

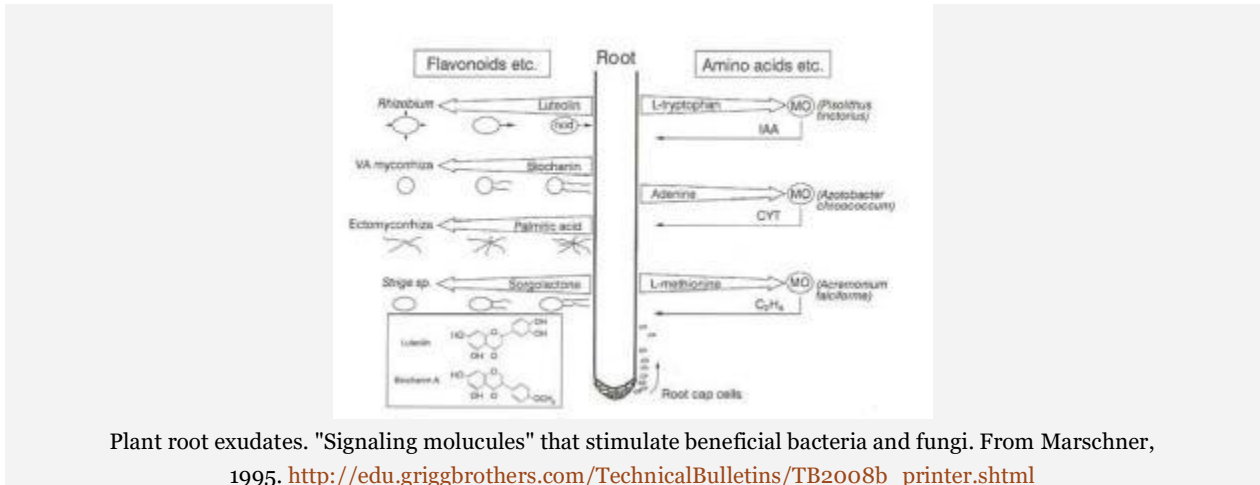
Acids and Exudates: Plant Diversity Improves Soil

Posted by Kelly in [cover crop cocktail](#), [cover crops](#), [Dr. Jill Clapperton](#), [microbes](#), [soil](#), [soil biology](#), [soil ecology](#). **2 comments**

The more I learn about farming, the more I realize that plants are truly wondrous living things. It's easy to think plants are boring and passive. After all, they just sit there. But here's some news! Plants are powerful chemists and VERY active participators in their environment. For our farm, we now see plant properties and behaviors as a tool for rejuvenating our dead soil. This post explains what we've learned so far and how we plan to implement our new plant knowledge.

Plants Leak Yummy Exudates

At the 2011 Acres USA conference, we learned a lot about what plants do below ground. We learned that plants make a lot of sugars and other compounds from photosynthesis, and instead of using them all for energy, they leak a lot of them from their roots to attract and stimulate soil microbes. These compounds are called "root exudates".



Plant root exudates. "Signaling molecules" that stimulate beneficial bacteria and fungi. From Marschner, 1995. http://edu.griggbrothers.com/TechnicalBulletins/TB2008b_printer.shtml

We learned even more about root exudates from Jill Clapperton. She said that every plant variety leaks its own signature of chemicals in the form of amino acids, carbon, and organic acids to attract the beneficial soil microbes it needs to live and thrive. She said that plants modify their environment and build their own microbial community in the soil. Plants MODIFY their environment and build their own community? This was news to us, and we thought it was really cool!

She went on to say that plants leak a LOT of chemicals. These chemical compounds are signs of welcome and warning. Most of the compounds are welcome chemicals that attract a very beneficial and helpful bacteria and fungi community that like the plant and promote its growth. Plants also leak warning compounds to keep themselves safe from soil herbivores and other threats.

