Dear ,

You were a collaborator in a study of soil biology on blueberry farms. A major aim of the study was to describe how blueberry soils under organic management differ from those managed by conventional practices. We sampled eight pairs of organic and conventional blueberry fields that were matched by USDA-NRCS soil series, and as closely as possible, by blueberry cultivar and field age. Samples were collected in late September or early October of 2008, July, August, and October of 2009, and June of 2010. Prior to organic transition, all organic fields surveyed were managed conventionally, i.e., with synthetic fertilizer and pesticide inputs. The organic fields were certified by a Michigan Department of Agriculture-accredited agency and managed according to USDA organic standards for 4 to 25 years prior to our study.

The following pages are data collected from your blueberry field. Results are grouped into four categories: soil carbon, soil nitrogen, soil enzymes, and soil microbes. Measurements from your field are shown alongside the average from twelve blueberry fields on sandy soils (denoted as “MI Average” in the figures below). Because muck soils had average values 2- to 10-times greater than those in sandy soils, muck soils were excluded from the averages. The results are shown at two soil depths, 0-2 and 0-12 inches, except mycorrhizal colonization (roots collected at 0-12 inches) and nematode populations (0-2 inch soil depth and blueberry roots, assessed separately). The error bars represent the spread of data from approximately two-thirds of Michigan fields; values from your field falling outside the error bars can be considered as a deviation from the “typical” blueberry field in Michigan. The report concludes with a brief discussion of the results.

We hope this report is useful to you. I can be reached by email, sadowsky@msu.edu, to answer any questions you might have. Thank you kindly for participating in the study.

Sincerely,

Jesse Sadowsky

M.S. Plant Pathology 2010

*(Reviewed by Eric Hanson, professor of horticulture,* *hansone@msu.edu**, and Annemiek Schilder, professor of plant pathology,* *schilder@msu.edu**,)*

**Soil carbon**

**Total soil organic matter** –consists of all non-mineral matter in soil *(measured on 9-Oct-2009)*.

**Light fraction soil organic matter (LF-SOM)** – consists mainly of partly decomposed fragments of plant debris and turns over more rapidly (within a few years) than total soil organic matter. Its density is less than 1.7 g/cm3 *(measured on 25-Sept-2008)*.

**Labile soil carbon** – this organic matter pool constitutes readily available carbon that is a major source of energy for soil microbes. It was modelled as the exponential decay of CO2 production over a 462-day laboratory soil incubation *(measured on 25-Sept-2008)*.

**Slow + recalcitrant soil carbon** – consists mainly of organic matter that that is not broken down easily by microbes and contributes little to overall microbial activity. It was assessed as the steady rate of soil respiration after the labile pool of soil carbon has been consumed during a 462-day laboratory incubation *(measured on 25-Sept-2008)*.

**Soil carbon, cont’d**

**Soil respiration** – represents carbon that is immediately available to soil microbes. It was assessed as the rate of CO2 release from soil over the first 30 days of a laboratory incubation. *(measured on three dates in 2009)*.

**Soil nitrogen**

**Ammonium-N** –is a preferred nitrogen source of blueberries and less prone to leaching and runoff than nitrate *(measured on three dates in 2009)*.

**Nitrate-N** –is less desirable than ammonium because it is not utilized efficiently by blueberries and more prone to soil leaching and runoff *(measured on three dates in 2009)*.

**Mineral N (nitrate + ammonium)** – indicates soil nitrogen availablility *(measured on three dates in 2009)*.

**Potentially mineralizable nitrogen** –assesses the short-term capacity of soil microbes to release nitrogen from organic matter. It was measured as the accumulation of inorganic nitrogen over a 30-day laboratory soil incubation *(measured on three dates in 2009)*.

**Soil enzyme activity**

**Beta-glucosidase (BG)** – releases glucose from cellobiose, the final step in cellulose decomposition. Microbes secrete BG from their cells to obtain energy (glucose) from organic matter *(measured on three dates in 2009)*.

**Cellobiosidase (CBH)** – releases cellobiose from cellulose polymers, an intermediary step in the breakdown of cellulose, which may be further decomposed to glucose to be used as an energy source by microbes. CBH activity is related to the turnover of plant debris in soil, including leaves, fine roots and mulches *(measured on three dates in 2009)*.

