Evaluating Soil-Water Retention with Pressure Plate Analysis: 2024-2025

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To better understand the relationship between soil characteristics, soil health, and the dynamics of water in soil, ONFARM recently added a new layer of analysis (pressure plate analysis) to the suite of soil monitoring for several sites. The first dataset from pressure plate analysis was completed by the Biswas Soil Lab at the University of Guelph in 2024, on intact soil cores collected by the Soil Resource Group (SRG). Soil cores (pictured in Figures 1 and 2) were collected after crop harvest in November 2023 from four sites and from an additional three sites in November 2024 (to be analyzed in 2025).

Figure 1. Photograph of soil core collection

In 2023, sites included:

- One Soil Health BMP Trial - Site 7. Located in Brant County, this trial compares the impact of cover crops across two neighbouring fields with a control and treatment strip in each.
- A paired set of Edge-of-Field sites, Merlin A and Merlin B (also referred to as EF2 and EF3, respectively). A single set of soil samples were taken from each of the neighbouring sites – Merlin A serves as a control implementing conventional tillage, compared to the adjacent Merlin B site using cover crops and implementing no-till practices.
- A third Edge-of-Field site, Gully (also referred to as EF6), where the effect of growing cover crops is compared between a harvested and unharvested section.

Sites sampled in 2024 (to be analyzed in 2025) include:

- Two Soil Health BMP trials, Sites 3 and 20, both using combinations of cover crops and organic amendments (biosolids, biopellets, and compost).
- One Edge-of-Field monitoring site, North Kettle, implementing cover crops.

Intact soil cores were collected from benchmark sampling positions established by SRG in 2020, to align with other regular soil sampling and agronomic monitoring. Samples were taken in triplicate from two depths representing the surface soils (0-15 cm) and a shallow depth (15-30 cm). Each treatment strip includes three benchmark locations chosen at different landscape positions along a hillslope to be representative of lower, mid, and upper slope positions.

Figure 2. Photograph of soil cores prepared for analysis in the low pressure system.

To determine each sample's water retention, cores were weighed, saturated with water, and then repeatedly subjected to greater amounts of pressure ranging from 33 millibar to 15 bar. Soil cores were weighed at each interval to determine the volume of water extruded, allowing the permanent wilting point, field capacity, and plant available water content to be calculated. Cores were dried after this determination to calculate soil bulk density.

The permanent wilting point is the level of water held in soil that a plant requires to prevent wilting from water stress. Below this level, water is held too tightly in soil pores such that plants cannot access it. Field capacity is the maximum amount of water that a soil can retain. The difference between field capacity and permanent wilting point is the volume of plant available water.

Comparing the values across all samples, there was a strong positive correlation between field capacity and permanent wilting point (Figure 3). As such, it is clear that increasing field capacity in a soil would not lead to a one-to-one increase in plant available water, as an expected increase in permanent wilting point would limit those gains. However, the benchmarks areas with the greatest field capacity generally still had the greatest plant available water levels.