Exudates Can Improve Soil

Then Clapperton started talking about how farmers and gardeners can take advantage of plant properties to improve soil and grow food that's very nutritious. She encouraged the audience to fill the soil profile with different plants that have shallow, medium, and deep roots. Filling the soil with many diverse plant roots will take advantage of the fact that all plants leak different compounds that will stimulate different segments of soil's beneficial biology.

Our soil has a long way to go before it is truly fertile with a fully restored biology. We need a diverse soil biology community, so we were very interested in what she said about advantages of different plant categories:



Cowpeas (black-eyed peas), one of the best legumes for building soil.

LEGUMES such as peas, beans, clover, and alfalfa leak exudates that attract both Rhizobium bacteria and mycorrhizae fungi. Both of these are huge plant growth promoters. Rhizobium fixes nitrogen from the air in return for sugary exudates. Mycorrhizae are amazing symbiotic fungi that work wonders for the soil. They go for maximum carbon exudates from the plant. To get what they want, they boost the plant's photosynthesis by conferring drought resistance and bringing phosphorus, copper, zinc, manganese and other ions and amino acids to the plant. By making the plant healthier, they get even more carbonaceous exudates from their host. Mycorrhizae turn a lot of it into glomalin, a significant carbon component in the soil that helps glue soil particles together and form wonderful aggregates that let more air and water percolate through the soil. Legumes are clearly a win-win-win for soil.



Sorghum, a warm season grass

- CORN and WARM-SEASON GRASSES and Broadleaves such as SUNFLOWERS leak massive amounts of exudates. They are trying to attract a large, diverse microbe community for protection and growth promotion, including lots of mycorrhizae (myco). So this plant category can also stimulate lots of soil biology and sequester quite a bit of carbon via myco.
- BRASSICAS such as mustards, radishes, broccoli, kale, etc. are different. They do not associate with



Mustard, a great brassica for improving soil.

myco. Instead, they leak some rather harsh acids. They don't need myco to go get soil minerals because they can use acids to get it for themselves. Brassicas' acid exudates can cleave off calcium that is tightly bound to phosphorus in the soil. The brassica plant then soaks the phosphorus right up. That's why planting brassicas is a good method for "mineralizing" tightly bound phosphorus and making it available for the next plants that grow as the brassica decomposes. Brassicas also stimulate the middle of the soil food web, arguably the most important part – the mites, earthworms, and other recyclers that prey on bacteria and fungi to keep them in a healthy balance. Clapperton said she found through multiple studies that for some reason, brassicas make earthworms and other soil animals go really nuts in a good way. So brassicas are key for mineralizing hard to get soil minerals and for stimulating the very important soil animals.



- **DEEP ROOTERS** such as **ALFALFA** and **SWEET CLOVER** can bring up fertilizers from long ago that have leached deep into the soil profile. The long roots also make channels for earthworms and other beneficial biology to travel. The channels provide for better air and water percolation which fights compaction and improves soil structure.
- **POLLINATORS** like **PHACELIA** and other **FLOWERS** have nice, fine roots with lots of fungi. As pollinators, they can attract more above-ground diversity to our farm.

Our Plan

We probably won't get livestock this year, so we're going to take advantage of our prolonged delay to improve the soil by growing a big cover crop cocktail. We've ordered the seed mix that includes several varieties from each category mentioned above.



Phacelia tanacetifolia, a native pollinator that also helps rejuvenate soil. And it's pretty!

Our neighbor's 20 acres has a rye and vetch cover crop growing like crazy right now. We'll mow when it flowers to kill it, then drill (plant) the cover crop seed. Our own 20 acres are in perennial grasses (planted fall 2008). We'll lightly rotovate them to kill, then drill in the cover crop. We're really excited to see how the cocktail grows. With the big diversity of plants and flowers, I'm hoping it will be super pretty. As late summer nears, we hope to see more wildlife and insects and good water retention. And as all the different plants stimulate all parts of soil life, we should see our subsequent crops growing much better. Thanks for reading!