Happy Feet? Look below ground to see why your walnuts are dancing or distressed

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Walking across a walnut plantation, you may observe that trees in one area may be growing more vigorously than trees elsewhere. This was the case at Boone Creek Farms in Licking, Missouri, one of the field trip sites for the Missouri Woodland Owner's & Walnut Council's Conference this past October. Their walnut grove is planted along Boone Creek and extends from the floodplain to the footslopes of the surrounding hills. Walnuts on the footslope were taller and larger than those planted along the floodplain. The question arises: why are trees succeeding in one area while the others are struggling? The answer lies in the soil.

Soil tests from laboratories are great for understanding nutrient supply and possible deficiencies to equip you with information to help your walnut trees and keep them happy. Before you plant walnuts, or any crop, it is advisable to get a soil test to find out the chemical properties of your surface soil. However, doing an in-field inspection of your soil is also a great tool to answer the essential question of how well your soil's characteristics will support walnut growth in terms of soil physical properties. This involves considering your soil as an entire profile, past the six to eight inches of the surface that usually get sampled for lab analysis. Observing a soil's characteristics and its location on the landscape can clue you in to its suitability for walnuts.

Soils have layers, called horizons by soil scientists. Each layer is separated by differences in morphology, like changes in sand percentage, clay percentage, color, structure, and other unique features. These characteristics, along with the soil's position on a landscape, affect water habits on the site. A clayey soil will hold water for a long period of time, but water will drain very quickly through a sandy soil. A goldilocks loamy soil (a texture with significant amounts all three particle sizes: sand, silt, and clay) will typically have good drainage while also having a good

capacity to hold water. Landscape position is also important to note. Positions lower on a hill, like footslopes, will receive water coming down by gravity from the hill upslope. Floodplains receive water from upslope and through the water channel running through them, especially during flooding events.

Doug Wallace, former USDA Natural Resources Conservation Service (NRCS) State Forester, analyzed published results from studies carried out by forestry and soil scientists, Wayne Geyer and Felix Ponder, who worked together on developing a walnut site index and then modelled their results to create the soil suitability index. Specific soil characteristics were identified to be ideal for supporting vigorous black walnuts in Missouri. Walnuts prefer to grow in very deep, well-drained soils with high available water capacity. This means that the soil doesn't have a root restricting layer (like bedrock, a claypan, or a fragipan within 60 inches of the surface), and that the soil will allow water to drain fast enough to not oversaturate the soil but slow enough to give the walnuts time to use it (this is the case with loamy soils!). Walnuts like to have abundant water available, but don't want to be drowned in it. When water sits in soil for a long period of time, all the oxygen gets used up, creating an anaerobic environment. This can be stressful for trees not adapted to environments with frequent saturation and flooding. Walnuts do like to grow in floodplain sites, so long as they are well-drained and only briefly flooded (maximum of seven days a year).

To find out the story of the Boone Creek soils, I worked with NRCS soil scientists Lindsey Anderson, Gene Campbell, and JR Perkins. Using a Giddings hydraulic probe to extract soil cores, we sampled the footslope and the floodplain. After describing each core, we saw noticeable morphological differences. The footslope soil was deep, with loamy soils in each horizon, to a depth of 42 inches (as far as the probe could sample with the dry soil conditions this fall!). In contrast, the floodplain soil had a loamy sand surface to 12 inches that turned into pure sand for the rest of the core. Mystery solved: the floodplain soil can't hold enough water for the walnuts to use! Sands are excessively well drained, so despite receiving water from higher positions on the landscape and the nearby creek, the

floodplain has a lower available water capacity than the walnuts need to thrive. The loamy soils on the footslope receive water from upslope and can soak it up and hold it long enough to satisfy the walnuts.

There are several useful resources you can use to get acquainted with your soil. Web Soil Survey, created by the NRCS, is a database of soil information. You can explore your area of interest to discover important features of the soils mapped for walnut growth, like depth to root restricting layer, drainage class, pH, available water capacity, rock percentages, historic vegetation, and more. Under the Soil Data Explorer tab, you can navigate to Suitabilities and Limitations for Use, then Vegetative Productivity tab to find Wallace's **Black Walnut Suitability Index**, developed specifically for Missouri. This index considers multiple soil components affecting walnut tree success and weighs them out to generate an all-encompassing walnut suitability rating for each soil map unit. If you have difficulty finding this information or have questions about your soils, reach out to your county's local NRCS office using the NRCS Service Center Locator.

The Web Soil Survey is a very powerful tool, but it was created for general land use planning and was not meant to replace on-site soil evaluations. The soil survey was created at a coarser scale than your individual farms, so there will be local soil variation you will observe at a smaller scale when you're walking around your farm. So, to get to know your soils even better, grab a shovel and dig around! Observe the soil horizons changing in color and texture, note where you have clayey and sandy soils, color changes, water interactions, location on the landscape, and the vegetation it supports. Soil is the foundation for life. Knowing your soil will enhance the stewardship of your walnut trees, forests, and ecosystems.

The SoilWeb App simplifies the process of querying and exploring soil data at your site.



Above: Sandy floodplain soil



Above: Loamy footslope soil



Sarah Higgins with Lindsey Anderson, USDA-NRCS, Soil Scientist



Sarah Higgins using a Munsell color chart to describe this soil core.