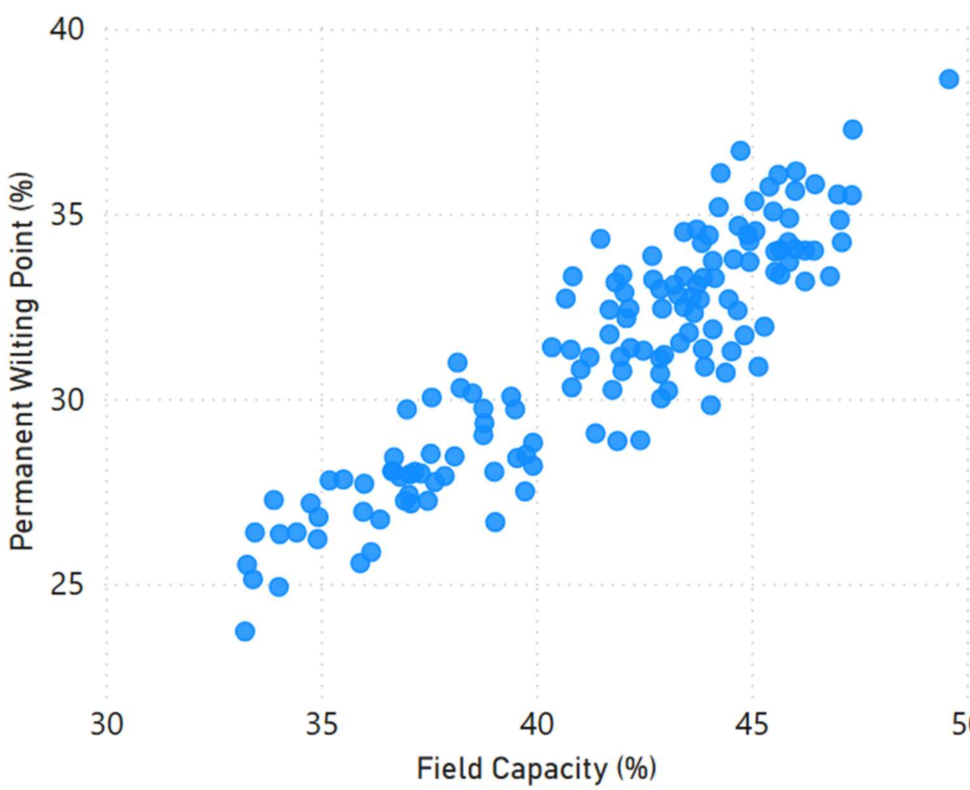

Figure 3. Values of measured permanent wilting point and field capacity from all samples taken from all sites.

There was also a weaker, negative relationship observed between soil bulk density and plant available water (Figure 4). This relationship is expected, as typically lower bulk densities occur in clay-based soils with smaller pore spaces holding water compared to higher bulk densities in sandy soils that offer better water drainage. However, the relationship shows that bulk density alone is insufficient to predict a soil's water holding capacity. For example, at a bulk density of 1.52 g/cm^3, the measured plant available water ranged from 7.5-13.2%. However, other soil health indicators collected through ONFARM monitoring, such as soil organic matter, active carbon, and wet aggregate stability, showed poor to no correlation with plant available water.

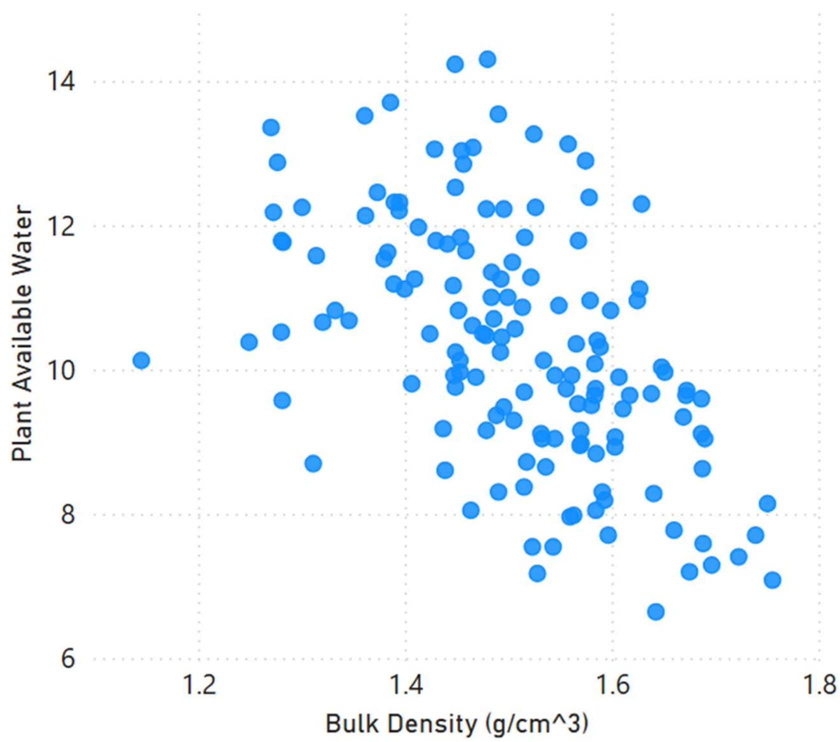

Figure 4. Values of measured plant available water levels vs soil bulk density from all samples taken from all sites.

