dominance of potentially glyphosate resistant bacteria can be concerning if they have consequences on plant health in the long run," says Dr. Mathew.

More information: Suni Anie Mathew et al, Glyphosate-based herbicide use affects individual microbial taxa in strawberry endosphere but not the microbial community composition, *Journal of Applied Microbiology* (2023). DOI: 10.1093/jambio/lxad006

Provided by University of Turku