**N-acetyl-glucosaminidase (NAG)** – releases N-acetylglucosamine from cell walls of dead fungi, bacteria, and other soil organisms, which may then be taken up by living microbes or broken down further and taken up by plant roots as a source of nitrogen *(measured on three dates in 2009)*.

**Acid phosphatase (PHOS)** – releases phosphate from various forms of organic matter, including plant detritus, phospholipids in microbial cell walls, and nucleic acids, that can be taken up as a source of phosphorus by microbes or plant roots *(measured on three dates in 2009)*.

**Soil enzyme activity, cont’d**

**Tyrosine aminopeptidase (TAP)** – releases amino acids from peptides and proteins that make up about half of the total nitrogen content of soil. Amino acids released by TAP are taken up by microbes or degraded further and taken up by plant roots as a source of nitrogen *(measured on three dates in 2009)*.

**Peroxidase (PER)** – contributes to transformation and breakdown of structural polymers in plant debris, such as lignin, and complex forms of soil organic matter, such as humus *(measured on three dates in 2009)*.

**Phenol oxidase (POX)** – contributes to transformation and breakdown of structural polymers in plant debris, such as lignin, and complex forms of soil organic matter, such as humus *(measured on three dates in 2009)*.

**Soil microbes**

**Ericoid mycorrhizae** – are fungus-root associations found in the outside cell layer of hair roots of blueberries. Ericoid mycorrhizae aid in plant uptake of nitrate and organic nitrogen from soil. Mycorrhizal colonization was assessed on roots collected at 0- to 30-cm soil depth in fall 2008 and three dates in 2009.

**Soil bacteria** – feed on organic matter in soil. They were assessed by counting the number of bacteria that grew from soil added to culture media *(assessed 25-Sept-2008 and 9-Oct-2009)*.

**Soil fungi** – feed on organic matter in soil. They were assessed by counting the number of fungi that grew from soil added to culture media *(assessed 25-Sept-2008 and 9-Oct-2009)*.

**Soil microbes,**  **cont’d**

**Non-plant-parasitic nematodes** **in soil** – are “beneficial” because they consume other microorganisms and in the process release nitrogen and other nutrients. *(assessed by Michigan State University Diagnostic Services on 6-Jun-2010 at 0- to 2-inch soil depth).*

**Plant-parasitic nematodes in soil** – include lesion, sheath, ring, and spiral nematodes. They only feed on living roots of blueberries and other plants *(assessed by Michigan State University Diagnostic Services on 6-Jun-2010 at 0- to 2-inch soil depth).*

**Summary/Discussion**

Across sampling dates, nitrogen availability at 0-12-inch soil depth in your field was similar to the average for the fields we sampled. Nitrogen availability was slightly lower than average in the upper two inches of your soil in July, possibly due to temporary nitrogen immobilization in wood mulch.

Soil biological activity in your field was in general high and on par with many organic fields. Potentially mineralizable nitrogen and soil respiration rates were closely related, suggesting microbial activity is associated with nitrogen release in your soil. Enzymes involved in cellulose breakdown and nitrogen and phosphorus mobilization were higher than the average Michigan blueberry soil. The deep layer of wood mulch likely contributes to soil health in your field.

Microbial populations in your soil include higher than average fungal counts but lower than average bacterial counts. Fungi have threadlike hyphae which allow for movement of nutrients between nutrient-rich and nutrient-poor substrates within soil microhabitats, while unicellular bacteria do not have this ability. Fungi may be better-equipped than bacteria to degrade coarse, high C:N materials such as wood chips, and wood mulch probably increased the ratio of fungi to bacteria in your soil relative to the average of the fields we sampled.

Nematodes thrive in very moist soils, and soil moisture near the soil surface was generally low compared to other blueberry fields we sampled. Subsurface drip irrigation in your field is may thus explain a lower than average count of beneficial, non-plant-parasitic nematodes in the upper 2 inches of your soil compared to the average field. No pathogenic nematodes were found in a sample of blueberry roots we submitted to the MSU diagnostic clinic, meaning there is low risk posed by root-feeding nematodes in your field.