Plant available water levels ranged from 6.64-14.30% across all samples, while site averages ranged from 8.80% at Gully to 11.02% at Site 7. There was a consistent relationship between soil depth across all sites; samples taken from surface soils held approximately 1% more plant available water on average than soils at the lower depth (Figure 5). Soil bulk density was greater in the lower depth samples, on average a 0.1 g/cm^3 difference at Site 7 and the two Merlin sites. However, sample depth did not affect the bulk density at the Gully site, which differed by only 0.01 g/cm^3 on average.

There was generally less than a 1% difference in average plant available water measurements taken from samples in different treatment strips within each site, suggesting BMPs implemented up to the 2023 sampling date had little impact. Analysis of repeat measurements taken after a further three years of study will be completed to measure any potential impact of these BMPs on water holding capacity and plant available water levels.

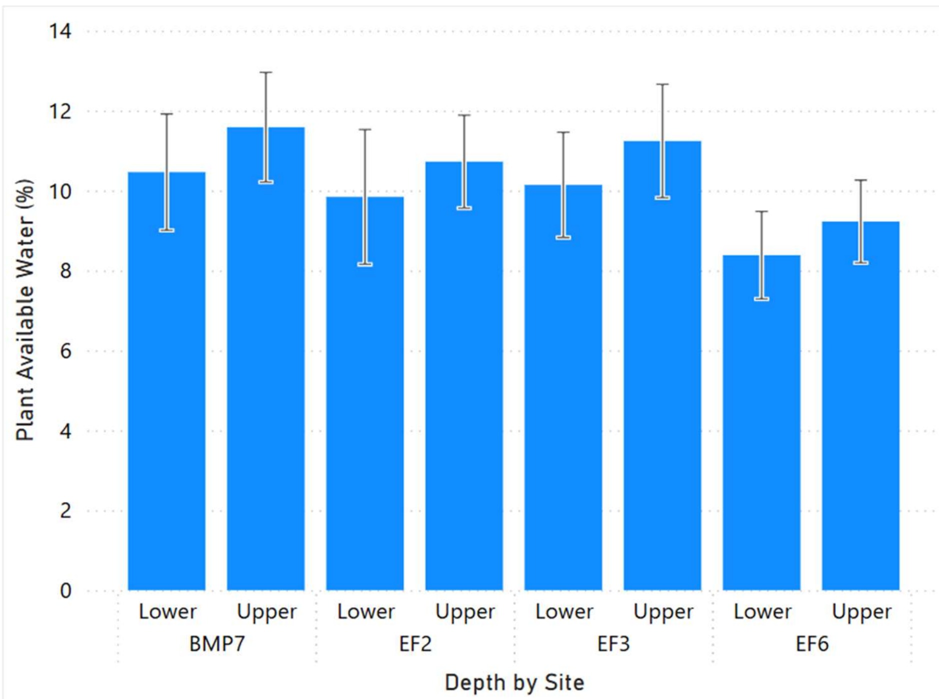

Figure 5. Average and standard deviation of plant available water by soil sampling depth for Site 7 (BMP7), Merlin A(EF2), Merlin B (EF3), and Gully (EF6).

Additionally, new sites sampled in 2024 will provide broader insight into the impact of soil texture on plant available water. All sites sampled in 2023 were predominantly clay, clay loam, and silty clay loam, whereas additional sites will include loam and sandy textured soils.

In the future, plant available water and field capacity measurements taken from ONFARM edge-of-field sites will be used to help characterize field and weather conditions that result in runoff and nutrient export into surface waters. To stay up-to-date on ONFARM activities, and to view other reports on the soil health and water quality research, please visit the ONFARM Web Page.